A paper prepared for the

Un document préparé pour le

Economic Council of Canada

Conseil économique du Canada

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DISCUSSION PAPER NO. 357

U.S.-Canada Productivity Gap, Scale Economies, and the Gains from Freer Trade

by

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ISSN-0225-8013

September 1988

RÉSUMÉ

Cette étude porte sur deux points particuliers du débat sur le projet de libre-échange canado-américain : l'écart de productivité entre les industries manufacturières au Canada et aux États-Unis et l'effet des économies d'échelle sur cet écart. Nous essayons de répondre, entre autres, aux questions qui suivent. Existe-t-il un écart de productivité global entre le Canada et les États-Unis? Dans quelle mesure cet écart de productivité global est-il attribuable à la faiblesse de la productivité dans les industries manufacturières au Canada? Quels facteurs peuvent expliquer le fait surprenant que l'écart de productivité dans le secteur manufacturier non seulement n'a pas diminué depuis 1970, mais s'est aggravé récemment? Quelle est l'importance des économies de taille industrielle pour le secteur manufacturier au Canada? Est-ce que la rationalisation et la spécialisation permettraient aux industries manufacturières canadiennes d'accroître leur productivité d'une façon notable?

Les principales conclusions de cette étude sont les suivantes :

- Au Canada, en 1986, le revenu par habitant et la productivité globale étaient de 10 % moins élevé qu'aux États-Unis;

- contrairement à l'écart de productivité global entre la main-d'oeuvre canadienne et américaine, l'écart de productivité des industries manufacturières des deux pays est demeuré plus ou moins stable, à environ 18 % au cours de la période 1970-1980. En outre, étant donné que la productivité dans le domaine de la fabrication a augmenté plus rapidement aux États-Unis qu'au Canada, l'écart de productivité dans ce secteur est passé de 18 % en 1980 à environ 25 % en 1987, une situation semblable à celle qui a régné en 1965;

- l'écart de productivité dans le domaine de la fabrication représentait environ 20 % de l'écart de productivité global en 1965, mais plus de 55 % en 1987, de sorte qu'il apparaît maintenant essentiel, si on veut rapprocher davantage les revenus réels du Canada et des États-Unis, de réduire l'écart de productivité des industries manufacturières;

- les résultats d'une analyse de régression indiquent que l'élargissement récent (1980-1986) de l'écart de productivité dans le secteur manufacturier a été causé avant tout par deux facteurs interdépendants : d'abord, l'accroissement de la productivité des industries manufacturières américaines suite aux efforts de

rationalisation déclenchés par l'évolution du taux de change, et ensuite, les effets positifs d'une diminution marquée de l'écart entre le salaire réel et la productivité sur la production et la productivité du secteur manufacturier aux États-Unis. L'augmentation considérable du prix réel du pétrole, la forte dépréciation du dollar canadien et la réduction de l'écart entre le salaire réel et la productivité dans les manufactures américaines expliquent l'invariance de l'écart de productivité entre le Canada et les États-Unis durant la période de 1970 à 1980;

- une analyse des coefficients de taille estimés pour vingt industries manufacturières représentées par des codes de deux chiffres indique des rendements d'échelle légèrement croissants; ceci nous permet de croire qu'un élargissement de la taille du secteur manufacturier au Canada n'apporterait qu'une légère augmentation de la productivité;

- toutefois, le secteur manufacturier au Canada comprend un grand nombre (plus de 70 %) d'usines petites et inefficaces dont les coûts unitaires sont supérieurs à la moyenne. Par conséquent, le libre-échange entre le Canada et les États-Unis, en stimulant la concurrence et la rationalisation essentielle des manufactures, pourrait accroître la productivité totale des facteurs de production d'environ 4 % dans ce secteur. Ces seuls gains pourraient contribuer à une hausse de 2 % dans le revenu réel au Canada.

Le libre-échange aurait divers autres effets notables sur la productivité et le niveau de vie des Canadiens : accélération de la réaffectation des ressources utilisées par les industries en déclin aux industries croissantes, adoption plus rapide des nouvelles technologies, accroissement de la concurrence et amélioration du fonctionnement des marchés. Ainsi, les augmentations dynamiques d'efficacité qui découleraient du libre-échange, quoique difficiles à quantifier, pourraient s'avérer plus importantes que les gains procurés par les économies d'échelle. À longue échéance, le libre-échange pourrait donc entraîner d'importants accroissements nets de la production et du revenu réel.

ABSTRACT

The paper is concerned with two specific aspects of the Canada-United States free trade debate: the size of U.S.-Canada manufacturing productivity gap and the role of scale economies in explaining this gap. The following are some of the important questions the paper attempts to answer. Is there an aggregate productivity gap between the U.S. and Canada? How much of the aggregate productivity gap can be attributed to the poor performance of Canadian manufacturing productivity? What factors could account for the puzzling result of no improvement in the manufacturing productivity gap since 1970, especially the recent deterioration? How important are the industry size economies to Canadian manufacturing sector? Is there room for a significant improvement in Canadian manufacturing productivity from rationalization and specialization?

The important findings of this paper are:

- In 1986, Canadian per capita income and aggregate labour productivity levels were about 10 per cent below their United States counterparts;

- In contrast to the good performance of aggregate labour productivity gap, the Canadian manufacturing productivity gap remained more or less stable around 18 per cent over the period 1970-80. Moreover, because of faster growth in U.S. manufacturing productivity, the manufacturing productivity gap has increased from 18 per cent in 1980 to about 25 per cent in 1987, very similar to the situation that prevailed back in 1965;

- The contribution of manufacturing productivity gap to the aggregate productivity gap has gone up from about 20 per cent in 1960 to over 55 per cent in 1987, implying that improvements in manufacturing productivity gap are crucial for further improvement in real income gap between the two countries;

- Regression results suggest that the recent deterioration (1980-86) of manufacturing productivity gap was mainly caused by two inter-related factors: the exchange rate induced rationalization gains in U.S. manufacturing productivity and the positive influence of a significant decline in the real wage-productivity gap in the U.S. manufacturing industry on its output and productivity. The dramatic increase in the real price of oil, the marked depreciation of Canadian dollar and the decline in the real wage-productivity gap in the U.S.

manufacturing industry explain the constancy of manufacturing productivity gap during the period 1970-80;

- The survey of scale parameter estimates for twenty two-digit manufacturing industries implies slightly increasing returns to scale in the Canadian manufacturing sector, implying that the productivity gains from increasing the size of the Canadian manufacturing sector would be modest; and

- However, Canadian manufacturing industry has a large number (over 70 per cent) of small and inefficient plants, operating with above average unit costs. Therefore, Canada-U.S. free trade, by enhancing competition and speeding up the much needed rationalization of the manufacturing industry, could produce total factor productivity gains of about 4.0 per cent in this industry. These gains alone could increase real incomes in Canada by about 2.0 per cent.

Moreover, productivity and living standards are likely to be influenced by free trade in a number important ways: speeding up the reallocation of resources from declining to growing industries, adoption of new technology more quickly, increasing the degree of competition and improving the working of markets. Indeed, these dynamic gains in efficiency from free trade, though hard to quantify, could be more important than the gains due to scale economies. Hence, the net long-term output and real income gains from freer trade could be significant.

CONTENTS

FOREWORD

Trade liberalization (bilateral and/or multilateral) has long been advocated as a way to improve the working of Canadian economy and enhance the living standards of Canadians. Economic analysis identified two main sources of real income gains from trade: increased efficiency from resource reallocation and productivity gains through scale economies and rationalization. It is generally argued that an economy with a small market like Canada will benefit much more from trade than an economy with a large market, because of greater opportunities for exploiting the scale economies.

In the course of research undertaken for the Council's Trade Policy Project, an attempt was made to examine the two important economic aspects of the Canada-U.S. free trade debate: the Canada-U.S. Productivity and Per capita real income gaps, and the role of scale economies in explaining the gaps. This study also analyzes in detail the factors that may have contributed to the lack of progress in narrowing the manufacturing productivity gap between Canada and the United States since 1970, especially the recent deterioration. A preliminary version of this paper was earlier discussed at the Roundtable Conference on this subject, involving over 40 Canadian experts in this field, held at the Council in Ottawa on March 20, 1987. The results from this study were used in the Council's Statement **Venturing Forth: An Assessment of the Canada-U.S. Trade Agreement** and **Open Borders** (Discussion paper 344). The main conclusion of the paper is that there is sizeable manufacturing productivity gap (about 25 per cent) and the free trade induced plant rationalization and product specialization could narrow some of this gap, providing significant long term benefits to the Canadian economy in terms of increased output, real incomes, price flexibility, and improved competitiveness.

The author, Someshwar Rao, is a senior researcher on the Council's staff.

Judith Maxwell
Chairman

September 1988

ACKNOWLEDGEMENTS

I would like to thank Judith Maxwell, Bob Jenness and Sunder Magun for their encouragement and advice. I have benefited a great deal from the valuable comments and criticism by many of my colleagues at the Council, including Sylvester Damus, Ross Preston, Bimal Lodh, and Paul Gorecki. I have obtained advice and assistance from many people outside the Council, including Andrew Sharpe of Canadian Labour Market and Productivity Centre, John Lester of the Department of Finance, B. Slater of Statistics Canada and Arthur Neef of the U.S. Department of Labour. Comments made at the Roundtable by the participants, in particular Bill Alexander, Ernie Berndt, Don Daly, Melvin Fuss, John Helliwell, Claude Simard, Paul Oprysek, and Bruce Wilkinson were very helpful in revising the paper. Danielle Wright and the Council's Text Processing Unit have ably assisted me with all the revisions.

I INTRODUCTION

Freer trade has long been advocated as a way to improve the working of Canadian markets and enhance Canadian living standards. Economic analysis has identified two major sources of gains from trade liberalization - allocative efficiencies stemming from comparative advantage and production efficiencies stemming from economies of scale [see Lipsey and Smith (1984), Hill and Whalley (1985) and ECC (1975)]. The theory of comparative advantage says that freer trade will encourage greater international specialization - i.e., nations will produce domestically the goods in which they are most efficient and import those in which they are least efficient --, leading to higher productivity and living standards in all the participating countries (a positive sum game). Similarly, only <u>changes</u> in relative competitiveness, rather than the <u>levels</u> of relative competitiveness, are important for analyzing trade patterns. Therefore, the absolute size of manufacturing productivity gap between the U.S. and Canada is not important for Canadian trade performance under freer trade, rather changes in the productivity gap will influence the competitive position of Canadian industry. For instance, if bilateral free trade improves Canadian manufacturing productivity performance relative to the U.S., Canadian competitive position and its trade performance will improve, provided the Canadian dollar does not appreciate in real terms vis-à-vis the U.S. dollar, and vice versa.

The other more compelling economic argument for freer trade in Canada is the exploitation of scale economies. It is commonly argued that a country with a relatively small market will benefit much more from trade liberalization through scale economies than a country with a large market. [See Lipsey and Smith (1984), ECC (1975), Helpman and Krugman (1985), and Harris and Cox (1984).] Like a technological improvement, trade based on economies of scale could enhance the productivity of all factors. The experience of the European Economic Community (EEC), the European Free Trade Association (EFTA), and the Australia-New Zeland free trade agreement suggests that scale economies and rationalization played a far more important arole in improving the productivity of participating countries than the resource reallocation between industries [see Helpman and Krugman (1985).]

Economies of scale stem in part from the existence of overhead and fixed costs. In the presence of such fixed costs, it becomes advantageous to increase production in order to spread these expenses over greater output. Specialization and longer production runs also contribute to reducing average costs. When domestic markets are too small to take advantage of scale economies, then countries can reap large gains from international trade. Freer trade offers an opportunity for a simultaneous increase in the diversity products available and in the scale at which it is produced. If firms respond to this opportunity, smaller countries such as Canada could benefit significantly from trade, over and above those accruing from comparative advantage.

Pioneering research done for the Council in the late 1960s and the early 1970s concerning U.S.-Canada labour productivity and per capita income comparisons concluded that Canada's productivity and real income were substantially below United States levels. [See Walters (1968), West (1971), Wonnacott (1975), Daly, Keyes and Spence (1968), Wilton (1976), and Emerson (1975).] This gap was due to the poor productivity performance of the manufacturing sector, which in turn could be attributed to inefficient production practices characterized by very small, inefficient plants and short production runs. The gap was, in effect, a direct result of the small Canadian market.

These empirical results lend support to the view that, if only the size of the market available to Canadian producers could be expanded, it would be possible to lengthen production runs and therefore benefit from economies of scope and specialization of production. Both productivity and per capita incomes would rise as a result.

The most obvious way to enlarge the market for Canadian products is through freer trade (bilateral free trade with the United States and/or multilateral free trade), a proposed solution, which the Council has long advocated (e.g., Looking Outward, 1975). The extent of the income and productivity gains which might be realized in this way is still open to debate; however, the size of the income gap between the two countries may provide an estimate of the maximum gain that might result. It is clear from the foregoing that the gains will depend in part on the extent to which economies of scale will be realized.

In view of the current debate about the economic impact of Canada-U.S. free trade agreement on the Canadian economy and possibly the crucial role of the productivity gap and scale economies, the objective of this paper is to provide some perspective on this very important subject.[1] The following are some of the important questions we attempt to answer: Is there an aggregate productivity gap between the U.S. and Canada? How much of the aggregate productivity gap can be attributed to the poor performance of Canadian manufacturing productivity? Did the trade liberalization of past 25 years or so reduce the manufacturing productivity gap? If not, what factors could account for this puzzling result? How important are the industry size economies to Canadian manufacturing sector? Is there room for significant improvement in Canadian manufacturing productivity from rationalizaton and specialization?

The organization of the paper is as follows:

In the second section, we survey the existing estimates of the productivity and the real income gaps between the United States and Canada at the aggregate level. Then, using our own up-to-date estimates of the aggregate productivity gap, we evaluate alternative estimates of the gap and discuss possible causes of the disparity. We will also provide some insights into more recent trends concerning the U.S.-Canada productivity gap. In the third section, we examine in detail trends in the manufacturing productivity gap between the United States and Canada. The fourth section presents an econometric analysis of the determinants of trends in the manufacturing productivity gap. The fifth section contains our review of both the theoretical issues and the empirical evidence regarding scale economies and specialization, and their implications for improvements in productivity and real incomes from free trade. The final section summarizes the empirical findings on the U.S.-Canada productivity gap and the scale economies and assesses their implications for gains in productivity and real income from free trade.

II UNITED STATES-CANADA PER CAPITA INCOME COMPARISONS

As mentioned earlier, the common argument is that the productivity measured by the total output per employed worker and living standards (measured by per capita GDP) is lower in Canada than in the United States. For example, Dorothy Walters in her path-breaking 1968 study found that in 1960 Canadian per capita income and aggregate labour productivity (output per employed person) respectively, were 27 per cent and 18 per cent below United States levels. More recent work in this area by other researchers [Ward (1985), Helliwell (1985), Summers and Heston (1984)] suggests however that both the per capita income and the aggregate labour productivity gap have improved substantially and by 1975 they were close to par with their United States counterparts. But in contrast to these results, the latest OECD computations suggest that Canadian per capita income was only 91 per cent of the United States level in 1985 and that the per capita income gap between the two countries remained more or less stable over the 1980-85 period, providing support to the conventional view. There is, in short, no consensus on the magnitude of the real income and productivity gap that exists at present between the United States and Canada. In this section, therefore, we review all the existing estimates of productivity and real income gap measures and analyze the causes of disparities between the different sets of estimates.

IMPORTANCE OF THE PURCHASING POWER PARITY EXCHANGE RATE (PPP) IN INTERNATIONAL REAL INCOME COMPARISONS

Comparisons of per capita income and productivity on a country by country basis often use market exchange rates for currency conversions. Such measures provide data in a common currency but valued at different sets of prices. Consequently, international comparisons of productivity or living standards based on market exchange rates reflect not only differences in the quantities of goods and services produced or consumed in different countries, but also differences in price levels between countries. Furthermore, the relationship between the nominal and the real figures tends to be quite unstable over time because exchange rates are liable to fluctuate significantly over fairly short periods. The recent experience of the United States dollar is a case in point. Therefore, use of market exchange rates to convert national currencies into a common currency can produce extremely unreliable and seriously misleading indicators of relative productivity and standards of living (see Table 1).

As a means of overcoming this problem, economists can compute purchasing power parity (PPP) exchange rates for purposes of real quantity comparisons across countries. A PPP is an "international" price index calculated by comparing the prices of the same commodities in different countries. It is an index of relative national price levels and has the same dimensions as an exchange rate. Currency conversions with the PPPs thus provide

Table 1

Comparisons of Gross Domestic Product Per Capita Based on Purchasing Power Parity Versus Market Exchange Rates
(United States = 100)

Year	United States	Canada	Japan	Belgium	France	Germany	Italy	Nether-lands	United Kingdom
A) Market exchange rates									
1950	100	67.6	7.1	NA	36.5	26.1	20.4	27.0	38.2
1960	100	80.3	16.7	43.7	47.6	46.2	30.3	36.2	48.8
1970	100	81.4	40.3	54.4	57.7	62.1	44.0	52.3	45.1
1975	100	101.4	61.3	87.9	89.5	92.4	54.5	87.1	57.3
1980	100	93.4	77.3	103.8	104.8	112.3	68.7	101.7	80.7
1986	100	82.2	92.7	67.2	75.2	84.3	60.2	66.9	55.5
B) Purchasing-power-parity exchange rates (OECD price weights)									
1950	100	70.2	16.1	46.2	42.8	36.0	33.4	52.5	60.3
1960	100	72.9	28.8	50.5	52.7	61.1	47.3	62.1	66.1
1970	100	79.2	55.8	60.6	63.8	67.8	60.4	70.2	64.4
1975	100	90.9	60.6	67.3	70.8	69.9	62.4	74.3	67.4
1980	100	93.4	66.1	69.7	73.1	74.2	66.4	73.3	65.6
1986	100	93.5	71.0	66.2	70.5	73.7	65.8	67.7	65.8

NA Not Available.

Source U.S. Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology, August 1987 (unpublished). These estimates are based on OECD multilateral price weights.

data in a common currency valued at a common set of prices which can be used in international comparisons of productivity and per capita income. The application of PPPs for international comparisons of real income is closely associated with the pioneering work of Irving Kravis and his colleagues at the University of Pennsylvania as well as with the ongoing work at EUROSTAT, UNSO and the OECD.

Calculation of a set of benchmark PPPs and associated estimates of real gross domestic product (GDP) is a major operation involving the collection of very detailed information on prices and final expenditures in all the countries concerned. It is generally agreed that the natural choice of international prices for a set of multilateral measures is a weighted average of the prices within the group of countries in question.[2]

It is possible to calculate PPPs for the years preceding or following the benchmark year by using information about the relative rates of inflation in different countries. However, it should be noted that PPPs estimated in this way will usually differ from parities obtained by means of full-scale surveys. This is because of improvements in the basic data over time, and fuller coverage and revisions to the expenditure estimates. Moreover, the criteria used for calculating inter-temporal price indices, including implicit price deflators, and their coverage are different from those used to construct inter-spatial price indices.

Table 2

Sensitivity of the Aggregate PPP Rate to Alternative Measures of the Inflation Rate

Measure of Inflation	1975	1980	1985
		($ U.S./$ CAN)	
GDP deflator	0.8591	0.8340	0.7974
Final demand deflator	0.8603	0.8340	0.7974
Consumer expenditure deflator	0.8856	0.8763	0.7974
CPI	0.8667	0.8741	0.7974
Unit labour costs	0.9060	0.8940	0.7974
Official Exchange Rate	0.9830	0.8554	0.7325

Source Estimates based on the data from Statistics Canada and the Wharton Econometric Forecasting Associates, and the OECD 1985 aggregate benchmark PPP rate. These estimates are based on 1985 OECD bilateral price weights, obtained from Barbara Slater of Statistics Canada.

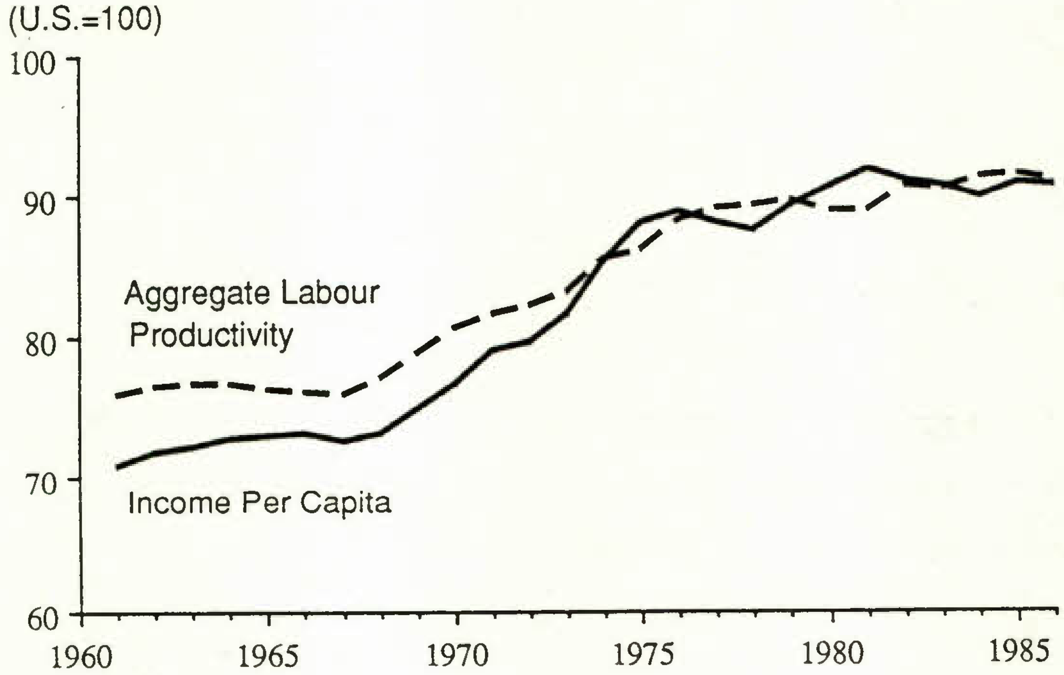
However, they provide reasonable estimates of the relative purchasing power of the two currencies over time provided that the time period covered is not too far from the benchmark year. We therefore believe that the most meaningful international comparisons will be based on the most recent and comprehensive measures of PPP that are available. In our opinion, the most recent work of the OECD best meets this criterion.

U.S.-Canada Real Income Comparisons

Using the aggregate benchmark bilateral PPP rate for 1985 developed at the OECD (1987), we have updated and extended their Canada/U.S. per capita real income and aggregate labour productivity (GDP per employed person) series for the years 1961-85. We have used the most recent National Accounts data (revised and rebased) for the two countries. The results are summarized in Tables 3 and 4. The figures in Column 3 in these tables assume parity between the two currencies (1 $CAN = 1 $US); Column 4 uses the actual exchange rate between the two currencies for converting the data in Column 3 and the PPP-based measures are displayed in Columns 5 and 6 and Chart 1. Consequently, the discrepancy between Column 3 and Columns 5 and 6 shows the size of the deviation of the PPP exchange rate from parity. Trends in the gap estimates in Column 3 are deficient insofar as they are solely determined by the relative growth rates of productivity and per capita income in the two countries and take no account of relative

CHART 1

Ratio of Canadian to U.S. Income
Per Capita and Aggregate Labour Productivity, 1961-86



Note Income per capita is defined as GDP per person and aggregate labour productivity is measured as GDP per person employed, based on bilateral purchasing power parity (PPP) exchange rate.

Table 3

Per Capita GDP Comparisons Between the U.S. and Canada

Year	Per capita GDP (thousands of $) 1982 Prices Canada (C$)	U.S. (US$)	Canada/U.S. (U.S. = 100.0), using Nominal[1] Parity (1C$= 1US$)	Actual Exchange Rate	PPP Exchange Rate (1980 OECD Multilateral Price Weights)	PPP Exchange Rate (1985 OECD Bilateral Price Weights)
1960	8.2	9.2	76.0	73.7	78.3	70.1
1965	9.7	10.7	80.5	74.7	81.0	72.9
1970	11.2	11.7	84.4	80.7	85.3	76.7
1975	13.6	12.3	102.1	99.6	97.7	88.0
1980	15.5	13.8	108.5	92.8	100.5	90.5
1986	17.2	15.1	113.8	81.9	101.2	90.6

1 Ratio of the two per capita GDPs in current prices, without correcting for exchange rate differences.

Source Author's estimates based on the data from Statistics Canada and the Wharton Econometric Forecasting Associates. Trends in GDP deflator are used to measure trends in the PPP exchange rate.

Table 4

Aggregate GDP Per Person Employed

	Per person employed (thousands of $) 1982 Prices		Canada/U.S. (U.S. = 100.0), using		
Year	Canada (C$)	U.S. (US$)	Nominal[1] Parity (1C$= 1US$)	Actual Exchange Rate	PPP Exchange Rate (1985 OECD Bilateral Price Weights)
1960	23.7	25.1	82.4	81.3	75.6
1970	30.4	30.5	88.5	85.0	80.5
1975	33.2	31.1	100.1	98.3	86.0
1980	34.9	31.5	107.1	91.7	88.9
1986	37.6	33.2	114.3	82.3	91.0

1 Ratio of the two productivities in current prices, without correcting for exchange rate differences.

Source Author's estimates based on the data from Statistics Canada and the Wharton Econometric Forecasting Associates. Trends in GDP deflator are used to measure trends in the PPP exchange rate.

rates of inflation. In contrast, the PPP based estimates are also influenced by changes in the relative purchasing power of the two currencies, measured by trends in the GDP deflator in the two countries.

It is worth noting that trends in the PPP rate are sensitive to the measure of inflation chosen as an extrapolator. For example, the PPP rate (US$/CAN$), based on the GDP deflator, drops from 0.8315 in 1980 to 0.7974 in 1985. In contrast, the PPP rates based on the consumer price index or unit labour costs imply a bigger drop between these two periods (see Table 2). Consequently, the trends in productivity and per capita income gap measures are also sensitive to the measure of inflation. Following the lead of OECD [see Ward (1985)] and the BLS, we have opted for the GDP deflator chosen as an extrapolator. Therefore, all the results reported in Tables 3 and 4 are extrapolated from the various benchmarks using the GDP deflator for the two countries.

The following conclusions can be derived from an examination of the date displayed in Tables 3 and 4:

(a) In both countries, aggregate labour productivity and per capita real income have expanded at a significantly slower pace in recent years, compared to the period 1960 to 1975.[3]

(b) Canadian per capita income and aggregate labour productivity improved substantially vis-à-vis the United States over the period 1961-80 (see Tables 3 and 4). For example, our per capita income increased from around 71 per cent of the U.S. level in 1961 to about 91 per cent in 1980. However, it should be pointed out that the relative performance of Japan, West Germany, France and Italy has been more impressive than the Canadian progress over this period (see (Table 1).

(c) However, over the period 1980-86, the per capita income gap remained more or less stable around 91 per cent.

(d) Canadian aggregate labour productivity moved up slightly from about 89 per cent of the U.S. level in 1980 to 91 per cent in 1986. The poor performance of per capita income over this period, compared to the aggregate labour productivity, could be explained by a significant increase in the Canadian unemployment rate relative to the American rate.

We have compared OECD (1987) estimates with the results from the other studies on the subject (see Tables 5 and 6). The estimates from the OECD (1987) and the BLS (1987) are very similar as they both are derived from the 1985 PPP benchmark, the former from the Canada/U.S. bilateral results and the latter from the multilateral study. There are differences, however, between these studies and the studies by Ward (1985) and Helliwell (1985) which were based

Table 5

Comparisons of U.S.-Canada Per Capita Income (GDP) Levels
(United States = 100)

Year	Walters[1] (1968)	Summers, Kravis and Heston (1980)	Summers and Heston (1984)	BLS (1987) (1985 OECD multi-lateral price weights)	Ward (1985)	Helliwell (1985)	This study[2] (1985 OECD bilateral price weights)
1960	73.0	74.0	76.0	71.3	NA	NA	70.1
1970	NA	82.0	83.0	77.4	92.0	NA	76.4
1975	NA	90.0	95.0	88.8	103.0	NA	87.5
1980	NA	NA	93.0	91.3	102.1	100.0	90.0
1986	NA	NA	NA	91.5	98.1('84)	96.0	90.6

1 Net national income per capita.
2 Based on the OECD data.

NA Not available

Source See the cited references, and the U.S. Department of Labour, Bureau of Labor Statistics, Office of Productivity and Technology, May 1975 (unpublished). OECD (1987) estimates are obtained from Barbara Slater of Statistics Canada.

Table 6

Comparisons of U.S.-Canada Productivity
(GDP per person employed)
(United States = 100)

Year	Walters[1] (1968)	BLS (1987) multilateral 1985 OECD price weights	This study[2] (1985 OECD bilateral price weights
1960	82.0	80.1	75.6
1970	NA	84.1	80.5
1975	NA	89.9	86.1
1980	NA	92.8	88.9
1986	NA	95.0	91.0

1 Net national income per employed person.
2 Based on the OECD data.

NA Not available.

Source See the cited references, and the United States Department of Labor, Bureau of Labor Statistics (BLS), Office of Productivity and Technology, March 1987. BLS estimates are based on 1985 OECD multi lateral price weights. OECD (1987) estimates are taken from Table 4.

on the 1980 OECD multilateral benchmark PPP. The latest OECD results suggest that the 1980 PPP exchange rates over-estimated U.S. prices by at least 10 per cent (see Table 3). Since the U.S. is the base country, this translated into about a 10 per cent underestimate of American productivity and per capita income relative to other countries. Similarly, slight differences in benchmark data explain the small discrepancies between the OECD (1987) and the BLS (1987) results and those of Summers and Heston (1984).[4]

Like the results of OECD (1987), BLS (1987), and Ward (1985), research by Summers and Heston also indicates substantial improvements in Canadian productivity and per capita income over the period 1960-80.

In summary, all these estimates indicate that the U.S.-Canada per capita income gap narrowed significantly over the last 25 years or so. However, based on the best estimates available to date we conclude that there is still a gap which has remained more or less stable around 10 per cent since 1980. These results are not out of line with the earlier work by West, Walters, etc.

III UNITED STATES-CANADA MANUFACTURING PRODUCTIVITY GAP

It is often argued that since Canada has a small domestic market, protected by tariff and nontariff barriers, and since its manufacturers for the most part do not have unlimited access to the large United States market, a great majority of Canadian manufacturing firms are relatively small. Smallness in turn is accompanied by suboptimal plant scale and suboptimal production runs as well as major structural weaknesses: low R&D, slow diffusion of technology, and high debt/equity ratios. As a result, Canadian manufacturing firms are said, on average, to be substantially less efficient than their United States counterparts.[5] In his 1971 study, West found that Canadian manufacturing productivity was 28 per cent below the United States level in 1963 and that about a third of the variation in productivity performance between industries was associated with the scale effect. Recent findings of Baldwin and Gorecki (1986) for 1979 are very similar to the West results. Similarly, Frank (1977), DRI (1986), and Daly and MacCharles (1986 B) report that as recently as the period 1975-80, the manufacturing productivity gap remained in the range of 25-27 per cent. These independent studies are remarkably consistent in their estimate of the productivity gap.

However, not all previous studies have reached this same conclusion. For example, the findings of Thurow (1985) and the study by Opryszek (1986) suggest that Canadian manufacturing productivity was not significantly below the United States level in 1980.

In view of these conflicting results, we examine in the remainder of this section both the level and the trends in the manufacturing productivity gap and assess the contribution of the manufacturing sector to the aggregate productivity gap reported in Section 2. Using the latest industry output data in the two countries and the manufacturing sector PPP exchange rate, defined below, we provide a new estimate of the productivity gap in the manufacturing sector. We also compare our results with the findings of other researchers [West (1971), Frank (1977), Baldwin and Gorecki (1986), Daly and MacCharles (1986), DRI (1986), Thurow (1985) and Opryszek (1986)] and suggest possible reasons for the discrepancies between various estimates.

Labour Productivity and
Total Factor Productivity

In the past, most of the studies of Canada-U.S. manufacturing productivity comparisons relied on labour productivity (value-added per person hour) as the indicator of overall efficiency of the production process in the two countries. Since the growth in per capita real income (standard of living) is mainly determined by improvements in aggregate labour productivity in the medium to long run and the manufacturing sector is an important source of growth in aggregate labour productivity, the emphasis on labour productivity is not surprising. In addition, computation of labour productivity, unlike total factor productivity or multifactor productivity, is relatively straight forward and does not put too many demands on data.

However, labour productivity might not be the true indicator of the efficiency with which all the inputs are used to produce a given level of output -- i.e., total-factor productivity. Movements in labour productivity are influenced by movements in total factor productivity and substitution of other inputs (capital and intermediate inputs) for labour in response to changes in relative prices and demand conditions. Nevertheless, in the medium to long term, trends in labour productivity are expected to be mainly influenced by trends in total factor productivity, because the impact of relative prices and demand conditions on factor substitution and hence on labour productivity is expected to be quite small [see Rao and Preston (1984), and Baily (1984)]. Hence, variations in manufacturing labour productivity over time in the two countries and hence trends in the manufacturing labour productivity gap are expected to be reliable indicators of trends in the manufacturing total factor productivity gap in the medium to long term.

Due to the difficulties in obtaining a consistent set of data on gross and intermediate inputs, price indices for output and inputs and capital stock for the two countries, we have also confined our analysis in Sections III and IV to labour productivity (value-added per person hour), despite the above mentioned reservations. Nevertheless, it will enable us to compare our productivity gap estimates with those of other studies on the subject.

U.S.-CANADA MANUFACTURING PRODUCTIVITY (VALUE ADDED PER PERSON HOUR) COMPARISONS

To provide some perspective on the U.S.-Canada productivity gap, we compare labour productivity (value added per person hour) in the manufacturing sector for the two countries over the period 1961-85 (see Table 8). Using the tradable goods PPP (total goods less construction) from the latest OECD Study and the relative inflation rates, measured by the manufacturing sector GDP deflator, we have computed the PPPs for years preceding the benchmark year, 1985 (see Table 7). These PPPs in turn are used

Table 7

Benchmark PPP exchange rates used for the manufacturing sector: Alternative Estimates in 1980

Source	($U.S./$CAN) 1980
Aggregate PPP rate - OECD 1985 price weights	0.8423
Tradable goods - OECD 1985 price weights	0.7980
Opryszek (1986) - U.S. prices	0.9010

Source Based on OECD (1987) and Opryszek (1986). Using the 1985 OECD benchmark PPP rates and trends in the manufacturing sector GDP deflator, OECD PPP rates for 1980 are computed. OECD (91987) results are obtained from Barbara Slater of Statistics Canada.

Table 8

Canada-U.S. Comparisons of Manufacturing Productivity
[output (value added) per person hour] (1982 $)

Year	Total Manufacturing		
	Canada* (C$)	U.S.** (US$)	Canada/U.S.*** (U.S.=100)
1961	10.0	9.7	96.0
1965	12.2	11.7	97.0
1970	14.1	12.2	107.0
1975	16.6	14.2	107.0
1980	18.3	15.6	106.0
1986	22.3	19.8	100.0
	Growth rates (per cent)		
1965/61	21.6	20.6	
1970/65	16.2	4.3	
1975/70	17.2	16.4	
1980/75	10.8	9.9	
1986/80	21.6	27.0	

Source Based on the data from Statistics Canada and the Wharton Econometric Forecasting Associates.

* Hours worked.
** Hours paid.
*** After adjusting for the difference between hours paid and hours worked, unadjusted for the exchange rate (PPP or market) differences.

to convert the Canadian measures into United States dollars, and results are presented in Table 9.

This simple method should, however, be regarded as a rough approximation for four main reasons. First, the basic data sources (value added and person hours) in the two countries are not fully comparable because of some definitional differences. Second, even though much of the manufacturing sector's output is of an intermediate sort which does not enter into final expenditure, our benchmark PPP rates have been derived from final expenditures deflators.[6] Third, as we have pointed out in the previous section, this method provides reliable estimates of the PPPs only for the years not too far from the benchmark year (full scale survey). Finally, estimates of labour productivity are only a rough proxy for the total factor productivity, i.e., the efficiency with which all the inputs are used to produce a given level of output.

Our estimates are displayed in Tables 8 and 9. The principal findings are as follows:

(a) In the two countries, labour productivity growth in the manufacturing sector slowed down significantly during the

Table 9

PPP Based Comparisons of Canada/U.S. Manufacturing Productivity
[output (value added) per person hour] (U.S. = 100)

	Based on		
Year	Tradable goods PPP rate (1985 OECD price weights)	Aggregate PPP Rate (1985 OECD price weights)	Opryszek's PPP Rate
1961	72.8	77.8	84.8
1965	74.0	79.0	86.0
1970	81.5	86.5	93.5
1975	81.7	86.7	93.7
1980	82.0	87.0	94.0
1986	77.3	82.3	89.3

Source Based on the data from Statistics Canada and the Wharton Econometric Forecasting Associates. Trends in the manufacturing sector GDP deflator are used to project trends in the benchmark PPP rates, given in Table 8. These PPP rates are in turn used to convert the Canadian data (current dollars) into U.S. currency.

1975-80 period, as indeed did aggregate labour productivity. For example, Canadian manufacturing productivity growth declined from 17.2 per cent over the period 1970-75 to 10.8 per cent during the period 1975-80 (see Table 8).

(b) Over the last six years, however, labour productivity in the manufacturing sector has improved substantially in both countries, but at a slower pace in Canada. Between 1980 and 1986, manufacturing productivity increased by almost 27 per cent in the United States but by only about 22 per cent in Canada. Consequently, the Canada-U.S. productivity index dropped from 105.5 in 1980 to 100.5 in 1986 (see Table 8).

(c) Our results suggest that, on average, Canadian manufacturing productivity level was about 23 per cent below the United States level in 1986, compared to 27 per cent in 1961. Moreover, Canada lost significant ground to the United States in the manufacturing sector over the period 1980-86. The manufacturing productivity gap increased from 18 per cent in 1980 to around 23 per cent in 1986 (see column 1 of Table 10). Moreover, preliminary data for 1987 suggests that the gap has increased from 23 per cent in 1986 to 25 per cent in 1987.

Table 10

Comparisons of U.S.-Canada Productivity in the Manufacturing Sector
(value added per person hour) (U.S. = 100)

Year	West (1971)	Frank[1] (1977)	Daly and MacCharles (1986)	Baldwin and Gorecki (1986)[2]	Thurow (1985)	DRI (1986)	Opryszek (1986)	This Study
1965	72.8('63)	65('67) (70)	64.1	NA	NA	NA	NA	74.0
1970	NA	NA	72.3	63.0	NA	NA	100.0('72)	81.5
1975	78.7('74)	82.0('74) (98.0)	72.7	NA	NA	73.0	120.0	81.7
1980	NA	NA	74.7	73.0	NA	74.0	100.0	82.0
1986	NA	NA	72.4('84)	NA	93.5('83)	76.0	85.0('83)	77.3 (87) 77.9

1 Figures in the parenthesis refer to the durable manufacturing industries (American price relatives).

2 Total productivity, based on net output (value added).

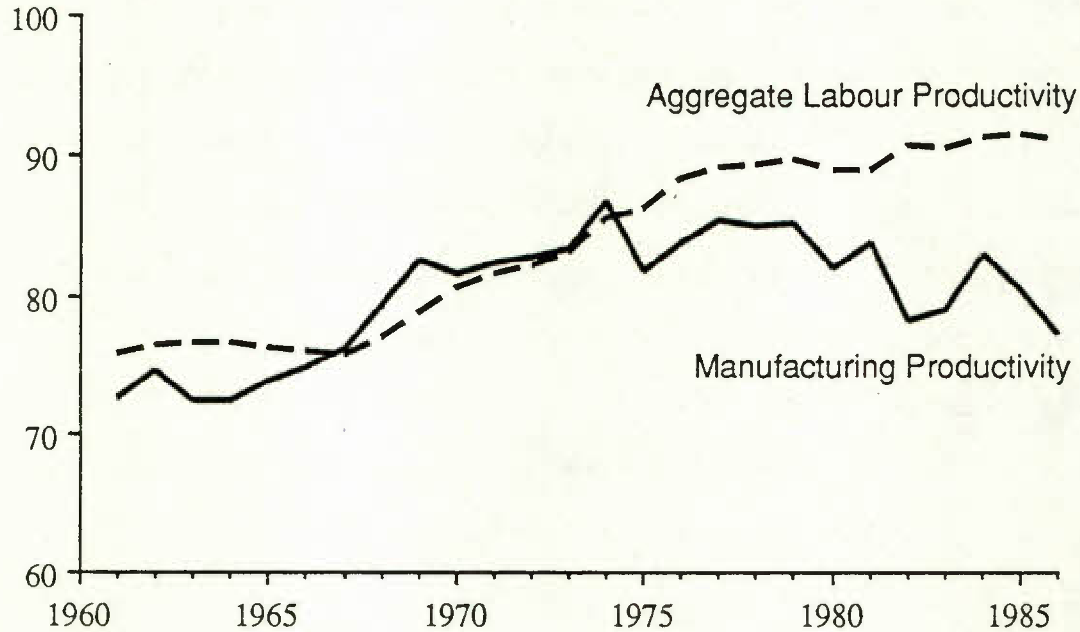
3 1983 value.

4 Value added per employed person.

Source Updates to E.C. West (1971), reported in ECC (1975), Table 6-4; Frank (1977), based on American prices, Table 9; Daly and MacCharles (1986b), Table 2-2; Baldwin and Gorecki (1986), unadjusted for scale; Thurow (1985); Opryszek (1986), based on U.S. prices. DRI estimates are obtained from Government of Ontario (1986).

CHART 2

Ratio of Canadian to U.S. Aggregate Labour Productivity and Manufacturing Productivity, 1961-86
(U.S.= 100)



Note Aggregate labour productivity is defined as GDP per person employed and manufacturing labour productivity is measured as GDP per person-hour, based on bilateral purchasing power parity (PPP) exchange rate.

(d) Because of the poor performance of the manufacturing productivity gap relative the aggregate productivity gap (see Chart 2), the contribution of the manufacturing productivity gap to the aggregate productivity gap has gone up from about 20 per cent in 1965 to over 55 per cent in 1986; this, in turn, implies a better productivity performance in the Canadian nonmanufacturing sector (resource industries and the service sector) relative to its United States counterpart, suggesting that Canadian nonmanufacturing sector productivity, on average, was only about 5.0 per cent below its United States counterpart in 1986. Therefore, improvements in the manufacturing productivity gap are crucial for further improvements in aggregate labour productivity and per capita income gap.

Table 10 compares our estimates of the manufacturing productivity gap with other available estimates. Our estimates in general are in line with the findings of Daly and MacCharles (1986), Baldwin and Gorecki (1986) DRI (1986) and Frank (1977), which indicate the existence of a sizable U.S.-Canada manufacturing productivity gap which remained relatively stable over the period 1970-80. For example, in 1980 according to these studies the productivity gap was between 25 to 30 per cent. Our estimates imply a productivity gap of about 23 per cent in 1986.

In contrast to the above results, the estimates by Opryszek (1986) and Thurow (1985) suggest that Canadian manufacturing productivity was more or less on a par with its United States counterpart. How can we reconcile these differences? Since the raw data come from the same basic sources in all these studies, the differences among various estimates reflect the differences in relative price weights (PPP rates).[7]

For example, if we use Opryszek's (1986) PPP rate as the converter, our results are very close to his findings (see Tables 8 and 9). This result again points out the sensitivity of gap estimates to the benchmark PPP rate. Since Opryszek's (1986) results are based on a sample of only nine industries, his PPP rate and hence his gap estimates might be subject to sampling bias. Recall that Opyszek's study attempts to update the earlier work by Frank (1977), using the latter's methodology. The big difference between the two studies is the sample size. Opryszek's study examines only nine manufacturing sectors, compared to 33 manufacturing sectors in Frank's study. We also remind the reader that Frank's study reported that, on average, the Canadian manufacturing productivity was about 18 per cent below the U.S. level in 1975, compared to a 20 per cent advantage in favour of Canada in Opryzek (1986). But it is interesting to note that Frank's gap estimates for the nine industries studied by Opryszek are almost identical to the latter's results. This similarity of findings in the two studies confirm our hypothesis that Opryszek's aggregate manufacturing productivity gap estimates suffer from a serious sampling bias and are biased upward.

Thurow's estimates of manufacturing productivity gap are based on data from DRI. But recently DRI has substantially revised these data. Their revised data show that a substantial manufacturing productivity gap exists, in line with the other estimates, including ours (see Table 10). Thus we conclude that the results of both the Opryszek and Thurow studies should be discounted.

In summary, our survey results indicate that, on average, the Canadian manufacturing productivity is substantially below the U.S. level (about 25 to 30 per cent), opening the possibility for substantial gains in productivity and real income in Canada from freer trade. Our own work tends to confirm these results.

IV DETERMINANTS OF TRENDS IN CANADA-U.S. MANUFACTURING PRODUCTIVITY GAP: SOME PRELIMINARY RESULTS

In the previous two sections we have analyzed the recent trends in aggregate labour productivity gap and the manufacturing productivity gap. In contrast to the decent performance of Canadian aggregate labour productivity gap, the manufacturing productivity gap remained more or less constant at around 18 per cent between 1970 and 1980. Furthermore, since 1980 the productivity gap has been widening, primarily due to a faster growth in American manufacturing productivity. Preliminary productivity estimates in the two countries for 1987 suggest that the manufacturing productivity gap has increased from about 23 per cent in 1986 to 25 per cent in 1987, very similar to the situation that prevailed back in 1965.

The existence of a sizeable manufacturing productivity gap provides opportunities as well as risks for Canada. If Canada-U.S. free trade, by providing a secure and more open access to the large rich U.S. market, permits Canadian companies to take advantage of scale economies of larger plants and longer production runs and lead to higher productivity and lower unit costs, Canadian manufacturing sector would prosper under the tariff free North American market, and contribute significantly towards the enhancement of living standards for Canadians. On the other hand, if Canadian manufacturing productivity improvements continue to lag behind the U.S. productivity performance, the Canadian manufacturing sector could face serious adjustment problems under free trade, and make further improvements in Canadian aggregate labour productivity and real per-capita income gap difficult. For example, the recent Economic Council report [ECC (1988b)] on the Canada-U.S. free trade agreement has concluded that without further improvements in manufacturing productivity, 16 of the 20 manufacturing sectors will experience some reduction in output and employment under free trade, compared to the base case scenario. Whereas, with a modest improvement in manufacturing productivity (a 6 per cent increase over 10 years), the losses in output and employment disappear in ten industries and the declines moderate in the other seven industries, and the potential gains in output and employment from the Canada-U.S. free trade will increase significantly.

Therefore, the size of output, employment and real income gains from free trade critically depends on the size of manufacturing productivity improvements. The supporters of the Canada-U.S. free trade agreement maintain that free trade, by permitting companies to take advantage of scale economies more effectively, will close some of the existing manufacturing productivity gap and improve the real incomes of Canadians. On the other hand, the opponents of free trade argue that in spite of significant trade liberalization achieved under the Kennedy and Tokyo rounds of multilateral trade negotiations and a substantial increase in

Canadian exports and imports, the manufacturing productivity gap has not improved significantly, suggesting that the importance of scale economies is over stated. They further argue that the recent deterioration of the manufacturing productivity gap and the associated deterioration in international competitiveness could pose serious problems for the health of Canadian manufacturing sector during the medium-term, especially under the Canada-U.S. free trade agreement.

However, the lack of improvement in the manufacturing productivity gap in the past need not necessarily contradict the traditional view - i.e., free trade would improve the relative performance of Canadian manufacturing productivity due to increased importance of scale economies of larger plants and longer production runs. For example, in the past the positive impact of scale economies on the manufacturing productivity gap could have been offset by the negative influence of other factors, such as slower adoption of best practice technology, poor management practices, the relatively large adverse impact of the two energy price shocks on inflation, output and employment, exacerbated by incomplete factor mobility and wage-price rigidities, the severity of the 1981-82 recession, and the exchange rate induced rationalization gains in the U.S. manufacturing productivity over the 1980-86 period.[8]

The objective of this section is to conduct an econometric analysis of the determinants of past trends in the Canada-U.S. manufacturing productivity gap, to provide insights into the causes of lack of improvement in the manufacturing productivity gap since 1970, in particular the recent deterioration.

THE MODEL

Trends in the manufacturing productivity gap depend on the differential growth rates in manufacturing productivity between Canada and the United States. Canadian productivity growth in excess of U.S. productivity improvements will narrow the productivity gap and vice versa. The recent widening of the manufacturing productivity gap is the result of Canadian productivity growth lagging behind the U.S. productivity growth. During the 1980-86 period, Canadian manufacturing productivity increased by an impressive 22 per cent. But, U.S. productivity improved at a faster pace than in Canada (27 per cent). Consequently, the manufacturing productivity gap has increased from 18 per cent in 1980 to about 25 per cent in 1987.

Therefore, the factors which determine productivity trends in the two countries over the last 25 years will provide insights into the past trends in manufacturing productivity gap. The productivity gap equation we have estimated empirically is a reduced form equation, derived from two country productivity growth equations. For each country, we have specified a productivity growth equation. The productivity gap equation is simply derived from the difference of the two productivity growth equations. Hence, the explanatory variables in the productivity gap equation are expected to capture more effectively the variation in manufacturing productivity gap over time.

Based on the productivity research done at the Council, elsewhere in Canada, and in the United States, manufacturing productivity growth (output per person-hour) is assumed to depend on the following variables; growth in the investment-output ratio, growth in the real wage-productivity gap, growth in the real price of energy, per cent change in the real effective (trade weighted) exchange rate, time trend (to capture trend productivity growth), and the overall slack in the economy.[9]

$$\ln(PROD \cdot US) = \emptyset_0 + \overset{(+)}{\beta_1}\,TIME + \overset{(+)}{\beta_2}\ln(I \cdot US/Q \cdot US)_{-1}$$

$$+ \overset{(-)}{\beta_3}\ln(RW \cdot US/PROD \cdot US)_{-1} + \overset{(-)}{\beta_4}\ln(RPE)_{-1}$$

$$+ \overset{(?)}{\beta_5}\ln(RER \cdot US)_{-1} + \overset{(-)}{\beta_6}\,URATE \cdot US \qquad (1)$$

$$\ln(PROD \cdot C) = \alpha_0 + \overset{(+)}{\alpha_1}\,TIME + \overset{(+)}{\alpha_2}\ln(I \cdot C/Q \cdot C)_{-1}$$

$$+ \overset{(-)}{\alpha_3}\ln(RW \cdot C/PROD \cdot C)_{-1} + \overset{(-)}{\alpha_4}\ln(RPE)_{-1}$$

$$+ \overset{(?)}{\alpha_5}\ln(RER \cdot C)_{-1} + \overset{(-)}{\alpha_6}\,URATE \cdot C \qquad (2)$$

Taking the difference of equations (1) and (2) we can derive the productivity equation as:

$$\ln (PGAP) = (\beta_0 - \alpha_0) + (\beta_1 \overset{(?)}{-} \alpha_1) \, TIME - \overset{(-)}{\alpha_2} \ln (I{\cdot}C/Q{\cdot}C)_{-1}$$

$$+ \overset{(+)}{\beta_2} \ln (I{\cdot}US/Q{\cdot}US)_{-1} - \overset{(-)}{\alpha_3} \ln (RW{\cdot}C/PROD{\cdot}C)_{-1}$$

$$+ \overset{(+)}{\beta_3} \ln (RW{\cdot}US/PROD{\cdot}US)_{-1} + (\beta_4 \overset{(?)}{-} \alpha_4) \ln (RPE)_{-1}$$

$$- \overset{(?)}{\alpha_5} \ln (RER{\cdot}C)_{-1} + \overset{(?)}{\beta_5} \ln (RER{\cdot}US)_{-1} - \overset{(+)}{\alpha_6} URATE{\cdot}C$$

$$+ \overset{(-)}{\beta_6} \, URATE{\cdot}US \qquad (3)$$

where,

PROD•C = Canadian manufacturing productivity index (1977=100);

TIME = time trend;

(I•C/Q•C) = ratio of Canadian machinery and equipment investment in manufacturing to manufacturing output in Canada (1977=100);

(RW•C/PROD•C) = ratio of real wages in manufacturing to manufacturing productivity in Canada (1977=100);

RPE = real price of world oil (1977=100);

RER•C = real effective exchange rate, Canada (1980=100);

PROD•US = U.S. manufacturing productivity index (1977=100);

(I•US/Q•US) = ratio of machinery equipment investment in manufacturing to manufacturing output in the United States (1977=100);

(RW•US/PROD•US) = ratio of real wages in manufacturing to manufacturing productivity in the United States (1977=100);

RER•US = real effective exchange rate, United States (1980=100);

URATE•C = unemployment rate, Canada;

URATE•US = unemployment rate in the United States;

PGAP = ln (PROD•US) - ln (PROD•C);

ln (x) = Log (x);

(x) -1 = x, lagged one year; and

$\overset{(+)}{(\alpha)}$ = the expected sign of the coefficient.

Since each country's productivity is expected to be positively related to the investment/output ratio, the productivity gap (PGAP) in equation (3) is expected to be negatively influenced by (I•C/Q•C) and positively related to (I•US/Q•US).

Productivity growth in excess of real wage growth will increase profitability and/or improve competitiveness; if profit margins remain constant, a reduction of the real wage-productivity gap leads to lower costs and hence increased price competitiveness. On the other hand, if profit margins are increased, this situation may result in greater investment, faster adoption of new, and improved technology and hence stronger productivity growth. Of course, some combination of the two effects is possible. However, both these effects will give stimulus to output and productivity. Productivity growth and output growth are expected to be positively correlated, because of better utilization of resources and faster adoption of productivity enhancing technology, etc. [See Helliwell (1984), Strum and Salou (1985), Rao and Preston (1984), Kendrick (1981) and Sharpe (1983)]. Therefore, the manufacturing productivity gap is expected to be positively related to $(RW \cdot C/PR\phi D \cdot C)_{-1}$ and negatively related to $(RW \cdot US/PR\phi D \cdot US)_{-1}$.

An increase in the price of energy is expected to reduce productivity growth in two countries. Since energy costs are only a small proportion of total production costs, the direct effect of energy price shocks on productivity is expected to be small. In addition, to some extent Canada was insulated from the effects of higher OPEC prices by the government decision to keep oil prices below the world level. Nevertheless, empirical evidence supported by Rao and Preston (1984), Helliwell (1984), Baily (1981), and Stuber (1986) and Jorgenson (1980) suggest that the indirect impact of energy prices, working through a slowdown in technical progress and a premature obsolescence of capital stock, is negative and significant. Another indirect effect of the two energy price shocks was the acceleration of inflation that they sparked throughout the industrial world via a series of events. The acceleration of inflation in turn had an adverse impact on output and productivity growth, through its negative impact on consumer expenditure and investment. For example, in Canada the personal saving rate increased substantially during the latter half of the 1970s and the early 1980s, producing a sluggish growth in consumer expenditure.

However, the impact of the real energy price on productivity gap (PGAP) cannot be predicted a priori. If the impact of energy price shocks on productivity growth is the same in the two countries, there will be no significant impact on the productivity gap. On the other hand, if the energy price shocks had a more pronounced negative impact on Canadian manufacturing productivity than on the U.S. productivity, because of a larger impact on inflation and the slowdown in technical progress, the productivity gap (PGAP) in equation (3) will be negatively related to the real price of oil, and vice versa.

An appreciation of the exchange rate could have either a positive or a negative influence on a country's manufacturing productivity, depending on the relative strength of two opposing influences on manufacturing productivity. Other things remaining constant, an increase in the value of a country's currency will reduce its competitiveness and put pressure on its business sector to introduce revitalization and rationalization, to improve its productivity and overcome the competitive disadvantage caused by the exchange rate appreciation, and vice versa. On the other hand, an appreciation of the currency and the resulting competitive disadvantage will reduce exports and increase imports, reducing the pace of output growth. As pointed out earlier, output growth and productivity growth tend to go hand in hand, reducing the pace of productivity improvements. Therefore, the net impact of an exchange rate appreciation on productivity growth depends on the relative magnitude of these two effects: the rationalization effect and the output effect. If the rationalization effect is stronger than the output effect, manufacturing productivity will be positively influenced by an appreciation of the exchange rate. On the other hand, if the output effect dominates the rationalization effect, an increase in the external value of the country's currency will have a negative influence on its manufacturing productivity.

Therefore, the signs of Canadian and American effective exchange rate variables in the productivity gap (PGAP) equation cannot be predicted a priori. For example, if the rationalization effect dominates the output effect in the two country's productivity growth equations (1 and 2), an appreciation of the Canadian dollar vis-à-vis the other currencies will improve Canadian productivity and reduce the manufacturing productivity gap. On the other hand, an appreciation of the American dollar vis-à-vis its trading partners will improve American manufacturing productivity and increase the productivity gap. The opposite is true in the case of an exchange rate depreciation.

The sign of the time trend in the productivity gap equation (PGAP) will depend on the relative size of trend productivity growth in the two countries -- i.e., the size of the coefficient of the time trend in the two country productivity equations. Since Canadian manufacturing productivity is substantially below the U.S. productivity, other things remaining constant, over time productivity differences are expected to narrow (the "convergence" hypothesis of Helliwell, Strum and Salou (1985) and Baumol (1986)). In addition, the substantial liberalization of trade over the last two decades and the marked increase in Canadian trade with other countries, especially the United States, is likely to have increased the pace of Canadian manufacturing productivity growth relative to its U.S. counterpart due to the increased contribution of scale economies and rationalization to the productivity enhancement. Hence, the sign of time trend in the productivity gap equation (3) is expected to be negative - i.e., other things remaining constant, the manufacturing productivity gap is expected to decline steadily over time.

The two unemployment rate variables are introduced to pick-up the impact of cyclical factors on the productivity gap. For example, an increase in the Canadian unemployment rate (a proxy for the overall in the slack Canadian economy) is expected to influence adversely the Canadian manufacturing productivity and increase the manufacturing productivity gap, and vice versa. On the other hand, an increase in the U.S. unemployment rate is expected to reduce the manufacturing productivity gap.

Empirical Results

The econometric results of the productivity gap equation (3) are presented in Table 11 and they are very encouraging. The size of $\bar{R}^2$ (the coefficient of determination) and the Durbin - Watson statistic (D.W.) suggest that the explanatory power of the equations is fairly good and the equations are free from auto-correlation. In addition, the estimated coefficients of the productivity gap equations are fairly robust with the length of the sample period (see equations 4 and 4a), and are in line with the coefficients of the two country productivity equations, reported in Tables 12 and 13.

The coefficient on time trend in the productivity gap equation is consistently negative and significant, suggesting that the trend productivity growth in Canadian manufacturing is significantly larger than its U.S. counterpart. The coefficient on time trend in the productivity gap equations imply that other things remaining constant, Canadian manufacturing productivity growth will exceed the U.S. productivity growth by about 1.5 per cent per year, and would narrow the manufacturing productivity gap over time. This result is consistent with the coefficient of time trend in the two country specific productivity growth equations (see Tables 11 to 13). This finding is in line with the "convergence" hypothesis of Baumol (1986) and Helliwell, Strum and Salon (1985). However, the coefficient on the time trend in the productivity gap equations might also be capturing the possible

Estimated (Representative)
Productivity Gap Equations:

Sample Period: 1962-86

$$\ln(PGAP) = \underset{(0.4)}{0.1906} - \underset{(6.8)}{0.0159}\ TIME + \underset{(3.3)}{0.0718} \ln(RPE)_{-1}$$

$$+ \underset{(0.1)}{0.0219} \ln(RW{\cdot}C/PROD{\cdot}C)_{-1}$$

$$- \underset{(1.5)}{0.3640} \ln(RW{\cdot}US/PROD{\cdot}US)_{-1}$$

$$+ \underset{(3.4)}{0.2124} \ln(RER{\cdot}US)_{-1} - \underset{(2.5)}{0.2342} \ln(RER{\cdot}C)_{-1} \qquad (4)$$

$\bar{R}^2 = 0.888$ S.E. = 0.020 D.W. = 2.13

Sample Period: 1962-80

$$\ln(PGAP) = \underset{(0.2)}{0.1259} - \underset{(7.5)}{0.0168}\ TIME + \underset{(3.4)}{0.0774} \ln(RPE)_{-1}$$

$$+ \underset{(0.1)}{0.0250} \ln(RW{\cdot}C/PROD{\cdot}C)_{-1}$$

$$- \underset{(1.7)}{0.4289} \ln(RW{\cdot}US/PROD{\cdot}US)_{-1}$$

$$+ \underset{(1.6)}{0.2170} \ln(RER{\cdot}US)_{-1}$$

$$- \underset{(2.3)}{0.2250} \ln(RER{\cdot}C)_{-1} \qquad (4a)$$

$\bar{R}^2 = 0.925$ S.E. = 0.018 D.W. = 1.82

where, $\ln(PGAP) = \ln(PROD{\cdot}US) - \ln(PROD{\cdot}C)$

Table 11

Determinants of Trends in Canada-U.S. Manufacturing Productivity Gap [ln (PGAP)]*
(Output per Person Hour): 1962-86

Variable	Expected sign	Equations 1	2	3	4	5	6	7
Constant	(?)	+0.4745 (0.7)	+0.2075 (2.4)	+1.1100 (1.9)	+0.2093 (3.6)	-0.0309	+0.1906 (0.4)	+0.0796 (1.5)
TIME	(-)	-0.01794 (4.9	-0.0203 (6.5)	-0.0208 (8.5)	-0.0204	-0.0117 (10.1)	-0.0159 (6.8)	-0.0158 (7.1)
Real wage-productivity gap, United States	(-)	-0.4340 (1.7)	-1.0118 (4.3)	-0.7807 (5.0)	-1.0191 (5.0)		-0.3640 (1.5)	-0.3568 (1.6)
Real wage-productivity gap, Canada	(+)	+0.0142 (0.1)	+0.2930 (1.1)		+0.2898 (1.4)		+0.0219 (0.1)	+0.0161 (0.1)
Real price of oil	(?)	+0.0614 (2.3)	+0.0585 (2.2	+0.0598 (2.7)	+0.0582 (2.4)	+0.0716 (3.8)	+0.0718 (3.3)	+0.0739 (4.0)
Effective exchange rate, United States	(±)	+0.1654 (1.8)				+0.2952 (6.8)	+0.2124 (3.4)	
Effective exchange rate, Canada	(∓)	-0.2410 (2.5)		-0.1901 (1.6)		-0.2849 (3.0)	-0.2342 (2.5)	
Canadian effective exchange rate/ U.S. effective exchange rate	(-)							-0.2181 (4.0
Investment output ratio, U.S.	(+)		+0.002 (0)					
Investment output ratio, Canada	(-)		-0.007 (0.1)					
Unemployment rate, Canada	(+)	+0.0048 (0.7)						
$\bar{R}^2$		0.919	0.791	0.848	0.812	0.875	0.889	0.892
S.E.E.		0.021	0.028	0.026	0.026	0.021	0.020	0.020
D.W.		2.10	1.97	1.89	1.95	1.58	2.13	2.10

*ln (PGAP) = ln (PRØD·US) - ln (PROD·C).

Table 12

Determinants of Trends in Canadian Manufacturing Productivity [ln (PROD·C)] (Output per Person Hour): 1962-86

Variable	Expected sign	Equations 1	2	3	4	5
Constant	(+)	1.7448 (2.6)	1.8319 (2.8)	1.8422 (2.7)	1.7657 (2.8)	1.6890 (2.6)
TIME	(+)	0.0387 (16.8)	0.0385 (17.1)	0.0376 (20.9)	0.0373 (25.1)	0.0373 (24.7)
Real wage-productivity gap, Canada	(-)	0.0152 (0.8)	0.1267 (0.7)			
Real price of oil, world	(-)	-0.0694 (2.5)	-0.0714 (2.6)	-0.0656 (3.7)	-0.0606 (2.6)	-0.0574 (2.4)
Effective exchange rate, Canada	(?)	0.4964 (3.8)	0.4800 (3.8)	0.4811 (3.7)	0.4914 (3.9)	0.5057 (3.9)
Investment output ratio, Canada	(+)					-0.0216 (0.6)
Unemployment rate, Canada	(-)			-0.0171 (0.4)		
$\bar{R}^2$		0.983	0.984	0.983	0.984	0.984
S.E.E.		0.029	0.028	0.028	0.028	0.028
D.W.		1.45	1.53	1.60	1.59	1.55

Table 13

Determinants of Trends in U.S. Manufacturing Productivity [ln (PROD·US)] (Output per Person Hour): 1962-86

Variable	Expected sign	Equations 1	2	3	4	5
Constant	(+)	4.0727 (12.7)	3.6756 (15.3)	4.1735 (13.2)	4.3404 (15.6)	4.1349 (11.6)
TIME	(+)	0.0212 (8.7)	0.0269 (16.9)	0.0225 (9.1)	0.0201 (9.9)	0.0207 (7.6)
Real wage-productivity gap, U.S.	(-)	-0.3379 (2.0)		-0.3618 (2.2)	-0.4356 (3.5)	-0.3726 (1.9)
Real price of oil, world	(-)	-0.0294 (1.7)	-0.0284 (1.6)	-0.0312 (1.9)	-0.0334 (2.1)	-0.0367 (1.5)
Effective exchange rate, U.S.	(?)	0.0498 (0.8)	0.1123 (2.4)	0.0243 (0.4)		
Investment output ratio, U.S.	(+)		-0.0533 (1.2)	-0.0612 (1.3)		
Unemployment rate, U.S.	(-)					0.0024 (0.4)
$\bar{R}^2$		0.985	0.983	0.986	0.985	0.984
S.E.E.		0.021	0.023	0.021	0.021	0.022
D.W.		1.28	1.97	1.48	1.41	1.36

favourable influence of scale economies and rationalization on the manufacturing productivity gap.

In all the productivity gap equations, the coefficient of the real price of energy is positive and significant. In addition, both the sign and the size of the coefficient are in line with the coefficients in the country specific productivity equations. These results imply that the adverse impact of the two energy price shocks was significantly higher on Canadian manufacturing productivity than in the United States. It seems that the indirect effect of energy prices, operating through a slowdown in technical progress and an acceleration of inflation, was more pronounced in Canada than in the United States. This finding is consistent with the Canadian inflation performance during the latter half of the 1970s and the early 1980s, and a substantial increase in the Canadian personal savings rate during this period.

As expected, the coefficient of U.S. real wage-productivity gap variable in the productivity gap equation is consistly negative, and is in line with the coefficient in the U.S. productivity equation. It implies that any increases in U.S. manufacturing productivity growth, well in excess of real wage gains, other things remaining constant, would create a virtuous cycle of improved competitiveness, higher output growth and improve productivity performance in the U.S. manufacturing sector, and widen the Canadian manufacturing productivity gap.

In contrast, the size of the coefficient of real wage-productivity gap variable in all the productivity gap and Canadian productivity equations is fairly small and is not statistically significant. This weak supply side response is somewhat surprising. This finding implies a weak relationship between profitability and output growth in Canada, providing some indirect support to the thesis of poor management practices in Canada (see Daly [1980] and Daly and MacCharles [1986]). However, it should be acknowledged that our empirical results are based on aggregate industry data and could be subject to an aggregation bias. Therefore, these results should be interpreted with caution.

The coefficients of the two exchange rate variables in the productivity gap equations are statistically significant, and their signs are consistent with coefficients in the country specific productivity equations. Our estimates suggest that the rationalization effect dominated the output effect in both countries, producing a positive relationship between productivity and the exchange rate. An exchange rate appreciation, by increasing the competitive pressures on the industry, will lead to the introductin of rationalizaton and revitalization measures by business enterprises and improve their productivity. On the other hand, a depreciation of the exchange rate will provide protection to the domestic industry from external competition, similar to tariff and non-tariff barrier protection, and retard domestic competition, thus delaying the introduction of revitalization and cost cutting measures, and lowering the pace of productivity improvements.

The coefficients of two exchange rate variables in the productivity gap equations suggest that the marked depreciation of the Canadian dollar vis-à-vis its trading partners during the latter half of the 1970s has lowered the Canadian manufacturing productivity growth, relative to the underlying trend growth, and contributed significantly to the poor performance of Canadian manufacturing productivity gap during this period. Our results also imply that the large appreciation of the U.S. dollar vis-à-vis its trading partners since 1980, contributed significantly to the healthy performance of American manufacturing productivity during the 1980-86 period, and widened the Canadian manufacturing productivity gap since 1980.

The coefficients of two investment variables in the productivity gap equations are either statistically insignificant, and/or have wrong signs. Nevertheless, these results are in accordance with the country specific productivity equations (see Tables 11 to 13). This weak relationship between the investment-output ratio and manufacturing productivity could be a reflection of sluggish output growth and lower capacity utilization rates observed since 1973.

Recent Deterioration of the Manufacturing Productivity Gap: Possible Explanations

Using the parameters of the estimated productivity gap equation (equation (4) in the text), we have computed the contribution of each of the independent variables to the variation in productivity gap (PGAP) over the period 1965-86 (see Table 14). These calculations suggest that the decline in the real price of world oil and the increase in the real wage-productivity gap in the United States have contributed significantly to the narrowing of Canadian manufacturing productivity gap during the 1965-70 period, reinforcing the trend productivity growth effect on the productivity gap (see Table 14).

Whereas, during the 1970-75 period the dramatic increase in the world price of oil more or less offset the trend improvement in manufacturing productivity gap, resulting in no significant improvement in the producitivty gap during this period. The large depreciation of the Canadian dollar, the increase in the real price of oil and the decline in the real wage-productivity gap in the United States contributed to the constancy of Canadian manufacturing productivity gap during the 1975-80 period.

The recent deterioration of the Canadian manufacturing productivity gap could be mainly attributed to the large appreciation of the American dollar vis-à-vis its trading partners and the substantial reduction in the real wage-productivity gap

Table 14

Decomposition of Changes in the Canada-U.S. Manufacturing Productivity Gap: 1965-86

Time Period	Actual change in productivity gap* (1)	Estimated change in productivity gap (2)	Real wage-productivity gap, United States (3)	Real wage-productivity gap, Canada (4)	Real price of oil, world (5)	Effective exchange rate, United States (6)	Effective exchange rate, Canada (7)	Trend (8)
				(Per cent)				
1970-65	-9.8	-9.7	-1.1	+0.1	-0.7	0	0	-8.0
1975-70	-1.9	-3.0	+2.6	+0.1	+6.2	-3.5	-0.4	-8.0
1980-75	-1.5	-2.0	+2.1	0.0	+1.9	-2.2	+4.2	-8.0
1986-80	+4.6	+5.9	+8.6	+0.3	-1.5	+8.8	-0.7	-9.6

* U.S. productivity growth less Canadian productivity growth, unadjusted for changes in the ratio of hours worked to hours paid in the two countries. A negative sign indicates a reduction in the manufacturing productivity gap and vice versa.

Note The estimated change in productivity gap (column (2)) is the sum of the contribution of independent variables (Columns (3) to (8)). The contribution of each variable is computed as the product of the change in the variable concerned by its coefficient in the productivity gap equation presented in the text (equation 4).

in the U.S. manufacturing industry -- i.e., productivity growth was well in excess of real wage growth (see Table 14).[10]

In summary, the constancy of the Canada-U.S. manufacturing productivity gap during the period 1970-80 could be attributed to the adverse impact on the relative performance of Canadian manufacturing productivity of the following: two energy price shocks, the substantial depreciation of Canadian dollar, and the decline in the wage-productivity gap in the United States. The recent deterioration of the Canadian manufacturing productivity gap seems to have been caused by the positive impact of a large appreciation of the American dollar and the increased profitability in the U.S. manufacturing industry (the reduction in real wage-productivity gap) on U.S. manufacturing productivity during the period 1980-86. Therefore, the poor performance of the Canadian manufacturing productivity gap since 1970 is not inconsistent with the traditional Canadian view - i.e., under free trade, Canadian manufacturing productivity would increase relative to its American counterpart and narrow the productivity gap, because of the increased importance of scale economies and rationalization, faster adoption of new technology and improved allocation of resources.

V ECONOMIES OF SCALE: THEORY AND EVIDENCE

West (1971), Baldwin and Gorecki (1986), Daly and MacCharles (1986), conclude from their research on the productivity gap that scale disadvantage is an important reason for the Canadian manufacturing sector's poor productivity performance relative to the United States levels. In contrast, the research of Robidoux and Lester (1988), Fuss and Gupta (1981), Fuss and Waverman (1981, 1986B), Rao and Preston (1984), and Daly and Rao (1986) suggest that the gains in productivity from scale economies might not be large. In this section we review various aspects of scale economies and empirical estimates of the returns to scale in the Canadian manufacturing sector and attempt to provide a reconciliation of the opposing points of view.

SOURCES OF SCALE ECONOMIES

Economies of scale measure the sensitivity of average costs to changes in output, with factor prices remaining constant. Thus the long-run average cost curve of a firm for a given product is also referred to as the "scale curve."[11] Virtually all firms in a given industry produce more than one product. As a result, the concept of scale economies is complicated and involves several dimensions: plant economies, product economies, multi-plant economies, economies of scale in research and development, economies of market size, and economies of scope.[12] The important sources of scale economies are: indivisibilities, economies of increased dimensions and specialization, economies of massed resources, superior organization of production and the like. It is commonly argued that for modern day Canada, economies of longer production runs and product specialization are far more important than other types of plant economies.[13]

Methodology

To assess quantitatively the importance of scale economies in an industry, one needs to estimate the parameters of the total cost function or production function, using either cross-section or time-series data. The slope of the average cost function, derived from the total cost function, determines the importance of scale economies in that industry. The point at which the average cost curve becomes horizontal is defined as the minimum efficient scale (m.e.s.). If the scale curve has a steep slope, the average cost at m.e.s. will be considerably lower than at smaller levels of production. If this were not so, the m.e.s. would be of no great importance, since at smaller output levels no serious cost penalty would be incurred.

A useful summary statistic of scale economies is the elasticity of total costs with respect to output. If the cost elasticity is less than one, increasing returns to scale are present and vice versa. If it is one, the industry is said to exhibit constant to scale. Another useful indicator of the importance of scale economies is the percent increase in average cost at half of the size of m.e.s. plant.

These two indicators are commonly used to evaluate the importance of scale and specialization for improvements in total factor productivity or reduction in unit costs in a given industry. In the rest of this section, we review the available estimates of returns to scale parameters and discuss their implications for gains in productivity and real income from further trade liberalization.

Empirical Results

The returns to scale parameter for an industry can be computed by estimating either a total cost function or a production function, using cross-section or time-series data on either value added or gross output. Therefore, there are eight possible empirical approaches to estimating scale economies, and it is important to understand the key strengths and weaknesses of each.

In evaluating changes in efficiency and their sources, it is also important to distinguish between the two concepts of output: value added and gross output. At the aggregate level the appropriate concept is value added, a measure of the value of output produced by primary inputs (capital and labour) only. However, at the sectoral level, the use of value added data has some limitations and indeed gross output (value added plus intermediate inputs) is preferable as the output measure. Intermediate inputs should be included as one of the explanatory variables. Otherwise the use of value added data, by attributing some of the contribution of material inputs (omitted variable), may tend to bias upward the estimates of TFP (total factor productivity) and the returns to scale parameter. Note that in the manufacturing sector intermediate inputs account for about 65 per cent of the total costs; therefore, the returns to scale parameter and the TFP estimates based on the value added data are likely to be substantially higher than estimates obtained from gross output data.[14]

Time series estimates of scale economies capture the combined effect of plant scale economies, rationalization, and product specific economies. However, it is difficult to econometrically disentangle technical progress from the above mentioned scale effects. In contrast, with cross-section data one could separate out the pure scale effects from the rationalization effects and their impact on total factor productivity more satisfactorily, using the size distribution of plants in a given industry. This distinction is very important for policy analysis.

There are, of course, also some problems with cross-section estimates. For example, it is often argued that in a competitive industry plants with a cost disadvantage due to scale should not be expected to survive. If so, the cross-sectional estimates will not reflect accurately the scale economies since such plants will not be observed. Second, cross-sectional estimates might also be picking up the influence of other important factors, such as entrepreneurship and management practices, on unit costs. If these variables are positively correlated with the plant size, the scale parameter will be biased upward. Third the differences in unit costs between large and small firms might be partly reflecting the market power of larger firms [see Hazeldine (1984)], resulting in upward estimates for the scale parameter; and finally "regression fallacy" as noted by Whalley (1984) is also likely to give an upward bias to the cross-section estimates.

Although theoretically both the production function and the cost function approaches should produce similar estimates for the scale economies, the cost function approach is empirically superior because it will permit the use of flexible functional forms for estimation purposes (see Fuss and Waverman [1986B] and Daly and Rao [1986]). Furthermore, for a given firm or industry it is more realistic to assume the exogenity of factor prices (cost function) than the exogenity of input quantities (production function). On the basis of these considerations we would expect to place most weight on results obtained by fitting cost functions to cross section data.

Comparison of Scale Elasticities

Table 15 compares the available estimates of the returns to scale parameter for 20 two-digit manufacturing industries. All these estimates, with the exception of Zohar (1982) show only slightly increasing returns to scale, despite the differences in data sources and methodologies.

Baldwin and Gorecki (1986), as well as Robidoux and Lester (1986), used the plant-level data for 1969. However, there are some important differences between the two studies. Baldwin and Gorecki (1986) have used the production function (Cobb-Douglas) approach based on value added data, whereas, Robidoux and Lester (1986) and Fuss and Gupta (1981) used the cost function approach, based on gross output data. Not surprisingly, therefore, the estimates of scale parameters by Baldwin and Gorecki (1986) are consistently well above the estimates of Robidoux and Lester (1988) and Fuss and Gupta (1981) in almost all manufacturing industries.[15] Note that the Fuss and Gupta (1981) study is based on pooled cross-sectional industry size class data averages for the years 1965-68.

In contrast, the estimates reported by Daly and Rao (1986) and Zohar (1982) are based on time-series data. Like Fuss and Gupta (1981) and Robidoux and Lester (1988), Daly and Rao used the cost function approach based on gross output data, whereas Zohar used

Table 15

Various Estimates of Scale Economies in Manufacturing Industries

Industry	Daly and Rao[2] (1986) (maximum limit)	Baldwin and Gorecki[1] (1986)	Fuss and Gupta[1] (1981)	Robidoux and Lester[1] (1988)	Daly and Rao[2] (1986) (econometric estimates)	Zohar[2] (1982)
Total manufacturing	1.18	1.17	1.03	1.06	0.95	1.86
Wood	1.15	1.26	1.06	1.02	0.66	1.35
Furniture and fixtures	1.19	1.15	1.01	1.03	1.06	1.45
Primary metals	1.18	1.14	1.05	1.00	0.95	1.59
Metal fabricating	1.21	1.14	1.01	1.04	1.01	1.73(a)
Machinery	1.25	1.07	1.02	1.00	0.92	1.46
Transportation equipment	1.13	1.12	1.11	1.00	1.20(a)	1.92
Electrical products	1.34	1.13	1.01	1.06	1.04	1.61
Nonmetallic mineral products	1.28	1.30	1.12	1.08	0.94	1.67
Food and beverages	1.08	1.27	1.04	1.19	1.61(a)	1.41
Tobacco products	1.29	1.45	1.02	1.00	1.38(a)	1.07
Rubber and plastics	1.15	1.10	1.04	1.01	0.94	1.06
Leather	1.87	1.10	1.01	1.04	0.80	0.80
Textiles	1.40	1.10	1.01	1.03	1.04	0.36
Knitting mills	1.42	1.06	1.01	1.04	1.19	0.82
Clothing	1.42	1.04	1.02	1.02	1.19	1.24
Paper and allied industries	1.24	1.22	1.02	1.10	1.02	1.18
Printing and publishing	1.28	1.22	1.03	1.01	1.20	1.34
Petroleum and coal products	1.02	1.11	1.01	1.02	1.16	1.94
Chemical and chemical products	1.23	1.25	1.02	1.02	0.97	1.45
Miscellaneous manufacturing	1.15	1.04	1.01	1.05	0.92	N.A.

1 Cross-section data is used.
2 Time-series data is used.

(a) Authors estimate a negative productivity (growth) term for these industries.

Source The estimates of Column (2) are from Baldwin and Gorecki (1986) for 1979; the estimates in Column (3) are from Fuss and Gupta (1981) for 1965-68, reported in Baldwin and Gorecki (1986); the estimates in Column (4) are from Robidoux and Lester (1988), Table 5, for 1979; the estimates in Column (6) are from Zohar (1982), Volume 1 and Table 3-3; and the estimates in Columns (1 and 5) are from Daly and Rao (1986) for the period 1958-79.

the production function approach (Cobb-Douglas), based on the value added data.

To provide a benchmark for comparing the reasonableness of various estimates, in Column 1 of Table 14 we show the upper bound estimates for the degree of scale economies in all 20 industries calculated by Daly and Rao (1986). These were computed using time-series data on gross output and the associated inputs for the period 1958-79.[16] Zohar's (1982) results are consistently well above the maximum limits. As expected, the estimates of Baldwin and Gorecki (1986) are higher than the other estimates, with the exception of Zohar. They are close to the maximum limits suggested by Daly and Rao (1986). However, since on average only about 35 per cent of total production costs are accounted for by labour and capital in the manufacturing sector, Baldwin and Gorecki's estimates would be consistent with a scale elasticity of around 1.06 for the total manufacturing sector, based on gross output data or total costs. This result is compatible with the findings of small scale economies reported in Fuss and Gupta (1981), Robidoux and Lester (1988), and Daly and Rao (1986).

In summary, the available econometric estimates of the returns to scale parameter suggest slightly increasing returns to scale in the manufacturing sector. At the aggregate level, these results suggest a range of 0.95 to 1.06, with a median of about 1.03. This in turn implies that doubling manufacturing output will only reduce average costs of production by about 3 per cent, suggesting

Table 16

Summary Statistics for the Canadian Manufacturing Industries

	Canada/U.S. productivity[1] (U.S. = 1.00) (1979)	Level of relative plant product diversity[2] index (1979)	Relative plant scale (1979)	Nominal tariff[3] rate (1978)	Per cent of small plants[4] (1982)	Per cent of total production accounted by small plants[5] (1982)	Average cost penalty associated with sub-optimal production (per cent)	Exports as per cent of shipments (1982)	Imports[6] as per cent of domestic market (1982)
Food and beverages	0.5787	0.3418	0.573	9.9	78.8	18.8	4.16	12.6	8.7
Tobacco products	0.6031	0.1549	1.004	28.3	--	--	0.00	0.8	2.2
Rubber and plastic	--	--	--	12.2	78.0	22.4	1.15	17.4	20.8
Leather	0.6583	0.2577	0.857	17.6	69.0	17.4	3.28	9.4	6.1
Textiles	0.7138	0.3575	0.580	12.5	77.0	12.9	3.59	8.5	25.9
Knitting mills	0.7520	0.3502	0.314	22.9	58.8	21.0	2.24	1.5	28.8
Clothing	0.6453	0.3350	0.799	20.3	90.2	33.9	2.75	6.2	15.0
Wood products	0.6495	0.2486	1.004	4.4	86.0	24.6	3.49	51.7	8.4
Furniture and fixtures	0.5500	0.3552	0.195	15.7	76.7	15.6	3.73	13.6	11.2
Paper and allied industries	0.7267	0.2691	1.050	7.7	51.9	4.8	6.73	56.8	10.6
Printing and publishing	0.8243	0.3255	0.558	6.8	92.1	33.1	5.08	3.7	15.3
Primary metals	0.8774	0.4382	0.863	4.2	55.4	9.3	1.03	56.8	34.8
Metal fabricating	0.8001	0.2976	0.973	8.0	88.3	31.0	3.79	7.4	14.2
Machinery	0.7842	0.3927	0.472	5.9	77.3	19.3	2.50	54.8	74.7
Transportation equipment	0.6719	0.3901	0.773	2.5	73.5	3.4	5.10	82.5	80.2
Electrical products	0.9029	0.3262	0.415	9.5	65.0	18.2	6.94	24.7	39.9
Nonmetallic mineral products	0.8629	0.1045	1.324	5.7	87.1	30.0	5.53	11.5	17.8
Petroleum and coal products	--	0.7259	0.977	3.1	--	--	1.00	7.0	3.1
Chemical and chemical products	0.8335	0.4792	0.764	6.7	66.6	18.7	2.15	27.5	30.4
Misc. manufacturing	0.7910	0.3234	0.448	9.1	77.9	26.9	6.61	29.8	59.2
Weighted 2-digit industry average	0.7330	0.3372	0.736	7.8	82.0	15.0	3.81	31.4	29.8

1 Total factor productivity, based on value added.
2 Weighted average of all the constituent four-digit industries.
3 Ratio of the duty paid to the value of dutiable imports.
4 Plants employing less than 50 people.
5 Per cent of total industry output produced by plants employing less than 50 people.
6 Domestic market = domestic production - exports + imports.

Source Columns 1, 2, 3, 4, 8 and 9 are from J. Baldwin and P. Gorecki (1986); Columns 1 and 6 are authors' estimates based on Statistics Canada data and column 7 is from B. Robidoux and J. Lester (1988).

that the gains in efficiency from increasing the size of the market are probably rather modest.

Rationalization Gains

However, free trade could significantly improve productivity by inducing changes in the structure of manufacturing industries to permit Canadian industry to take advantage of scale economies of larger plants and longer production, and improve its relative productivity. Removal of tariff and non-tariff barriers through increased import competition would force Canadian manufacturing firms to rationalize their operations and reduce their average costs. Increased domestic competition could reduce the number of suboptimal plants through mergers and takeovers, and reduce the share of suboptimal plants in total manufacturing production. In other words, free trade induced restructuring would increase the average plant size in manufacturing.

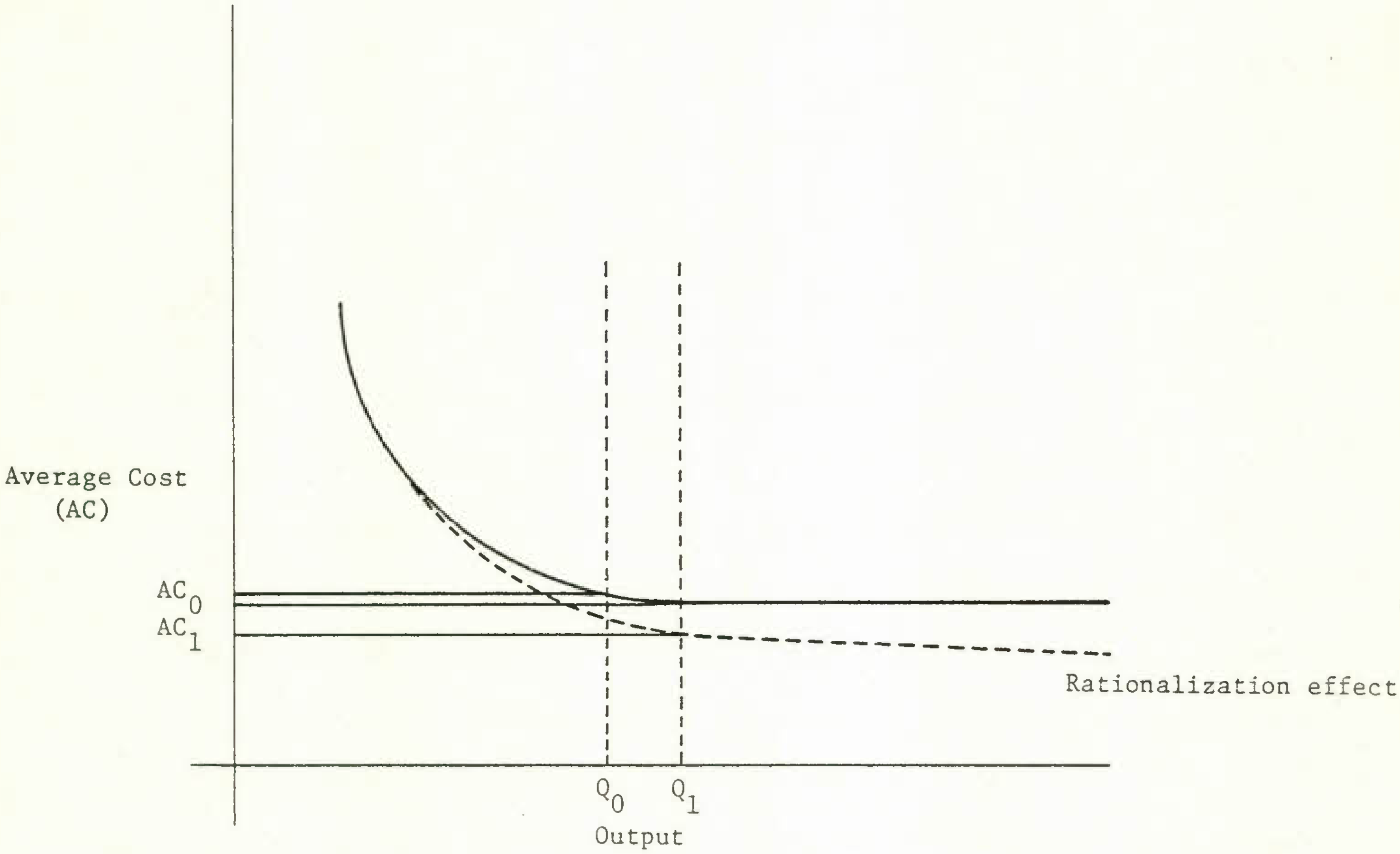
Gains in manufacturing productivity from bringing suboptimal plants to or above the minimum efficient scale levels by consolidating the industry could be more important than gains due to increases in the size of the industry. The size of potential gains in total factor productivity (reduction in average cost) due to rationalization in any given industry depends upon the number of suboptimal plants, their share in the industry's total output, and the sensitivity of plant specific average costs to changes in plant size. In contrast to the size economies discussed above, the size of rationalization gains is independent of changes in the size (output) of the industry. In other words, productivity gains from the restructuring of the industry are derived from a downward shift of the industry's average cost curve (that is a given amount of output is produced with lower unit costs). In contrast, the size economies refer to movements along the industry average curve (from Q0 to Q1 in Chart 3), whereby a reduction in average costs is derived from increases in the output of the industry.

Therefore, the gains in economic efficiency from rationalization -- i.e., restructuring of industry through consolidation of the small plants -- could be significant, even if the gains from <u>size</u> economies turned out to be small. The available estimates suggest that if all the suboptimal plants were to operate at the minimum efficient scale level (minimum average cost), total unit costs could on average decline 3.8 per cent in the manufacturing sector. Since the manufacturing sector's gross output accounts for over 60 per cent of GNP, the gains in GNP and real income from this source alone, even without accounting for any favourable indirect effects, could be over 2.0 per cent (see table 16).[17]

In an effort to check the robustness of this result, the cross-section data from Baldwin and Gorecki (1986) reported in Table 16, are used to compute the simple correlation coefficient matrix between the Canada/United States productivity gap estimates and

Chart 3

Average Cost (Industry) Saving Due To Scale Economies And Rationalization



some of the often-mentioned explanatory variables: relative plant scale, product diversity and the tariff rate. These results show the expected relationship among these variables.[18] Moreover, studies based on more disaggregated industry data found a significantly stronger relationship among the Canadian manufacturing productivity gap, plant scale, product diversity and tariff protection [see Baldwin and Gorecki (1986), Caves, Porter and Spence (1980), Daily and McCharles (1986), and Bernhardt (1981)].[19]

However, it must be acknowledged that the considerable potential productivity gains and the marked variations in the number of optimal and suboptimal plants within each industry, imply considerable adjustment problems for weak industries and those with a large number of inefficient plants. This is particularly true for the nondurable manufacturing industries. For example, in a majority of the nondurable manufacturing industries, the cost savings due to rationalization would be well above the industry average cost savings, a reflection of the importance of suboptimal plants in these industries, such as clothing, printing and publishing, miscellaneous manufacturing, and food and beverages. Similarly, most of the nondurable manufacturing firms are in the low- and mid-tech group, using less sophisticated or low-tech intermediate inputs. As a result, they experienced lower rates of output and employment growth throughout the 1970s and the early 1980s than did the high-tech sectors.[20]

VI CONCLUSIONS AND POLICY IMPLICATIONS

This paper has been concerned with two specific aspects of the Canada-United States free trade debate: the size of U.S.-Canada productivity and per capita income gap and the role of scale economies in explaining this gap. Towards this objective, in the second section, we have developed time series estimates of the aggregate labour productivity and the per capita income gap between the United States and Canada for the period 1961-86. The contribution of U.S.-Canada manufacturing productivity gap to the aggregate productivity gap and an econometric analysis of the past trends in manufacturing productivity gap are dealt in some detail in sections 3 and 4. The importance of scale economies and rationalization for productivity improvements in the twenty two-digit manufacturing industries is examined in section 5.

The important findings of our survey are as follows.

(1) In 1986, Canadian per capita income and aggregate labour productivity levels were about 10 per cent below their United States counterparts. Perhaps due to the severity of the 1981-82 recession and the associated large increase in the Canadian unemployment rate relative to the United States rate, the per capita income gap remained more or less constant around 10 per cent over the 1980-86 period.

(2) Similarly, Canadian manufacturing productivity, on average, is substantially below the United States level. In contrast to the aggregate productivity performance, the Canadian manufacturing productivity gap remained more or less stable around 18 per cent over the period 1970-80. Moreover, because of faster growth in U.S. manufacturing productivity, the manufacturing productivity gap has increased from 18 per cent in 1980 to about 25 per cent in 1987. Consequently, the contribution of manufacturing productivity gap to the aggregate productivity gap has gone up from about 20 per cent in 1960 to over 55 per cent in 1987.

(3) Our econometric analysis of productivity trends in the two countries imply that the indirect effect of the two energy price shocks on manufacturing productivity was significantly negative in the two countries, but was more pronounced in Canada than in the United States. Our results also imply that an exchange rate depreciation, even though it improves competitiveness artificially in the very short-run, could retard the productivity potential, undermine the competitiveness, and reduce the potential growth in real incomes over the medium to longer term.

(4) Our regression results suggest that the recent deterioration (1980-86) of the manufacturing productivity gap was mainly caused by two factors: the exchange rate induced rationalization gains in U.S. manufacturing productivity and

the positive influence of a significant decline in the real wage-productivity gap in the U.S. manufacturing industry on its output and productivity growth. The dramatic increase in the real price of oil, the marked depreciation of Canadian dollar and the decline in real wage-productivity gap in the U.S. manufacturing industry explain the constancy of manufacturing productivity gap during the period 1970-80. Therefore, the poor performance of the Canadian manufacturing productivity gap since 1970 is not inconsistent with the traditional Canadian productivity view - i.e., free trade will narrow the manufacturing productivity gap and improve real incomes in Canada.

(5) Our survey of scale parameters for the 20 manufacturing industries implies slightly increasing returns to scale in the Canadian manufacturing sector. Thus the gains in efficiency from increasing the size of the industry would be modest. For example, the scale parameter estimates imply that doubling of manufacturing sector output could improve the total factor productivity of this sector by about 6 per cent, leading to a 3.5 per cent increase in real GNE.[21]

(6) However, Canadian manufacturing sector has a large number of suboptimal plants (over 70 per cent), operating with high average costs. Therefore, Canada-U.S. free trade, by enhancing competition and speeding up the much needed rationalization of the manufacturing industry, could produce

efficiency gains of about 4.0 per cent in this sector. These gains in manufacturing total factor productivity alone could increase real GNE and per capita real incomes in Canada from free trade by about 2.0 per cent.

(7) Nevertheless, considerable variation in the productivity gap around the industry average, and marked variations among the plants and firms in a given industry imply considerable adjustment problems for weak firms and industries during the transition period under the free trade. But, the ten year phase-in allows an orderly transition period for industries and workers to adapt to tariff free North American market.

Our findings of only modest potential gains in real income from scale economies and rationalization in Canadian manufacturing should not be interpreted to mean that trade liberalization is not worth pursuing. On the contrary, a stable, predictable and liberal international trading system is fundamental to Canada's continued prosperity. In view of strong and rising protectionism in the United States, our largest trading partner, and a great deal of uncertainty about the outcome of current round of GATT negotiations, obtaining a certain and secure access to the United States market for our exports through a free trade agreement with the United States will be of fundamental importance in ensuring the future vitality of the Canadian economy.[22]

Moreover, free trade could influence productivity in a number of ways: speeding up the reallocation of resources from declining to growing industries, adopting new technology more quickly, and increasing the degree of competition. Indeed, these dynamic gains in efficiency from freer trade could be more important than gains due to scale economies [see Lipsy and Smith (1985)]. These positive developments in turn could improve the trade-off between inflation and the unemployment rate and thereby increase the likelihood of stimuli to aggregate demand and improve the utilization of resources, leading to higher output, employment and productivity growth.

In summary, the net long-term output and real incomes gains to Canada from the Canada-U.S. free trade could be significant [see ECC(1986), ECC(1988b) Lipsey and Smith (1985) and Wonnacott (1987)]. However, as the Macdonald Royal Commission report has rightly pointed out, the success of Canadian trade strategy critically depends on the ability of Canadian markets to adjust quickly to changing economic conditions both at home and abroad. Therefore, it remains as important as it has always been for Canada to learn to use new workplace technolooy more quickly and effectively, expand research and development to generate new products and services, develop a flexible and highly-educated labour force, and persue other policies designed to increase overall competitiveness of Canadian industry. If Canada acts quickly and decisively on all these fronts simulataneously, the pay off from the Canada-U.S. free trade could be fairly substantial.

NOTES

1 A comprehensive evaluation of the costs and benefits of free trade would also look into the other important related aspects of the free trade debate: pricing behaviour of the Canadian firms; response of multi-nationals firms to the dismantling of trade barriers, particularly with respect to foreign investment; harmonization of economic policies; costs of adjustment; and political and cultural sovereignty (see ECC [1988b], and Lipsey and Smith [1985]). Although each one of these issues deserves a detailed discussion is beyond the scope of this paper and calls for a separate investigation. Here, we confine our attention to the potential impact of free trade on productivity and real income, resulting from scale economies, specialization and rationalization.

2 It is worth noting that the consequences of using one set of international prices rather than another are well understood from index number theory and practice. The recent work at the OECD has computed the aggregate PPPs and the average prices simultaneously in an implicit process of successive iteration. For an excellent exposition of this technique, see M. Ward (1985).

3 This finding is consistent with the experience of productivity slowdown in almost all the industrialized countries during the post-1973 period. For a good survey of the causes of productivity slowdown, see Economic Council of Canada (1985), Chapters 3 and 4, and Daly and Rao (1985).

4 Like us, BLS (1987) has used the 1987 OECD price weights, whereas Summers and Heston (1986) have used 1975 world average price weights. However, BLS(1987) has used the multilateral price weights, compared to our use of bilateral price weights.

This difference in price weights explains the slight discrepancy between the two sets of estimates (levels). In addition, for computing the aggregate labour productivity, the BLS method includes the U.S. military personnel stationed outside the U.S. in total U.S. employment, whereas the Wharton data, which we have used, excludes them from total employment. Consequently, the BLS estimate of aggregate labour productivity gap is somewhat lower than our estimate. In summary, the differences in price weights and the definition of total employment explain, as expected, the differences in the two sets of estimates (levels). However, as expected, the trends in the two sets of estimates are almost identical.

5 For a detailed discussion of this argument, see ECC (1975) and Daly and MacCharles (1986).

6 Note, however, that the trends in the productivity gap are not influenced by the choice of the benchmark PPP rate, since we have used sector specific inflation rates.

7 However, historical revisions to the basic data in the two countries over time might also have played a significant role.

8 See Daly (1980), Daly and MacCharles (1986), ECC (1983), OECD (1986) and Bank of Canada (1987).

9 See Ostry and Rao (1980), Helliwell, Strum and Salou (1985), Rao and Preston (1984), Daly and Rao (1985), Helliwell (1984), and Kendrick (1981); Baily (1981), Jorgenson (1980), and Stuber (1986).

10 During the period 1980-86, the American real wage-productivity gap declined by about 20 per cent and the American dollar appreciated by more than 40 per cent vis-à-vis its trading partners.

11 At each point on the scale curve resources are assumed to be used efficiently - use of the least-cost combination of inputs and no slack or "X-inefficiency."

12 See Daly (1984), and Daly (1987).

13 For a good description of various types of scale economies, see Daly, Keys and Spence (1968), ECC (1975), Silbertson (1972) and Daly (1987).

14 See Star (1974), Hulten (1978), Silbertson (1972), West (1971) and Emerson (1975).

15 Note that the model of Robidoux and Lester (1988) also captures the product specific scale economies.

16 For a detailed description of this technique, see Daly and Rao (1986).

17 For a good discussion on the weighting procedures, see Hulten (1978) and Daly and Rao (1986).

18 The estimated correlation coefficient between the manufacturing productivity gap and plant scale economies, product diversity and tariff protection is 0.18, 0.16 and -0.40, respectively.

19 These findings are in line with the survey results reported in Daly and MacCharles (1986). Their estimates suggest that tripling of the manufacturing sector output could reduce its average cost by about 22 per cent.

20 See ECC (1987).

21 However, one could argue that the econometric estimates, in spite of the efforts to capture the product specific scale economics, will under estimate the scale economies, because the existing data do not provide the detailed commodity information on costs [see Daly and MacCharles (1986B), Daly (1987)].

22 For example, the protectionism simulation results in ECC (1986) suggest a substantial loss in output and employment in Canada from a significant deterioration in world trading environment. Moreover, the estimated losses in output and employment are on the conservative side, because the simulation results do not take into account the adverse impact of a trade war on the behaviour of Canadian firms. There is now considerable anecdotal evidence that the location decisions for new Canadian facilities are being strongly influenced by concerns about access to the U.S. market.

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