STAFF STUDY No. 32

Canada-United States Price and Productivity Differences in Manufacturing Industries, 1963

by

E. C. West

prepared for the Economic Council of Canada

CANADA-UNITED STATES
PRICE AND PRODUCTIVITY DIFFERENCES
IN MANUFACTURING INDUSTRIES, 1963

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ECONOMIC COUNCIL OF CANADA

1971

This is one of several studies prepared as background for the Seventh Annual Review of the Economic Council of Canada. Although these studies are published under the auspices of the Council, the views expressed are those of the authors themselves. A list of other Council publications appears at the end of this Study.

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PREFACE

This comparative study of Canadian and United States manufacturing industries reflects the Council's continuing research into reasons for persistent differences in levels of economic performance between the two countries. The intention was to move to a finer level of industry classification than that attempted previously. Data are developed on price, output, input and productivity differences in the two countries for a 30-industry sample within manufacturing, with the analysis attempting an explanation of performance differences.

Special thanks go to both Dorothy Walters and Dr. D. J. Daly for their support and interest through all stages of the preparation of this Study. Dr. O. E. Thür and J. E. Gander contributed helpful suggestions on an earlier draft, while Dr. R. Agarwala, Dr. H. H. Postner, and particularly J. B. Lacombe and S. Magun, were extremely helpful with comments on various sections. F. M. Pelletier gave competent assistance in developing the statistical material. The views expressed and the deficiencies of this Study are the sole responsibility of the author.

CONTENTS

Page

APPENDIX TABLES

CHAPTER 1

INTRODUCTION AND SUMMARY

This Staff Study is a continuation of the previous interest of the Economic Council of Canada in the reasons for the lower level of output per employed person in Canada than in the United States. A convenient analytical framework for attacking this problem is provided through the work of Edward F. Denison[1] of the United States which was concerned with the sources of growth and differences in income levels between the United States and eight Western European countries. Miss Dorothy Walters at the Economic Council of Canada, who fitted Canadian data within this framework,[2] concluded that the difference in output per person employed between Canada and the United States in 1960 was due, not to differences in the quantity or quality of resources used in the two countries, but almost solely to a lower level of efficiency in combining and using basic resources. A subsequent updating of this work estimated that real gross national product per person employed in Canada was some 10 per cent below that in the United States in 1964.[3]

The manufacturing sector is known to have an important bearing on this aggregate productivity gap,

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[1]Edward F. Denison, *The Sources of Economic Growth in the United States and the Alternatives Before Us* (New York: Committee for Economic Development, Supplementary Paper No. 13, 1962), and Edward F. Denison, assisted by Jean-Pierre Poullier, *Why Growth Rates Differ: Postwar Experience in Nine Western Countries* (Washington: The Brookings Institution, 1967).

[2]Dorothy Walters, *Canadian Income Levels and Growth: An International Perspective*, Staff Study No. 23, Economic Council of Canada (Ottawa: Queen's Printer, 1968).

[3]Dorothy Walters, *Canadian Growth Revisited, 1950-1967*, Staff Study No. 28, Economic Council of Canada (Ottawa: Queen's Printer, 1970), Table 21, p. 46.

considering its overall importance and wider productivity differential with the United States than most industries. Analysis undertaken by the Council[1] estimated Canadian output per person employed at some one-third less than that in the United States and through interviewing Canadian companies, assessed the importance of factors such as the greater diversification of products in Canada, shorter production runs, more frequent change-overs, etc., as well as the influence of the Canadian tariff in this regard. This analysis pointed up the need for greater scale and specialization in Canadian manufacturing as a means of raising productivity levels.

This present Staff Study has an affinity with both these previous studies. It presents the methodology and analytical results of price, output and productivity comparisons between Canada and the United States for a number of manufacturing industries. Initially, price and output comparisons are made for a sample of 30 manufacturing industries.[2] These are supplemented by data from other sources to make price and output comparisons for total manufacturing as a step in linking these industry comparisons to the more general, aggregative analysis of the other studies. Productivity comparisons were derived for the sample industries, using the output data in conjunction with estimates of inputs (labour, capital, materials and fuel). Price level disparities have analytical

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[1] D. J. Daly, B. A. Keys and E. J. Spence, *Scale and Specialization in Canadian Manufacturing*, Staff Study No. 21, Economic Council of Canada (Ottawa: Queen's Printer, 1968).

[2] Thirty industries at the three-digit level of the Canadian Standard Industrial Classification were selected. For data reasons, distilleries and breweries were combined for most comparisons. The absence of capital stock data at the appropriate level of detail resulted in some further combining of industries, so that 24 industry groups were used in those comparisons in which capital inputs form part of the analysis. The full list of 30 sample industries is given in Appendix A, together with the comparable U.S. industries. Further comments on sample selection appear under Prices and Net Output in this chapter and elsewhere in the Study.

interest in themselves, but also it is necessary to allow for them before meaningful output comparisons can be made between the two countries. The internal purchasing power of currencies differs from one country to another. These differences need not approximate the relation given by exchange rates, though these are sometimes used to convert national products to common currency units.

Both the output and price analyses follow in the tradition of the previous work cited. For example, as a prerequisite to the real output analysis of Walters' Staff Study No. 23, output expressed in the prices of individual countries (national currencies) was converted to a common pricing system. The work in this area as between Canada and the United States was done by the present author and appeared as an Appendix to Staff Study No. 23.[1] It followed methods developed in the 1950's by Milton Gilbert and Irving B. Kravis at the Organization for European Economic Co-operation (OEEC) in Paris.[2] The substantial price differences throughout the Gross National Expenditure (GNE) components (hereafter called the "expenditure approach") sparked interest in the extent of the differences on an industrial basis (the "industry approach").

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[1]In Staff Study No. 23, price comparisons were made between Canada and the United States throughout Gross National Expenditure components, allowing aggregation to overall GNE price and real output comparisons between the two countries. It was found, for instance, that the price level of all goods and services in Canada in 1960 was some 4 to 7 per cent lower than in the United States, with considerable variation from component to component, from lower-priced food and service items to considerably higher-priced appliances and industrial equipment.

[2]Milton Gilbert and Irving B. Kravis, *An International Comparison of National Products and the Purchasing Power of Currencies* (Paris: OEEC, 1954), and Milton Gilbert and Associates, *Comparative National Products and Price Levels* (Paris: OEEC, 1958).

The Scale and Specialization Study indicated that comparisons for manufacturing would make a particularly useful study: "These results, together with those of the three other independent studies, therefore, appeared to leave no doubt that the prices of manufactured products are generally higher in Canada than in the United States; the only uncertainty is in the extent of the difference for total manufacturing."[1] The results of these earlier studies, therefore, represent the point of departure for the price analysis in this Study. In Chapter 2, price comparisons are developed for manufacturing industries in an attempt to quantify this difference for 1963, the latest year for which all necessary data were available. This time lag from the current period is no serious disadvantage because productivity differences, and many of the other relationships, tend to remain at much the same orders of magnitude over longer periods of time.

Once the price level differences in the two countries were established for the sample industries and for total manufacturing, output and factor productivity differences could be examined. Chapter 2 contains many of the basic ratios for these comparisons, starting with a measure of output per employee (labour productivity), and with the relevant concepts, sources and methods for the sample industries. In Chapter 3, other inputs in addition to employment are introduced, both within a production function frame of reference and by a factor share method. Various productivity estimates are thus developed and analysed. Finally, in Chapter 4, by means of a cross-section regression analysis, a beginning is made at an explanation of the variation between the industries in the sample for both price and productivity differences between Canada and the United States. The Appendixes outline the methodology in more detail than is possible in the individual chapters.

Prices and Net Output

Methods of deriving absolute price level, output and output per employee differences with the United States for the sample of 30 three-digit manufacturing industries is the subject of Chapter 2. Weighted volume comparisons were made from the commodity detail for each industry, for gross output and for materials and fuel inputs, as contained

[1]Daly, Keys and Spence, *Scale and Specialization*, p. 12.

in *Census of Manufactures* for each country in 1963.[1] Put in its simplest terms, the method involves pricing each country's output and material inputs with prices of the other country and aggregating for each industry. These totals allow a value, price and volume comparison to be made for each industry for gross output and input. Net output by industry is derived by subtracting material inputs from gross output. However, since the weighting system of both countries is used in these comparisons, two answers are always involved for prices, output and output per employee for each industry. No unique answer is possible for these measurements since it is equally valid to use either country's weighting system for aggregation.

The choice of sample reflects the methodology adopted for making international price and output comparisons on an industry basis. The method requiring direct output comparisons is most appropriate to industries where commodity quality differences would be minimal. For example, in slaughtering and meat packing, commodities comprising output and input differ little in quality between the two countries. On the other hand, industries such as machinery and electrical equipment were not attempted, since the characteristics of their products can differ markedly. The sample selection thus has a disadvantage in that it cannot be used as a proxy for total manufacturing, and other methods were required to arrive at price and volume estimates at this level. The choice of sample, on the other hand, is not a significant factor for the cross-section regression analysis; here, relationships are studied that influence all industries to some degree.

Although the net output concept was used in Chapter 2 to illustrate how the manufacturing sector could be fitted into the overall comparison of the industry and expenditure approaches to international comparisons, its utility diminishes at lower levels of aggregation where its sensitivity, and the possible degree of error, increase. In the later chapters, therefore, in the analysis of the sample industries, the gross output concept is used rather than the net. This reduces the impact of statistical error and has the added advantage of allowing the introduction of materials and fuel as a separate input. For industry analysis, for tracing the impact of stages of processing, and for assessing relative efficiency in their use, the

[1] *Census of Manufactures*, Canada (Ottawa: Dominion Bureau of Statistics), United States (Washington: U.S. Department of Commerce, Bureau of the Census).

explicit introduction of the materials and fuel input offers an important additional line of investigation, in terms of resource use.

Gross Output, Factor Productivity and Total Resource Use

For factor productivity comparisons, some measure of capital service is required. The usual capital stock measures are not available at the three-digit level, so the "Giffen Method" was used. In this method, capital income is multiplied by the reciprocal of the rate of return by industry to derive the capital stock. This derivation of capital stock is described in Appendix D. Also included in Appendix D are estimates of the rate of return on capital for each industry in each country. These rates varied considerably from industry to industry, with the average level for Canada being well below that in the United States. This also is consistent with earlier findings.

The inclusion of capital and material inputs enables analysis of the productivity gap between Canada and the United States in terms of the progressive addition of these inputs. Two methods were used to examine these matters: a *production function* relationship and a *factor shares* approach.

First, a *production function* relation was fitted to the data to relate spatial gross output differences to various input differences, i.e., labour, capital and materials and fuel. However, this methodology did not go far in explaining the productivity difference for the sample. The analysis did suggest, however, that the production functions were quite different for the sample industries in the two countries, with indications of increasing returns to scale for the Canadian industries.

In the factor shares approach, the inputs are weighted according to their proportions in the value of production in each industry. Productivity ratios were calculated using labour inputs, combined labour and capital inputs (factor productivity), and gross output per unit of combined labour, capital and materials and fuel input (gross output per unit of total resource use). With the addition of capital inputs, it was found that the factor productivity estimate differed only marginally from the labour productivity estimate for

the sample aggregate. The introduction of materials and fuel inputs did result in a narrowing of the gap; however, as noted above, this result cannot be generalized to total manufacturing. Even so, for total manufacturing the estimated efficiency in the use of materials and fuel is considerably superior to that obtained for either labour or capital.

Variation Between Industries

While the output, input, price and productivity comparisons for the sample of industries are of considerable interest in themselves, the possibility of explaining the variation in productivity between industries, relative to the United States, holds even greater interest. Factors such as scale, specialization, quality of labour, capital and management, etc., can be expected to contribute to an explanation of these differences. Only a start has been made in this direction in the final chapter of the present Study. There the analysis is in terms of a cross-section regression analysis of the industries in the sample, using gross output per total resource use as the measure of productivity (the dependent variable). This measure of productivity displayed considerable interindustry variation, though not so great as that for the labour and for factor (labour and capital) productivity measures. The variation for the total resource use productivity measure ranged from 23 per cent below U.S. levels (for wool yarn mills) to 21 per cent above (for sawmills). Efforts were made to identify the effect of scale of operations, both in terms of aggregate output and in terms of size of establishment. The analysis also considered the proportion of "nonproduction" workers in the industry (i.e., those workers not engaged directly in the production process).

The final regression analysis dealt with the wide variation in the price of output leaving the factory, relative to comparable industries in the United States. Three factors appeared to be particularly significant to the price variation: materials and fuel costs, productivity differences and "market power" (represented by the proxy, rate of return on capital).

Basic Results

1. The expenditure approach had shown price levels to be some 4 to 7 per cent lower in Canada, with considerable variation between low-priced food and service items and higher-priced appliances and industrial equipment. This Study shows a similar high degree of price variability between industries for factory output within manufacturing. For total manufacturing, estimates of price discrepancies are 6 per cent higher for factory output, little different for materials and fuel input, with a resulting 18 per cent higher price for net output. Once this price discrepancy is allowed for, net output per employee is some one-third lower in Canada, confirming the previous estimates in the Scale and Specialization Study.

2. If net output differences for other industries, similar to the 18 per cent above for manufacturing, could be developed, a reconciliation would then be possible with the expenditure approach of a total price level some 4 to 7 per cent below the United States. Obviously many industries (for example, presumably some service industries) have significantly lower price levels to counteract the higher prices prevailing in manufacturing.

3. The wide range of variation in both price and labour productivity differences with the United States was a major finding. Prices of gross output ranged from 20 per cent below to 34 per cent above. Similarly, for labour productivity, the range was extensive, with the sample averaging 28 per cent below the United States (net output per employee).

4. Attempts were made to bring in other inputs so that output is more adequately related to actual resources used. These indicated that efficiency levels for labour and capital in Canadian manufacturing were more than 20 per cent lower than in the United States, and for materials and fuel, some 12 per cent lower.

5. Analysing both price and productivity performance in Canada vis-à-vis the United States by means of a cross-section regression analysis indicated about a third of the variation in productivity performance between industries is associated with a scale effect -- industries with a large gross output relative to the United States also displayed a high productivity relative to the United States. On the other hand, there is no relationship between

relative productivity performance and relative gross output per establishment. This would suggest that the economies of scale realized with large volume output most likely emanate not from differences in size of establishment but from greater specialization within particular establishments.

6. The regression analysis also indicated that Canadian industries with a low level of productivity relative to the United States tended to have a higher proportion of "nonproduction" workers. There are certain minimum requirements for nonproduction workers in the small-scale operations prevalent in Canada; the requirements need not rise proportionally as output is expanded.

7. As to the wide variation in the price of output leaving the factory relative to comparable industries in the United States, three-quarters of the variation between industries was explained by three factors -- productivity, materials and fuel costs and market power forces. The latter two factors were about equal in importance but were overshadowed by the effect of lower Canadian productivity relative to the United States. An increase in Canadian productivity relative to the United States was accompanied by a more than proportional decrease in the output price differential.

Conclusions

This Study did not go into the difficult question of the extent to which the particular industries might, under some set of circumstances, be able to move towards more favourable comparisons. However, the analysis of productivity and price differences with the United States reinforces the importance frequently attached to specialization and economies of scale. It supports the conclusion that if expansion of output were possible through access to larger markets, a substantial improvement in productivity levels could be expected. Since differentials in size of establishment between industries were not shown to be a significant factor, the higher productivity might come more readily through increased specialization in production within establishments. The improved productivity performance, in turn, could be expected to contribute to a more than proportional decrease in the higher output prices which prevail in Canadian manufacturing. The price reductions would be further facilitated

by a more competitive environment, since the measure of market power was also associated with higher price levels. Moreover, although materials and fuel prices were not substantially higher in Canada than in the United States, higher materials and fuel prices were found to be present, to a significant extent, in those industries with relatively high output prices. The factors giving rise to these higher materials and fuel costs merit further study as a means to more competitive output prices. Better productivity and price performance in the manufacturing industries could be expected, in turn, to contribute to a reduction in the disparity in per capita real income between Canada and the United States.

CHAPTER 2

SPATIAL PRICE, OUTPUT AND LABOUR PRODUCTIVITY COMPARISONS IN MANUFACTURING

The purpose of this chapter is to set forth the methods and procedures adopted for making price, output and labour productivity comparisons between Canadian and U.S. manufacturing industries. It is not possible to work directly with the output, input and value-added data for comparable industries expressed in national currencies since this presupposes equivalence between the internal purchasing power of each currency. Some method of data conversion to a common pricing system is essential as a first step. The chapter thus begins by outlining the methodology used to overcome this problem, which is oriented to making direct physical volume comparisons for each industry. The method is first applied to 30 three-digit manufacturing industries for the year 1963, with the finding that there are substantial and varied price differentials between Canada and the United States for the output and input of comparable industries.

Since prices are generally higher in Canada, real output and labour productivity estimates are lower than that suggested by value figures expressed in national currencies. Although prices in the sample industries were found to be somewhat higher in Canada than in the United States, available data on other manufacturing industries indicate that much greater price differentials prevail in the nonsample part of the industry. If more complete price estimates were developed for these other manufacturing industries, as well as for other industries in the economy, knowledge of significant differences in the price structures of the two countries would be greatly enhanced. However, this is not the orientation of this Study, which concentrates on the sample of manufacturing industries. Other productivity measures are developed to supersede labour productivity by industry to form the basis of a cross-section regression analysis of the variation between industries in both price and productivity differences with the United States.

International Real Output Comparisons

The definitive work in the area of international real output comparisons by Milton Gilbert and Irving Kravis appeared in the early 1950's.[1] This established the methodology for the expenditure approach. Working within GNE expenditure categories at a fine commodity detail level, spatial price and real output comparisons were made for final demand categories, as well as at the level of total output, for the United States and a number of West European countries. Following essentially similar, though less detailed, procedures, estimates were made for 1966 and selected years back to 1950 between Canada and the United States, allowing the Canadian data to be converted to a common pricing system prior to further analysis of differences in income levels between the various countries. These estimates appeared as an Appendix by the present author to Walters' Staff Study No. 23.[2]

The considerable variation in the estimates of the purchasing power equivalents or price differentials for different expenditure categories between Canada and the United States established in this manner suggested the need for similar estimates on an industrial basis. If prices of manufacturing products in Canada are higher than in the United States, and the differentials vary from commodity to commodity, no meaningful real output comparisons can be made for specific industries or for total manufacturing between the two countries by ignoring this fact or by converting to common dollars via the exchange rate.

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[1]Gilbert and Kravis, *An International Comparison of National Products* (1954) and Gilbert and Associates, *Comparative National Products and Price Levels* (1958).

[2]D. Walters, *Canadian Income Levels and Growth*, pp. 253-260.

Comparison of the Industry Approach and the Expenditure Approach

In order to appreciate the problems involved with the industry approach to spatial real output comparisons,[1] a contrast can be made between the methods used in this Study with the earlier expenditure approach. Both methods require the multiplication of Canadian prices (Pc) with U.S. quantities (Qu) and U.S. prices (Pu) with Canadian quantities (Qc). With the expenditure approach, since the majority of the Can./U.S. price comparisons are available in the form of price ratios or price relatives between Canada and the United States,[2] price relatives are the adjusting factor at the detail level of all components of GNE for each country. On aggregation, price and volume comparisons are then possible as shown in the following table.

	U.S. Weights	Canadian Weights
Using price ratios to adjust at detailed level	$\frac{Pu\ Qu}{Pu/Pc} = PcQu$	$\frac{Pc\ Qc}{Pc/Pu} = PuQc$
Price comparison	$\frac{\Sigma PcQu}{\Sigma PuQu}$	$\frac{\Sigma PcQc}{\Sigma PuQc}$
Volume comparison	$\frac{\Sigma PuQc}{\Sigma PuQu}$	$\frac{\Sigma PcQc}{\Sigma PcQu}$

[1]For applications of the industry approach, see J. B. Heath, "British-Canadian Industrial Productivity", *The Economic Journal*, December 1957, and Deborah Paige and Gottfried Bombach, *A Comparison of National Output and Productivity of the United Kingdom and the United States* (Paris: OEEC, 1959). Other international productivity comparisons are L. Rostas, *Comparative Productivity in British and American Industry* (Cambridge: Cambridge University Press, 1948) and M. Frankel, *British and American Manufacturing Productivity* (Urbana: University of Illinois Bulletin, 1957).

[2]Herbert Segal and Frances Pratt, *Comparative Urban Price Levels in the United States and Canada* (Ottawa: Dominion Bureau of Statistics, Prices Division, 1967, mimeo.), available on request.

In effect, by this method, price differentials at a fine level of commodity detail are being weighted by the appropriate U.S. and Canadian GNE categories to give an overall price differential, or purchasing power equivalent, for total output.

Two answers are always available at any level of aggregation for real output comparisons or for the internal purchasing power of currencies since it is equally valid to use either country's weighting system for aggregation. No single answer is possible, thus highlighting the fallacy of exchange rate conversion which "grossly oversimplifies the problem -- and in a way which may obscure facts most essential for analytical and policy-making purposes. This oversimplification results from the assumption implicit in the method that there is a unique answer to the question of the comparative income level between two countries. Since countries differ in the relative amounts of goods and services of different kinds that they utilize, and since their relative internal price structures differ, there need not in fact be such a unique answer to this question."[1]

The industry approach is an adaptation of the expenditure method. Rather than work with GNE expenditure categories, industry output is the weighting system. Quantities, prices and values by commodity are given in considerable detail in the *Census of Manufactures* in each country. Rather than apply price differentials arrived at independently, census of industry detailed

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[1]Gilbert and Kravis, *An International Comparison of National Products*, p. 16. Other points are made by the authors against the use of exchange rate conversion. Any equivalence between the internal purchasing power of currencies and exchange rates for internationally traded goods and services would require long-term equilibrium in exchange rates that in any case would be prevented by tariffs and transportation costs. However, even if the equivalence did in fact exist for internationally traded goods and services, it is unlikely to apply to the large part of output not internationally traded. The relationship of such prices to that given by the exchange rate would not be possible due to large international differences in natural resources, in the quantity and quality of labour and capital, etc.

quantity differentials are the adjusting factor to arrive at the same set of overall aggregates as follows:

	U.S. Weights	Canadian Weights
Using quantity ratios to adjust at detailed level	$\frac{PuQu}{Qu/Qc} = PuQc$	$\frac{PcQc}{Qc/Qu} = PcQu$
Price comparison	$\frac{\Sigma PcQu}{\Sigma PuQu}$	$\frac{\Sigma PcQc}{\Sigma PuQc}$
Volume comparison	$\frac{\Sigma PuQc}{\Sigma PuQu}$	$\frac{\Sigma PcQc}{\Sigma PcQu}$

In this case, the quantity relatives between Canada and the United States at a fine commodity detail level are weighted first with U.S. and then with Canadian industry output weights to arrive at an overall real output comparison. Aggregation can be over an industry or over all industries. Similar aggregates can be made for inputs, and net output can also be determined if inputs are subtracted from gross output, i.e.:

	U.S. Weights	Canadian Weights
Price comparison for net output	$\frac{\Sigma PcQu - \Sigma pcqu}{\Sigma PuQu - \Sigma puqu}$	$\frac{\Sigma PcQc - \Sigma pcqc}{\Sigma PuQc - \Sigma puqc}$
Volume comparison for net output	$\frac{\Sigma PuQc - \Sigma puqc}{\Sigma PuQu - \Sigma puqu}$	$\frac{\Sigma PcQc - \Sigma pcqc}{\Sigma PcQu - \Sigma pcqu}$

where the capital letters refer to gross output and the lower-case letters to inputs. This removes the duplication in gross output, recording only that produced in that industry. The net output price comparison can be interpreted as representative of the price differential for the combined factors of production in that industry relative to the U.S. industry.

The industry approach as outlined above is theoretically applicable to all industries, although data deficiencies in nonmanufacturing industries create practical

problems. The aggregation of net output over all industries would result in a price and volume comparison for the total economy similar to the expenditure approach. However, the two approaches to international comparisons are not conceptually identical at the total output level. Further reconciliations are required since the concept of output differs. Output as measured by final demand categories is national and at market prices, while output on an industrial basis is domestic and at factor cost. These reconciliations and other problems are analogous to those encountered in measuring total output in one country through time. The solution for spatial comparisons is likely similar to temporal comparisons; the weighting system and price relatives of the expenditure approach are more easily converted to the industry approach. In other words, it would be necessary to allocate indirect taxes over expenditure items so that the weighting system could be reduced from market prices to factor cost. Similarly, the price differentials could be adjusted from market to factor by determining the difference in tax incidence by item between the two countries. These adjustments need not be elaborated here, since our concern is manufacturing, not total, output. However, the above industry approach to price and volume comparisons for gross output, input and net output, as used throughout this Study, would be applicable to total manufacturing if it were to be integrated into overall industry and expenditure comparisons.

Further details on limitations, procedures, problems and adjustments in specific industries following the industry approach to international price and output comparisons are contained in Appendix B. A reading of such problem areas is necessary to appreciate the nature and limitation of the data and the approximate nature of some specific industry results.

The method for the industry approach as outlined above was applied to 30 industries for the year 1963 scattered throughout most industrial groups in manufacturing. With spatial price and output comparisons determined for the sample, an extension, by other estimating methods, was made for the nonsample portion and, hence, estimates for total manufacturing. This is the focus of the last section of this chapter.

Estimates by Industry

Table 2-1 sets out the results for the industries in the sample following the industry approach to spatial price and volume comparisons between Canada and the United States in 1963. The slaughtering and meat packing industry can be used by way of illustration. Since the distribution of output (or of input) is never identical between like industries in the two countries, two answers for price and volume of output result. Production in Canada is 4.72 per cent of the United States for net output in terms of U.S. weights and 5.58 per cent with Canadian weights. As Canada has a considerably higher proportion of employees in the industry than the United States (12.16 per cent), Canadian net output per employee is only 39 or 46 per cent of the United States. The absolute level of prices for the industry is about 12 per cent higher in Canada than in the United States for output at the factory, irrespective of the weighting system used. With input prices only about 2 per cent higher than in the United States, the effect on the net output price level is considerable, increasing it to 65 or 95 per cent higher than in the United States. The high sensitivity of the net output price comparison is enhanced by the high input-output ratio in slaughtering and meat packing. With the difference between output and input small in magnitude, a revaluation of Canadian output with substantially lower U.S. prices and little change for the input revaluation has a large impact on the difference in the two aggregates and thus in both the net output price and volume comparisons.

Subject to a higher margin of error, net output is less trustworthy in a statistical sense than the other measurements. For this as well as other reasons, the analysis in the following chapters is in terms of gross rather than net output. However, even subject to error, there are interesting differences in the interaction between different output and input prices throughout the sample. In the poultry processing industry for instance, the price differentials (Canadian weights) behave in a converse fashion to that displayed in slaughtering and meat packing. In this case, even though the price level for products leaving this industry are some 28 per cent above U.S. levels, there is no difference for the price related to net output, since high output prices are matched by high input prices.

Table 2-1

CANADA/UNITED STATES
PRICE, OUTPUT AND OUTPUT PER EMPLOYEE,
BY INDUSTRY, 1963

Industry	Value = Price x Real Output $\frac{\Sigma PcQc}{\Sigma PuQu} = \frac{\Sigma PcQu}{\Sigma PuQu} \times \frac{\Sigma PcQc}{\Sigma PcQu}$			or $\frac{\Sigma PcQc}{\Sigma PuQc} \times \frac{\Sigma PuQc}{\Sigma PuQu}$	
Slaughtering and Meat Packing					
Output	8.89	112.8	7.88	111.7	7.95
Input	8.83	102.2	8.64	102.5	8.62
Net output	9.18	164.5	5.58	194.5	4.72
Employee ratio			12.16		
Net output per employee			45.9		38.8
Poultry Processors					
Output	8.40	130.0	6.46	127.5	6.59
Input	8.83	134.0	6.58	133.9	6.59
Net output	6.59	112.9	5.83	100.0	6.59
Employee ratio			7.33		
Net output per employee			79.5		89.9
Dairy Products					
Output	9.83	93.8	10.47	90.5	10.86
Input	10.36	87.4	11.86	86.4	11.99
Net output	8.47	110.0	7.70	105.8	8.01
Employee ratio			12.64		
Net output per employee			60.9		63.4
Feed Manufacturers					
Output	11.37	113.3	10.04	115.0	9.89
Input	12.39	110.3	11.24	107.2	11.56
Net output	8.37	122.1	6.85	168.3	4.97
Employee ratio			15.00		
Net output per employee			45.7		33.1
Bakeries					
Output	9.61	80.2	11.98	80.3	11.97
Input	10.91	98.2	11.11	95.7	11.40
Net output	8.47	64.4	13.15	67.9	12.47
Employee ratio			13.22		
Net output per employee			99.5		94.3
Confectionery					
Output	7.97	99.7	8.00	104.3	7.65
Input	8.00	105.5	7.58	106.3	7.53
Net output	7.94	92.3	8.60	101.9	7.79
Employee ratio			12.90		
Net output per employee			66.7		60.4

Table 2-1 (cont'd.)

Industry	Value $\frac{\Sigma PcQc}{\Sigma PuQu}$	= Price $\frac{\Sigma PcQu}{\Sigma PuQu}$	x Real Output $\frac{\Sigma PcQc}{\Sigma PcQu}$	or $\frac{\Sigma PcQc}{\Sigma PuQc}$	x $\frac{\Sigma PuQc}{\Sigma PuQu}$
Sugar Refineries					
Output	11.08	119.1	9.31	118.3	9.37
Input	11.42	118.9	9.61	116.3	9.33
Net output	10.16	119.5	8.50	125.0	8.12
Employee ratio			9.88		
Net output per employee			86.0		82.2
Soft Drinks					
Output	7.39	94.8	7.80	94.5	7.82
Input	6.71	103.6	6.48	104.2	6.44
Net output	7.84	87.8	9.05	88.9	8.93
Employee ratio			11.27		
Net output per employee			80.3		79.2
Alcoholic beverages					
Output	14.14	130.0	10.88	130.0	10.88
Input	9.93	116.2	8.55	104.4	9.52
Net output	17.44	140.9	12.38	146.0	11.95
Employee ratio			15.66		
Net output per employee			79.1		76.3
Tobacco Products					
Output	8.01	118.9	6.73	118.9	6.74
Input	8.55	93.7	9.13	96.9	8.83
Net output	7.46	144.1	5.18	160.8	4.64
Employee ratio			12.72		
Net output per employee			40.7		36.5
Rubber Industries					
Output	7.39	103.7	7.12	100.5	7.35
Input	7.95	107.1	7.42	107.0	7.42
Net output	6.84	100.3	6.81	93.9	7.28
Employee ratio			8.56		
Net output per employee			79.6		85.0
Shoe Factories					
Output	8.01	96.0	8.34	95.0	8.43
Input	8.79	97.7	9.01	97.0	9.05
Net output	7.34	94.6	7.76	92.9	7.90
Employee ratio			9.91		
Net output per employee			78.3		79.7
Wool Yarn Mills					
Output	7.41	134.0	5.52	134.0	5.52
Input	6.64	98.6	6.75	91.8	7.25
Net output	9.27	223.3	4.16	798.7	1.16
Employee ratio			12.57		
Net output per employee			33.1		9.2

Table 2-1 (cont'd.)

Industry	Value = $\frac{\Sigma PcQc}{\Sigma PuQu}$	Price = $\frac{\Sigma PcQu}{\Sigma PuQu}$	x Real Output $\frac{\Sigma PcQc}{\Sigma PcQu}$	or $\frac{\Sigma PcQc}{\Sigma PuQc}$	x $\frac{\Sigma PuQc}{\Sigma PuQu}$
Hosiery Mills					
Output	7.23	103.1	7.01	92.9	7.78
Input	7.06	111.5	6.33	102.3	6.89
Net output	7.43	93.3	7.96	84.2	8.82
Employee ratio				8.05	
Net output per employee			98.9		109.6
Men's Clothing					
Output	6.66	128.0	5.19	116.2	5.73
Input	6.99	120.0	5.83	120.0	5.83
Net output	6.29	137.4	4.58	112.0	5.62
Employee ratio				8.35	
Net output per employee			54.9		67.3
Sawmills					
Output	26.15	94.0	27.82	94.0	27.82
Input	26.60	123.5	21.55	123.9	21.47
Net output	25.57	55.9	45.76	70.9	36.04
Employee ratio				23.79	
Net output per employee			192.3		151.5
Veneer and Plywood					
Output	15.51	109.6	14.15	99.0	15.67
Input	15.54	131.1	11.86	124.7	12.46
Net output	15.47	79.6	19.43	76.7	20.17
Employee ratio				19.63	
Net output per employee			99.0		102.8
Pulp and Paper					
Output	25.81	109.7	23.53	99.0	26.06
Input	25.21	107.4	23.47	102.4	24.62
Net output	26.42	112.0	23.59	96.0	27.51
Employee ratio				29.40	
Net output per employee			80.2		93.6
Other Paper Converters					
Output	6.23	107.3	5.81	106.7	5.84
Input	6.49	110.6	5.86	101.9	6.37
Net output	5.90	103.1	5.73	114.4	5.16
Employee ratio				8.60	
Net output per employee			66.6		60.0
Iron and Steel					
Output	5.37	96.8	5.55	95.7	5.61
Input	4.84	108.6	4.46	104.1	4.65
Net output	6.00	82.8	7.24	88.8	6.76
Employee ratio				6.56	
Net output per employee			110.4		103.0

Table 2-1 (cont'd.)

Industry	Value = $\frac{\Sigma PcQc}{\Sigma PuQu}$	Price = $\frac{\Sigma PcQu}{\Sigma PuQu}$	x Real Output $\frac{\Sigma PcQc}{\Sigma PcQu}$	or $\frac{\Sigma PcQc}{\Sigma PuQc}$	x $\frac{\Sigma PuQc}{\Sigma PuQu}$
Fabricated Structural					
Output	14.34	107.2	13.38	106.8	13.43
Input	13.13	102.6	12.80	101.9	12.89
Net output	15.98	113.3	14.10	112.8	14.16
Employee ratio				16.40	
Net output per employee			86.0		86.3
Motor Vehicles and Parts					
Output	6.36	102.3	6.22	99.6	6.39
Input	6.27	95.0	6.60	95.0	6.60
Net output	6.53	116.4	5.61	109.3	5.97
Employee ratio				8.29	
Net output per employee			67.7		72.0
Battery Manufacturers					
Output	7.29	110.6	6.60	109.6	6.66
Input	8.48	92.4	9.19	92.1	9.21
Net output	6.12	128.6	4.76	148.0	4.14
Employee ratio				7.71	
Net output per employee			61.7		53.7
Cement Manufacturers					
Output	10.50	97.3	10.79	97.3	10.79
Input	9.13	99.5	9.17	96.7	9.43
Net output	11.18	96.2	11.63	97.6	11.47
Employee ratio				9.16	
Net output per employee			127.0		125.2
Concrete Products					
Output	10.01	119.1	8.40	112.4	8.90
Input	10.47	94.9	11.04	91.4	11.46
Net output	9.62	139.0	6.93	141.6	6.80
Employee ratio				12.24	
Net output per employee			56.6		55.6
Ready-Mix Concrete					
Output	7.08	91.1	7.78	91.1	7.78
Input	7.74	97.7	7.93	97.6	7.93
Net output	6.20	82.3	7.53	81.9	7.57
Employee ratio				7.46	
Net output per employee			100.9		101.5
Petroleum Refineries					
Output	8.33	105.9	7.86	106.4	7.82
Input	8.27	94.5	8.75	94.0	8.80
Net output	8.56	154.4	5.53	233.0	3.66
Employee ratio				8.16	
Net output per employee			67.8		44.9

Table 2-1 (concl'd.)

Industry	Value = $\frac{\Sigma PcQc}{\Sigma PuQu}$	= Price $\frac{\Sigma PcQu}{\Sigma PuQu}$	x Real Output $\frac{\Sigma PcQc}{\Sigma PcQu}$	or $\frac{\Sigma PcQc}{\Sigma PuQc}$	x $\frac{\Sigma PuQc}{\Sigma PuQu}$
Paints and Varnishes					
Output	7.51	117.1	6.42	116.3	6.46
Input	7.18	105.3	6.82	103.6	6.94
Net output	7.91	131.3	6.02	134.4	5.88
Employee ratio			10.80		
Net output per employee			55.7		54.4
Soap and Cleaning Supplies					
Output	3.62	113.0	3.20	113.5	3.19
Input	4.04	115.0	3.51	115.0	3.51
Net output	3.27	111.3	2.94	111.9	2.92
Employee ratio			4.52		
Net output per employee			65.0		64.6

About half the industries presented in Table 2-1 fall into a category similar to poultry processors, since they have input price differentials with the United States that exceed the industry's output price differential and therefore make for more favourable price comparisons for net output. This characteristic is present in those industries that have a high labour productivity relative to the United States, such as sawmills, veneer and plywood, pulp and paper, and iron and steel. In these industries, as in the others, the input and output price comparisons are a major factor affecting the productivity comparisons when these are expressed in terms of net output.

The major interest in the data as presented in Table 2-1 at this point is the high variability by industry in the estimates. Both the output and input price differentials have an extensive range of variation, from about 20 per cent below U.S. levels to more than 30 per cent above. The regression analysis of Chapter 4 is used to examine these differences between industries, and also to consider productivity differences in terms of the factor productivity measurements developed in the following chapters. The labour productivity estimates of Table 2-1 also exhibit a high degree of variability between industries, mainly because they are highly sensitive to the net price and net output derivations. The range of variations in labour productivity so derived is from 67 per cent below U.S. levels for wool yarn mills to 92 per cent above for sawmills. However, only seven of the industries in the sample exceed or approximately equal U.S. levels of productivity; these include bakeries, hosiery mills, sawmills, veneer and plywood, iron and steel, cement manufacturers, and ready-mix concrete industries. The majority of Canadian manufacturing industries in the sample are considerably below U.S. levels, and the average for the sample is some 25 per cent below the United States.

As noted above, all of the net price differentials, net output differentials and net output per employee differentials of Table 2-1 are highly sensitive to the relationship of input price differentials to output price differentials and, hence, are also highly sensitive to any errors in the price data. For this reason, undue emphasis should not be placed on the net labour productivity estimates. However, the net measures are conceptually correct when fitting manufacturing into the overall check between the expenditure and industry

comparisons. This will be apparent in the section on total manufacturing below.

Total Manufacturing

Methods used to move from price, output and labour productivity comparisons for the 30-industry sample to similar estimates for total manufacturing are given in Appendix C. Essentially the method involved reweighting the price differentials derived from the sample with weights relating to total manufacturing rather than to the sample. To increase coverage throughout all industrial groups, the sample results were supplemented by price data from other sources, such as the Segal-Pratt study, the expenditure study and the survey results of the Daly, Keys and Spence Study.

Further coverage of the residual, nonsample industries would be necessary to achieve strict comparability with the sample industries. Nevertheless, these estimates are at approximately the level of detail, and degree of accuracy, of the expenditure study which used similar methods to derive the overall GNE purchasing power equivalent between Canada and the United States.

Table 2-2 presents the results for total manufacturing. The form of presentation highlights the differences between our sample results and the estimates for the rest of manufacturing. The aggregation of the industries included in the sample to which the direct industry approach to international price and output comparisons was applied is shown at the top of Table 2-2, followed by the aggregation of all other industries in manufacturing where use was made of indirect methods of estimating price differences with the United States. The substantial difference in the estimates reflects the use of different prices and different weights in aggregation. A random sample of 30 manufacturing industries could be accepted as representative of total manufacturing. However, the selection of industries for our sample tended towards industries that were amenable to the industry approach (see Appendix B) so that industries with highly complex products with widely different characteristics, such as machinery and electrical equipment, were not attempted; price data for these industries were gathered from other sources. The output price levels in Canada for such industries were usually well above U.S. levels and have

a large weight in total manufacturing. Similarly with respect to inputs, industries such as electrical equipment, chemicals, clothing and textiles had high input prices, as well as high output prices, and also had a large weight in total manufacturing.

It is evident, then, that our sample cannot be used as a proxy for total manufacturing. The considerably higher price differentials for the nonsample industries raises the price differentials for total manufacturing considerably above those observed for the sample industries.

For total manufacturing, the level of prices for output leaving the factory is in the order of 6 or 11 per cent higher in Canada than in the United States, depending on whether the Canadian or U.S. weighting system is used. With input prices estimated as only slightly higher, the price level disparity is more acute at the net output level (18 or 26 per cent).

This much higher price differential for net output for the nonsample group is reflected in a much lower volume of net output. Principally as a result of these differences, the productivity level relative to the United States is about 10 percentage points lower for the nonsample manufacturing industries than for the sample. This is not reflected in productivity comparisons based on value figures where no account is taken of these price level differentials.

Total manufacturing before the adjustments shown in Table 2-2 is the aggregation throughout all industries in manufacturing, followed by our final estimate where account is taken of other inputs into manufacturing not deleted from census net value added (see Appendix C). Census net value added nets out only materials and fuel purchases. Outside purchases of business services such as advertising, telephone, insurance, etc., should also be deleted to reflect actual output for the industry, i.e., output on a Gross Domestic Product basis. Since such service charges are some 20 per cent lower in Canada, the effect is to lower our estimate of the input price differential for total manufacturing in the adjusted total.

Table 2-2

CANADA/UNITED STATES
PRICE, OUTPUT AND OUTPUT PER EMPLOYEE
IN MANUFACTURING, 1963

	Value = Price x Volume				
	$\frac{\Sigma PcQc}{\Sigma PuQu}$ =	$\frac{\Sigma PcQu}{\Sigma PuQu}$ x	$\frac{\Sigma PcQc}{\Sigma PcQu}$ or	$\frac{\Sigma PcQc}{\Sigma PuQc}$ x	$\frac{\Sigma PuQc}{\Sigma PuQu}$
Sum of Sample					
Gross output	8.77	104.6	8.38	101.3	8.66
Input	8.66	101.0	8.57	99.8	8.68
Net output	8.95	110.6	8.10	103.8	8.62
Employees	11.25				
Net output per employee	79.5		72.0		76.6
Sum of Nonsample					
Gross output	6.55	114.8	5.70	109.7	5.97
Input	7.40	108.6	6.81	106.5	6.94
Net output	5.72	120.8	4.73	113.9	5.02
Employees	7.39				
Net output per employee	77.4		64.0		67.9
Total Manufacturing Before Adjustments					
Gross output	7.40	110.9	6.67	105.7	7.00
Input	7.95	105.3	7.55	103.2	7.71
Net output	6.74	117.6	5.73	109.4	6.16
Employees	8.46				
Net output per employee	79.7		67.7		72.8
Total Manufacturing After GDP and Head Office Adjustment					
Gross output	7.40	110.9	6.67	105.7	7.00
Input	7.75	102.0	7.59	100.1	7.74
Net output	6.82	125.5	5.44	118.0	5.79
Employees	8.45				
Net output per employee	80.7		64.4		68.5

Price and output comparisons for gross output, input and net output, for both the industry and total manufacturing, supply valuable information on the structure of input prices as well as output prices. Moreover, for this analysis, the net price differential is conceptually the correct price in order to match results at the total output level between the industry and expenditure approach. If estimates for other industries were available for this net output price differential, a price level disparity for total output would be available, once net output price differentials were weighted with industry Gross Domestic Product weights. The expenditure approach, referred to earlier, found no substantial price level disparity between Canada and the United States at the total output level. Other industries, in total, therefore, must have price levels below those in the United States to counteract the higher prices which this Study indicates prevail in manufacturing. Presumably many of the service industries provide a large part of this offset. Much further research is needed on the industrial structure of Canadian prices in relation to the United States, both for these other sectors of the economy and for the nonsampled portion of manufacturing, before these relationships can be clarified.

It was principally for the above relationships with the expenditure approach that the net output estimates were prepared in this Study. The orientation of the Study now switches in the following chapters to a development of other productivity measures for our sample of industries, followed by a regression analysis of price and productivity differences between the industries in the sample. For the most part these are based on the gross output differentials.

CHAPTER 3

AGGREGATE OF SAMPLE INDUSTRIES

Objectives

In the previous chapter, spatial price and output comparisons were developed for the sample of manufacturing industries. These were used as part of similar comparisons for total manufacturing in order to relate to other labour productivity studies and to present a measure of the purchasing power equivalent for total manufacturing within the context of the overall price disparity between Canada and the United States. In this and the following chapter, attention is concentrated on the sample industries. The large and varied price differentials between industries in the sample relative to the United States establish the need for a measurement of purchasing power equivalents before any meaningful real output and productivity comparisons can be made between the two countries.

In Chapter 2, Table 2-2, *real* net output per employee for the industries in the sample was shown to be some 28 per cent below U.S. levels for 1963. Is it possible to explain this large productivity differential with the United States? This is the major theme of this chapter. However, the net output concept, although essential for relating total manufacturing with the expenditure approach, is less appropriate at the three-digit level due to the greater margin of error in the estimates. A further important consideration requiring the gross output concept is the introduction in this chapter of materials and fuel as a separate input like labour and capital. Separate estimates of the level of efficiency in the use of this specific input are then possible. The further analysis, therefore, is in terms of gross output rather than net output.

The intention in this chapter is to establish the difference in level for the measure of productivity that combines labour and capital for the aggregate of the sample, then progressively add other variables that influence output in order to explain the aggregate productivity difference. It is not surprising that this

ambitious undertaking was not wholly successful in its primary undertaking, though it has findings of importance.

The first approach, seeking an explanation to the sample's productivity differential with the United States (the Cobb-Douglas Type Production Function Method), is to fit a functional relation to the cross-section of sample data relating gross output differences with the United States to various input differences, i.e., labour, capital, and materials and fuel.

It is not possible to explain productivity differences with the United States for the aggregate of our sample by this production function approach, which can be faulted for its restrictive assumptions. The subsequent section of the chapter develops more refined productivity measures for the specific industries in the sample by the Factor Share Method. For each industry individually, factor shares going to labour, capital, and materials and fuel in gross output are used as a weighting system to combine these inputs. In addition to labour productivity, two additional measures of productivity are then available: combined labour and capital productivity (factor productivity), and combined labour, capital, and materials and fuel productivity (gross output per unit of total resource use).

The chapter concludes with an analysis of the behaviour of these three productivity measures in aggregate for the sample of industries. The stress, as in the previous method, is still with an explanation of the gap in productivity for our sample between Canada and the United States. In other words, in both methods, as additional inputs are added so that output is more adequately related to actual resources used, the question is whether there has been any narrowing of the gap in productivity with the United States. The conclusion is that by the factor share method, the most refined productivity measure (output per unit of total resource use) does show a narrowing of the gap for the aggregate of the sample. However, the sample cannot be regarded as the general case for all manufacturing, since it is not a random selection and therefore cannot be accepted as a proxy for total manufacturing.

In the following chapter, the approach to the problem of productivity differences with the United States changes. Rather than concentrate on the productivity gap for the aggregate of the sample, the emphasis shifts to the variation between industries in the sample as regards

productivity; a regression analysis is used to seek an explanation of the differences. The chapter concludes with a similar regression analysis of output price differences within the sample.

Capital Input

The data required for the calculation of different productivity measures in this chapter are available from Table 2-1, with the exception of a measure of capital input. These other measures include, for each industry, the Canada/United States percentage comparisons of gross output, materials and fuel input and net output (by both weighting systems), as well as the number of employees.[1] It was decided arbitrarily to restrict ourselves throughout to the Canadian weighting system, i.e., U.S. measures of output, materials and fuel inputs, etc., were revalued in Canadian prices (Canadian rather than U.S. price weights).

Some measure of capital input is required if our productivity measures are to reflect this input as well as labour, and to determine, for example, whether the Canadian industries are more or less efficient in the use of capital as well as labour. In other words, would the gap in productivity between Canada and the United States for our sample of industries tend to be increased or reduced if factor productivity (labour and capital)

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[1]Conceptually a more appropriate measure of labour input would be man-hour data. Unfortunately, the development of these data was completed too late for incorporation in this Study. It did, however, prove to be a minor adjustment, particularly for gross output per unit of total resource use -- the series used in the following chapter for the dependent variable in our productivity analysis. Here, the effect was minimal due to the reduced weight of labour input in this productivity measure. The mean for the sample remained the same whether on an employee or man-hour basis; only about a third of the industries were affected, and usually by only one index point in the productivity measure.

measures were used instead of simply labour productivity? Only an outline of the derivation of gross capital stock estimates for both countries is given here; more extended treatment of the technical details of the method are described in Appendix D.

The customary practice of estimating capital stock by the perpetual inventory method was not possible at the three-digit level of our sample because investment series extending back some fifty years were not available. As an alternative, assets reported by corporations for income tax purposes were used to derive capital stock estimates. This method, commonly called the Giffen Method, multiplies capital income by the reciprocal of the rate of return by industry to derive the capital stock. With each country's capital stock determined in this manner, it was then necessary to convert the U.S. stock to Canadian prices. Analogous to the concern of Chapter 2, purchasing power equivalents or price differentials between Canada and the United States were required for the different elements of capital stock, i.e., inventories, land, and plant and equipment. This repricing is particularly important for the latter two items, since construction prices are some 10 per cent lower in Canada while machinery and equipment prices are estimated at about 25 per cent higher. While subject to disadvantages, as are any capital stock measures, the use of the Giffen Method was considered adequate in order to give some indication of the *difference* rather than absolute levels in capital resources utilized in the United States and Canada for the industries in the sample.

Selected data derived from the implementation of the Giffen Method of capital stock estimation are presented in Appendix Table D-1. On average, over the sample, the price level for the total gross capital stock was estimated some 8 per cent higher in Canada, with considerable variation between industries. With Canadian gross capital stock for each industry now available, expressed as a percentage of the U.S. stock also in Canadian prices, a capital input measure can be combined with a labour input measure. Both measures of factor input exhibited the same degree of variation between industries. An interesting by-product of the Giffen Method is estimates of the rate of return on capital by industry in each country. Essentially a means to an end in the capital stock derivation, the estimates are of interest as they exhibit considerable

variation between industries in each country with a significantly lower rate prevailing on average for Canadian industries.

The Cobb-Douglas Type Production Function Method[1]

This method of estimating the sample's productivity differential with the United States fits a logarithmic relation to the data of output and input with a constant term denoting productivity differences, i.e., for each industry

$$(1) \qquad x = (a)l^{\alpha}$$

where x is the quantity of output and l the quantity of labour. (a) is a productivity parameter relating output to input and α is the elasticity of output with respect to labour. Since this is a cross-section study of Canadian and U.S. manufacturing, let

$$\frac{x_c}{x_u} = X \text{ and } \frac{l_c}{l_u} = L,$$

so that for each industry the Can./U.S. comparison is

$$(2) \qquad \frac{x_c}{x_u} = \left(\frac{a_c}{a_u}\right)\left(\frac{l_c}{l_u}\right)^{\alpha}$$

$$(3) \text{ or } \quad X = pL^{\alpha}$$

where p is a ratio of the two parameters relating output and the quantity of labour.

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[1]The methodology used in this section was suggested by Heath, *Economic Journal*, pp. 678-680, where it is applied to a British-Canadian manufacturing cross-section.

Bringing in capital, this function now becomes the Cobb-Douglas, i.e.,

$$(4) \qquad X = pL^{\alpha}K^{\beta}$$

Materials and fuel (M) can also be introduced if X is considered as gross output rather than net output, i.e.,

$$(5) \qquad X = pL^{\alpha}K^{\beta}M^{\delta}$$

In this conceptual framework, materials and fuel are treated as just another input.

The Can./U.S. productivity ratio, p, should approach unity as more factors are added to explain the output ratio; p would finally reach unity if all factors affecting output could be accounted for, such as differences in labour quality, vintage of capital, management quality, degree of monopoly, etc. With only the factors of production usually included, the p should be interpreted as the productivity ratio due to other variables not included.

This use of the Cobb-Douglas function would assume that the ratio of the elasticity of substitution between capital and labour is unity.[1] The production function is also unrestrained in that the coefficients can add to values other than unity testing the constant returns to scale hypothesis. It is also assumed that the elasticities of labour and capital are the same for each industry and the same between the two countries with respect to the matched group of industries used in the cross-section.

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[1]Given the divergent results for the value of the elasticity of substitution both within and between cross-section and time series studies, the use of the unit elasticity of substitution (Cobb-Douglas) still appears to be most useful for this Study. See A. A. Walters, *An Introduction to Econometrics* (Glasgow: Macmillan, 1968), p. 331, "the hypothesis of unit elasticity of substitution is not discredited by the data. The Cobb-Douglas function is therefore a good approximation." A similar conclusion is arrived at by Hall and Jorgenson after their review of the literature. See Robert E. Hall and Dale W. Jorgenson, "Tax Policy and Investment Behaviour: Reply and Further Results", *American Economic Review*, June 1969.

Fitting equation (3) (labour productivity) across the 24-industry[1] cross-section for gross output[2] on labour, $X = pL^{\alpha}$:

	p	α
	.72	1.01
Student T	(-1.24)	(9.36)

$\bar{R}^2 = .79 \quad N = 24$

Since the equation is fitted in the logarithms, the elasticity of output with respect to labour is immediately available and p gives the Canadian labour productivity level vis-à-vis the United States. Canadian labour productivity is 72 per cent of the United States. It is significant at approximately the 12 per cent level of significance and compares with the previous estimate in Chapter 2 of 75 per cent.[3]

This level of labour productivity of 72 per cent means that the remaining gap of 28 per cent must be explained by the sum of all other factors affecting output other than labour (assuming labour quality the same between Canada and the United States).

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[1]The original 29 industries declined to 24 when capital stock estimates could not be developed for poultry, sugar refineries and fabricated structural steel. Cement, concrete products and ready-mix concrete also had to be aggregated for the capital stock estimate.

[2]The equations were also fitted using net output as the output variable as well as gross output. This gave more erratic results due to the greater margin of error in this data where inputs are subtracted from gross output expressed in comparable prices.

[3]In Chapter 2, Table 2-2, net output per employee for the sum of sample is given as 72.0 per cent of the United States. The comparable gross output per employee estimate is 74.5 (8.38/11.25).

Adding capital inputs, as in equation (4), is the Cobb-Douglas formulation, gross output on labour and capital, $X = pL^{\alpha}K^{\beta}$

	p	α	β	
	.58*	.75*	.34*	
Student T	(-2.15)	(5.35)	(2.55)	
				$\bar{R}^2 = .83$ $N = 24$

With all the coefficients significant and a greater percentage of the variation in output explained with the addition of capital (the $\bar{R}^2$ increasing from .79 to .83), the p parameter would be expected to move towards unity rather than declining. This indicates an inferior use of capital in Canada as well as labour relative to the United States, or use of a relatively poorer quality of capital, so that the combined effect, or factor productivity level, fails to improve. There is also the necessity of using relatively more capital in the form of plant in Canada relative to the United States because of climate. Note that the coefficients sum to 1.09, suggesting increasing returns to scale.

The additional input of *materials and fuel* was then included in the function to test its impact on the productivity ratio, thus rounding out the methodology.

$X = pL^{\alpha}K^{\beta}M^{\delta}$

	p	α	β	δ	
	.68*	.31*	.14	.66*	
Student T	(-2.00)	(1.99)	(1.24)	(3.94)	
					$\bar{R}^2 = .90$ $N = 24$

The productivity ratio, although increasing somewhat, reflecting the greater relative efficiency in the use of materials than of labour and capital combined, has not moved significantly towards unity as anticipated. The productivity gap of roughly 30 per cent still has to be explained by factors other than labour, capital, and

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* Significant at the 10 per cent level, one-tail test.

materials and fuel, as measured here. $\bar{R}^2$ is still increasing but a problem of multicollinearity is introduced. Materials and fuel has the highest correlation with output (r = .94) but also has a high correlation with labour (r = .88). This stronger variable thus captures much of the influence on output and reduces the importance of the other variables, so that the coefficient of capital now ceases to be significant. The sum of all the coefficients continues to increase to 1.11.

Scale of operations is often cited as an important factor explaining *productivity differences* between Canada and the United States. If this hypothesis is correct, introducing a specific variable representing scale into the production function should result in a significant coefficient for this variable and result in the coefficients adding to more than unity. The specific scale variable developed was based on a comparison of the average size of establishment, in terms of number of employees, in Canada compared with the United States.[1]

The introduction of "scale" gives the following equation:

(6) $X = pL^{\alpha}K^{\beta}M^{\delta}S^{\lambda}$

	p	α	β	δ	λ
	.55*	.22	.15	.71*	.07
Student T	(-2.06)	(1.24)	(1.29)	(4.04)	(.95)

$\bar{R}^2$ = .90 N = 24

This also proved unsuccessful, as "scale" failed to explain any part of the output variation, i.e., the $\bar{R}^2$ remains .90; the productivity ratio drops to .55 of the

[1]For each country, number of establishments and number of employees is given for each employee size group, i.e., firms employing 1-4, 5-9 employees, etc. The average number of employees per establishment for each size group was then calculated and weighted by total employment in each group. The weighting is intended to give a weighted average which is representative of where actual employment is concentrated.

United States, while the labour, capital and "scale" coefficients all become not significant at the 10 per cent level. Even though the coefficients add to 1.15, it has not been possible to confirm this suggested increasing returns to scale by this method of adding a specific variable for scale.[1]

The results thus far in combining various inputs and their relation to output can now be summarized. When labour input differences alone are related to output differences between Canada and the United States, the productivity level is 72 per cent of that of the United States, compared with 75 per cent by the previous method that did not fit a functional relation to the data. Labour and capital together, and labour, capital, and materials and fuel combined, give productivity levels somewhat lower, i.e., 58 and 68 per cent of the United States, respectively. The introduction of one measure of "scale" as a specific variable, causes the productivity level to drop to 55 per cent of the United States. In other words, taking account of these other inputs and the "scale" factor, in no way explains the productivity gap between Canada and the United States for our sample of manufacturing industries. In fact, the methodology is suspect, with the productivity gap increasing rather than decreasing as more factors explaining output are included.

One of the assumptions underlying this approach is the similarity of the elasticities of labour and capital in the two countries for this particular group of industries. In order to test this assumption, equation (4) can be fitted to the data for each country individually with the following results:

	p	α	β	
United States	.67	.23*	.72*	
Student T	(-.37)	(1.76)	(6.53)	$\bar{R}^2 = .86$ $N = 24$
Canada	.15*	.34*	.73*	
Student T	(-2.57)	(3.04)	(7.53)	$\bar{R}^2 = .90$ $N = 24$

[1]The average number of employees per establishment has a low correlation with both gross output and labour productivity, i.e., .36 and .18 respectively, suggesting it is a poor indicator of "scale".

It is evident that the value of the coefficient for labour differs significantly between the two countries,[1] while the productivity parameter for Canada divided by the productivity parameter for the United States is only .21 rather than .58 by the ratio method of equation (4) above. The major problem is the different scale factor for the two countries, i.e., $\alpha + \beta$ for Canada = 1.07 but only .95 for the United States.

The only formulation where it was possible to get a reasonable value for the p parameter under this methodology was the fitting of the following equation to each country separately, i.e.:

$$X = pL^{1-\alpha}K^{\alpha}$$

$$= p\ L/L^{\alpha}\ K^{\alpha}$$

$$(7) \quad X/L = p(K/L)^{\alpha}$$

	p	α	$1-\alpha$		
United States	17.25*	.72*	.28		
Student T	(2.54)	(6.76)		$\bar{R}^2 = .66$	$N = 24$
Canada	14.08*	.71*	.29		
Student T	(2.66)	(7.52)		$\bar{R}^2 = .71$	$N = 24$

The productivity parameter for Canada divided by that for the United States gives the more reasonable value of 82 per cent of the United States for labour and capital combined,

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[1]The switch in the values of the coefficients away from the expected 70 for labour and 30 for capital is a result of the higher correlation of capital with output that applies in both countries, i.e.:

Correlation with Dependent Variable

	Labour	Capital
United States	.79	.92
Canada	.82	.93

which reduces the labour elasticity. This is reinforced by the multicollinearity between labour and capital of .73 in both countries.

since the coefficients are roughly similar and economies of scale have been held constant between the two countries.

It must be concluded that the Cobb-Douglas production function approach, as used here, fails to explain the productivity gap for our sample of manufacturing industries between Canada and the United States. Further analysis, therefore, was carried out using the factor share method, as outlined in the section that follows. However, there are indications, although inconclusive, of increasing returns to scale for our sample of manufacturing industries in Canada. When the Cobb-Douglas function is used in the Can./U.S. ratios and also when it is used for the Canada data separately, the sum of the coefficients of labour and capital exceeds unity. This increase in labour and capital inputs bringing about a more than proportional increase in output is subject, of course, to the limitation of the Cobb-Douglas assumptions. This entails that the coefficients be considered as an average for the sample cross-section. This, however, should not be a disadvantage for the measurement of returns to scale. On the other hand, the unsatisfactory performance of the average number of employees per establishment as an indicator of scale further beclouds the issue. Its failure could be related to the variable itself or to the methodology. This subject will be taken up again in the following chapter.

The Factor Share Method

The assumption of identical production functions for different industries in the sample is the most questionable assumption of the Cobb-Douglas approach. In order to relax this assumption, factor shares going to labour, capital, and materials and fuel in gross output in each industry were taken as estimates for the coefficients.[1] The use of factor shares for this purpose also requires assumptions, i.e., constant returns to scale, perfect competition in the factor and goods markets, and that the marginal productivity law holds. In

[1]Canadian shares were used for combining labour, capital, and materials and fuel for both countries. There is considerable difference in shares between industries, but relatively minor differences for the same industry in each country.

this situation, in equilibrium, the coefficients measure the share of receipts paid to each factor. While these assumptions may not necessarily hold for particular industries, the use of factor shares is at least superior to the assumption that the coefficients are the same for each industry as in the previous approach. An added advantage is the calculation separately for each industry of gross output per unit of labour and capital, and gross output per unit of labour, capital, and materials and fuel combined, with different coefficients for each industry. Table 3-1 presents the results of this method.[1]

The relation between the three productivity measures shown in Table 3-1 can best be appreciated by noting the relative use of inputs. The sum of the sample shown at the bottom of the table gives some indication in aggregate of the relative use of inputs and the effect on the productivity estimate. Since on average the industries in the sample use both proportionally more capital as well as labour to about the same degree in their production relative to the United States, the combined labour and capital productivity measure differs little in aggregate from that of labour productivity. While this may be the case on average, there are wide differences in these propensities between industries. In the rubber industries and petroleum refining, for example, the relative use of capital in Canada is quite high compared with that of labour. The converse applies in iron and steel, and a number of other industries, where the capital input is lower than that in the United States. With the degree of dispersion in the relative use of labour and capital about the same between industries, the wide disparities between industries in the sample noted in Chapter 2 for labour productivity has not been diminished for combined labour and capital productivity.

Since both materials and fuel have been treated in detail and revalued in the prices of the other country,

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[1]The productivity estimates for the sum of the sample were obtained by calculating output in relation to the three inputs separately and combining them with factor share weights from the sample.

it is also possible to introduce another measure of productivity. This measure, conceptually more appropriate in respect of *gross* output, combines labour, capital, and materials and fuel inputs, as shown at the extreme right in Table 3-1 in terms of gross output per unit of total resource use. Materials and fuel are here considered as another input, in the use of which there may be economies or diseconomies just as there might be for labour and capital.[1]

This more inclusive measure of the productivity differential with the United States is not as unfavourable to Canadian performance as the other two measures. Rather than a 25 per cent productivity gap, output in relation to total resource use averages only 12 per cent below U.S. levels in this sample of industries. The remaining gap may be explained by differences in factors not specified, such as labour quality, age, quality or efficiency of capital, and differences in management, organization, effort, etc.

In most of the industries in Table 3-1, the relative use of materials and fuel is considerably lower than that of labour or capital inputs. The average for the industries in the sample for the materials and fuel input is very close to relative output. Thus, in this sample, Canada is closer to U.S. efficiency levels in the use of materials and fuel inputs than it is for labour and capital. Not only do the measures of productivity move to a higher level relative to the United States, when account is taken of total resource use, but the dispersion of productivity differentials also decreases somewhat. It is also of interest that the production function method, referred to previously, gave the same direction of movement for labour productivity, factor productivity and output per unit of total resource use as this factor share method, though the levels and variations differ appreciably: i.e., 72, 58, 68, and 75, 73, 88, respectively.

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[1]See Lawrence R. Klein, *An Introduction to Econometrics* (Englewood Cliffs, N.J.: Prentice-Hall, 1962), p. 97, where a preference is expressed for a gross output, rather than value-added, concept for manufacturing with materials and fuel treated as a separate factor of production.

Table 3-1

CANADA/UNITED STATES RATIO OF OUTPUT, INPUTS AND PRODUCTIVITY, MANUFACTURING INDUSTRIES, 1963(1)

(Canada as percentage of United States)

	Can./U.S. Gross Output	Inputs			Can./U.S. Gross Output per Unit of:		
		Labour	Capital	Materials and Fuel	Labour	Labour and Capital	Labour, Capital Materials and Fuel
Slaughtering and Meat Packing	7.88	12.16	14.23	8.64	64.8	60.6	85.0
Dairy Products	10.47	12.64	11.77	11.86	82.9	86.0	87.7
Feed Manufacturers	10.04	15.00	9.27	11.24	66.9	89.7	89.4
Bakeries	11.98	13.22	9.12	11.11	90.6	106.8	107.4
Confectionery	8.00	12.90	14.44	7.58	62.0	58.3	81.2
Soft Drinks	7.80	11.27	10.23	6.48	69.2	73.3	89.5
Alcoholic Beverages	10.88	15.66	14.94	8.55	69.5	72.1	85.9
Tobacco Products	6.73	12.72	7.31	9.13	53.0	78.3	75.8
Rubber Industries	7.12	8.56	13.45	7.42	83.3	65.7	80.5
Shoe Factories	8.34	9.91	12.63	9.01	84.2	78.0	85.1
Wool Yarn Mills	5.52	12.57	10.53	6.57	44.0	47.1	67.2
Hosiery Mills	7.01	8.05	14.53	6.33	87.1	69.0	88.5
Men's Clothing	5.19	8.35	6.62	5.83	62.2	67.2	78.5
Sawmills	27.82	23.79	27.13	21.55	116.9	110.4	120.8
Veneer and Plywood	14.15	19.63	18.50	11.86	72.1	73.8	97.7
Pulp and Paper	23.53	29.40	28.02	23.47	80.0	82.4	90.8
Other Paper Converters	5.81	8.60	8.44	5.86	67.5	68.1	84.8
Iron and Steel	5.55	6.56	4.94	4.46	84.6	98.9	110.6
Motor Vehicles and Parts	6.22	8.29	8.32	6.60	75.0	74.8	86.9
Battery Manufacturers	6.60	7.71	12.18	9.19	85.4	65.2	68.9
Cement, Concrete Products and Ready-Mix	8.69	9.78	12.79	8.97	88.9	75.1	84.8
Petroleum Refining	7.86	8.16	15.70	8.75	96.4	58.2	82.5
Paints and Varnishes	6.42	10.80	13.37	6.82	59.4	51.8	70.8
Soap and Cleaning Supplies	3.20	4.52	5.21	3.51	70.9	64.1	76.8
Sum of Sample	8.38	11.25	11.61	8.57	74.5	73.2	88.3

(1) Calculations based on Canadian weights.

Source: United States and Canada 1963 *Census of Manufactures* and estimates by Economic Council of Canada. Gross capital stock estimates derived from *Source Book Statistics of Income* for the United States (Washington: U.S. Treasury Department, Internal Revenue Service) and *Taxation Statistics* for Canada (Ottawa: Department of National Revenue).

The Productivity Gap

The sample of industries suggests that the productivity gap is widest between Canada and the United States for factor productivity and there is a narrowing of the productivity gap if account is taken of materials and fuel inputs. When all inputs are combined, output per unit of total resource use of the sample industries in Canada is 88 per cent of that for those industries in the United States.

The question now arises as to whether this narrowing of the productivity gap would also apply to total manufacturing. However, due to the significant difference in prices, output and productivity between the sample and nonsample, the sample cannot be taken as a proxy for total manufacturing. Some rough estimate of the probable magnitudes for total manufacturing can be obtained from the data in Table 2-2 and a proxy approach to the missing relative capital inputs.

From Table 2-2 it will be seen that, for total manufacturing, gross output per unit of labour input is 79 per cent of the United States (6.67/8.45). Gross output per unit of material input is 88 per cent of the United States (6.67/7.59). With no knowledge of capital input for total manufacturing, a tentative solution is to use an estimate derived from the Walters' estimate of capital stock per person employed in manufacturing relative to the United States that is considerably higher than that suggested by our sample.[1] If the output per unit of capital input for total manufacturing derived from this source is combined with the other inputs, the combined output per total resource use is 81 per cent

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[1] D. Walters, *Canadian Income Levels and Growth*, p. 83. Her estimate differs in many respects from the one used here -- for example, by excluding land and inventories. The Walters' estimate implies a much larger capital input in Canada relative to the United States, and output per unit of capital input considerably lower than in this Study (see Table 3-2). The Walters' estimate of the relative capital stock per employed person in manufacturing, in 1960, was 123 Can./U.S. compared with our sample estimate of 109 in 1963.

of the United States, and the narrowing of the gap between Canada and the United States for total manufacturing is slight and hardly significant, i.e., from 79 per cent of the United States for labour productivity to 81 per cent for output per total resource use. These comparisons are summarized in Table 3-2.

Table 3-2

COMPARISON OF SAMPLE AND TOTAL MANUFACTURING PRODUCTIVITY MEASURES, 1963

(Canada as percentage of United States)

	Sample	Total Manufacturing
Output per unit of labour input	75	79
Output per unit of capital input	72	64[1]
Output per unit of materials and fuel input	98	88
Output per unit of total resource use	88	81

[1] Derived from D. Walters' Can./U.S. capital stock per employed person.

It is apparent from Table 3-2 that output per unit of materials and fuel input is 98 for the sample industries but only 88 for total manufacturing. The latter is not too dissimilar from that of the Table 2-2 estimate for the nonsample of 84 per cent of the United States (5.70/6.81). By these measures, therefore, the sample industries appear to be considerably more efficient in materials and fuel use than the rest of manufacturing. The weighted average of the sample and nonsample industries would indicate that the efficiency in materials and fuel use at the total manufacturing level is 88 per cent that of the United States.

In summary, this chapter has sought an explanation for the 25 per cent labour productivity gap for our sample of manufacturing industries with the United States. Our first approach, which fitted a functional relation to

the data on output and input, failed in this primary objective. Results from this approach should be discounted to some extent, due to the rather unrealistic assumptions inherent in the approach. Such assumptions need not distract in any way, however, from its positive contribution that there are strong indications of increasing returns to scale for our sample industries. This will be supported by further evidence in the following chapter. The second or factor share approach, which combines inputs more realistically on an industry-by-industry basis, suggests a narrowing of the productivity gap with the United States as further inputs other than labour are considered. However, the sample does appear unique in its relative use of capital and materials and fuel inputs compared with total manufacturing. For total manufacturing, using a somewhat different measurement of capital inputs than for the sample industries, output per unit of capital input was much less favourable than in the sample; the same was true for materials and fuel inputs, though these continued to raise the relative productivity comparison for Canadian manufacturing above that shown for labour input only.

For total manufacturing, therefore, the conclusion is that not only does Canada use proportionally more labour than the United States to produce a comparable volume of output, but also that the efficiency level for capital is more than 20 per cent below the United States. Even in the use of materials and fuel, Canada is much less efficient than the United States, with output per unit of materials and fuel use some 12 per cent below the U.S. level.

It might be noted that the gap in productivity below the United States for total manufacturing persists at some 20 per cent for our final estimate of gross output per unit of total resource use. Future research would seem best directed to a study of other factors or characteristics aside from the quantities of basic resources used in production.

CHAPTER 4

VARIATION BETWEEN SAMPLE INDUSTRIES

In the previous chapter, while factor productivity estimates were developed for each industry in the sample via the factor share method, the analysis was directed to the sample as an aggregate and to total manufacturing. Now the emphasis in this chapter turns to the specific industry estimates, to the objective of making a beginning at an explanation of the wide disparaties *between* the industries in the sample in both their productivity and price performance vis-à-vis the United States. The methodology is a cross-section regression analysis of the 24 industries utilizing the data developed in the previous chapters. In particular, it examines the importance of relative differences in their levels of output and the proportion of "nonproduction" employees (that is, those employees in the establishment who are not directly engaged in the production process). Gross output per unit of total resource use relative to the United States, the final productivity measure under the factor share method from Table 3-1, will be the dependent variable for the productivity analysis.

The later part of the chapter deals with relative price performance. The gross output price differentials (Canadian weights) from Table 2-1 will be the measure of price performance in Canada relative to the United States that requires explanation. Keeping in mind that the sample is not representative of total manufacturing, it is still possible to use it to study relationships which could affect all industries to some degree, i.e., relationships that have general validity irrespective of the choice of sample.

Productivity Performance Relative to the United States

Factors contributing to the wide variation in productivity between industries need to be isolated. Is the relatively poor performance of many Canadian industries in the sample a reflection of small-scale operations, lack of specialization, a lower quality of labour, capital or management, etc.? To attempt to

answer such questions requires the development of variables for each industry related to these factors. This is a large undertaking that would require considerable further research. At the moment only a few variables have been developed related to the scale of operations and the incidence of nonproduction workers in our sample.

If *economies of scale* is an important factor, the problem is to find an adequate measure of scale. In the previous chapter, average number of employees per establishment (weighted by employment) proved unsatisfactory as a scale variable. Two other options are now introduced as scale variables: (a) gross output Can./U.S., and (b) gross output per establishment Can./U.S. If a large gross output (X) relative to the United States or a large gross output per establishment (X/est) is associated with a high productivity relative to the United States (X/LKM),[1] some of the variation in the latter should be explained by regressing X/LKM on X or X/est.[2] The estimated equations are:

$$X/LKM = 79.41^{*} + .10\,X/est$$
$$\text{Student } T \quad (12.41) \quad (1.22) \qquad \bar{R}^2 = .02 \quad N = 24$$

$$X/LKM = 73.38^{*} + 1.42^{*}X$$
$$\text{Student } T \quad (18.36) \quad (3.83) \qquad \bar{R}^2 = .37 \quad N = 24$$

The second equation shows a more than proportional increase in total factor productivity in Canada associated with an increase in gross output relative to the United States with 37 per cent of the total variation explained.

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[1]Gross output per unit of labour, capital, materials and fuel inputs.

[2]See W.E.G. Salter, *Productivity and Technical Change* (Cambridge: Cambridge University Press, 1960), pp. 109-113 and Appendix C, for the possibility of spurious correlation since X appears in both variables. Salter's tests discounted the extent of serious error in the measured correlation. This conclusion is reinforced in this Study, since variables are all expressed as differences with the United States.

However, this is not the case with the first equation. A high factor productivity in a Canadian industry relative to the United States is not associated with a high average establishment output or establishment size. The scale effect registered in the second equation -- the more than proportional productivity increase with high volume output -- must then be associated with factors independent of the average size of the establishment. What these factors are, would be difficult to pinpoint. They may be peculiar to particular industries and differ from one industry to another, or Canada may simply have a comparative advantage in particular industries. However, it would appear most likely that the degree of specialization in some industries is limited by the extent of the market, while high volume production makes possible greater specialization in particular establishments *independent of their size*.

Size of establishment is also discounted in the Daly, Keys and Spence Study.[1] Their survey results of Canadian manufacturing companies as regards productivity differences with the United States point to greater diversification of products, shorter production runs, frequent change-overs, etc., rather than size of establishment, as the significant factors in the differences in productivity between the two countries. "... on the basis of the information which has been collected, *the limited extent of specialization* has turned out to be not only an important, but also a pervasive, factor adversely affecting costs and productivity in manufacturing in Canada."[2]

A few of the industries that are close to or above U.S. factor productivity are shown in Table 4-1, together

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[1]On the other hand, see Z. Griliches, "Production Functions in Manufacturing: Some Preliminary Results", M. Brown, ed., in *The Theory and Empirical Analysis of Production*, N.B.E.R., Studies in Income and Wealth, vol. 31, 1967, pp. 297-305, where, working with fine size classes based on average number of employees, economies of scale are found to be zero for lower size classes and significantly positive for large size classes.

[2]Daly, Keys and Spence, *Scale and Specialization*, p. 23.

with their relative gross output, relative gross output per establishment, and relative average number of employees per establishment (weighted by employment). These high-performance industries have quite different characteristics. Iron and steel is below average output relative to the United States, but close to it in gross output per establishment. The converse is true for bakeries. The wood and paper industries, on the other hand, are consistent in a higher-than-average output relative to the United States, as well as having a higher output per establishment.

Table 4-1

HIGH-PERFORMANCE INDUSTRIES RELATIVE TO THE UNITED STATES AND SELECTED SCALE VARIABLES

(Canada as percentage of United States)

	Gross Output per LKM (1)	Gross Output	Gross Output per Establishment	Average Number of Employees per Establishment
Bakeries	107.4	11.98	23.3	63.8
Sawmills	120.8	27.82	110.0	81.0
Veneer and Plywood	97.7	14.15	112.0	164.1
Pulp and Paper	90.8	23.53	135.2	93.1
Iron and Steel	110.6	5.55	95.6	73.0
Mean of Total Sample	86.5	9.28	70.5	68.9

(1) Per unit of labour, capital, materials and fuel inputs.

It is significant that if all these highly proficient industries appearing in Table 4-1 are deleted from the regression of X/LKM on X, the relationship still holds.

$$X/LKM = 66.49^* + 2.05^*X$$
$$\text{Student } T \quad (12.00) \quad (2.80)$$
$$\bar{R}^2 = .28 \qquad N = 19$$

In other words, there is a consistent, more than proportional, increase in factor productivity as output is expanded relative to the United States over the whole

range of output comparisons. This is not evident in the case of *output per establishment* where no relationship between the two is observable whether these proficient industries are included or excluded. Note that the coefficient of the independent variable has increased significantly, indicating a much stronger scale effect for industries with below-average output relative to the United States.

In the previous chapter, the Cobb-Douglas formulation gave indications of increasing returns to scale, with the coefficients of labour and capital exceeding unity. The evidence above supports these previous findings. In this particular case, increasing the scale of operations in Canada is associated with a more than proportional increase in productivity relative to the United States. It is also significant that, while formerly the scale effect may have been simply a reflection of a unique sample, it now appears more general. As shown above, the scale effect is even stronger for those industries with a below-average scale of operations.

The percentage of *nonproduction employees* Can./U.S. by industry (X_2) is the remaining variable developed to date in our attempted explanation of productivity differences with the United States. The regression of productivity on the percentage of nonproduction workers (X_2) gave the following equation:

$$X/LKM = 117.14^* - 0.27^* X_2$$
$$\text{Student } T \quad (8.82) \quad (-2.44)$$
$$\bar{R}^2 = .18 \quad N = 23^1$$

Eighteen per cent of the variation in productivity between industries has been explained by this variable, with the coefficient of X_2 significant at the 10 per cent level. Canadian manufacturing industries in our

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[1]The coefficient of X_2 was not significant using the original 24 observations. Sawmills was then dropped as an extreme. Of the total sample, sawmills fell well outside the other observations, having both the highest percentage of nonproduction workers relative to the United States as well as the highest gross output per total resource use.

sample, therefore, with a high level of productivity relative to the United States, tend to have a percentage of nonproduction workers more closely in line with the U.S. proportions than do Canadian manufacturing industries at lower levels of relative productivity performance.[1] The effect, as measured by the coefficient of X_2 is, on average, a decline of about three percentage points in the productivity differential associated with an increase of 10 percentage points in the percentage nonproduction workers differential. Throughout the sample, a relatively large number of nonproduction workers in Canada is the rule, with only a few industries (confectionery, rubber, pulp and paper and cement, concrete products and ready-mix) having a lower proportion of nonproduction workers than the comparable U.S. industry. The most plausible explanation for this higher incidence of nonproduction workers in Canada in our sample may again be related to the scale of operations. Relatively low volume output is the norm in our sample. Gross output in Canada averages only 8.4 per cent of the United States even with the inclusion of such large-scale producers as sawmills and pulp and paper. This is lower than would be expected on a population basis. Low volume output in Canada could account for the high percentage of nonproduction workers due to the fixed nature of nonproduction activity. An expansion of output in Canada might be expected to take place without an equal relative increase in nonproduction personnel.

The factors noted above touch on some possible explanatory factors. Considerable further research is required for an understanding of Can./U.S. productivity differences; this research requires the development of additional variables related to these differences. While scale of operation appears as an important factor explaining productivity differences with the United States, it can account for only a portion of the variation between industries. Numerous other variables come

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[1]The concept of production worker differs between the two countries. In Canada, employees engaged in construction activity for the establishment are included as production workers but are classed as nonproduction personnel in the United States. Canadian nonproduction workers are therefore understated in this respect relative to the United States.

to mind, many of which would express differences in quality and other characteristics of inputs. For example, variables are needed related to the age, sex and education of the labour force, the age or vintage of capital and its degree of utilization, the quality of management, and so on. Other hypotheses could be tested. The proportion of output exported for Canadian industries in the sample may give some indication of the degree to which the size or extent of the market is related to productivity differences. A comparison of effective rates of duty by industry in Canada and the United States might give an indication of relative productivity performance associated with differences in resource allocation in the two countries. A high effective tariff relative to the United States would be expected to be associated with a lower productivity performance because of less efficient resource allocation. All these areas need to be explored.

The conclusions that follow from our productivity analysis of Canadian industries relative to the United States are:

(1) An expansion of output in Canadian manufacturing relative to the United States could be expected to bring about an improvement in productivity performance due to the large potential for economies of scale. Any elimination of existing restraints of trade and/or a further penetration of international markets would be beneficial.

(2) Since the evidence does not suggest that relative size of establishment is an important factor, economies of scale seem best realized by greater specialization in particular establishments.

(3) The higher incidence of nonproduction workers in Canadian manufacturing industries in our sample is associated with a lower productivity performance relative to the United States. As a result of this higher incidence, it is reasonable to expect to find higher relative overhead costs in Canada, associated with small-scale operations.

Higher Manufacturing Output Prices in Canada

In Chapter 2, Table 2-1, a substantial range of variation was found to exist *between* the industries in our sample for the price of output leaving the factory vis-à-vis the United States. As in the previous section on productivity, our purpose now is to seek a quantitative assessment of factors influencing the Can./U.S. price differential for factory output. With the gross output price differential Can./U.S. as the dependent variable, a number of regressions were run in order to isolate the relevant variables. Consideration was given to five possible explanatory variables that were fitted in different combinations. A discussion now follows of the variables chosen.

Since the tariff is assumed to be an important factor contributing to higher prices in Canada, a measure of its level by industry would be required. The nominal tariff rate is the obvious candidate, since it influences what a producer can charge for his output domestically. High input prices could also force him closer to the protection of the tariff, so the use of both variables is relevant. The effective tariff rate, on the other hand, is not appropriate since it is related to value added and not to gross output. However, since the U.S. producer can also price up to his nominal rate, as well as the Canadian, the ideal variable is the Can./U.S. nominal rate by industry. Lacking the U.S. nominal rate for the 70 U.S. four-digit industries that are summed to match activity in three-digit Canadian industries, it is necessary to use only the Canadian nominal rate.[1] Its use would assume that the degree of competition in the large U.S. market is keen enough for U.S. producers to be largely unaffected by the U.S. tariff. This is obviously not true in some instances and is a deficiency in the use of the Canadian nominal tariff rate alone.

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[1]See James R. Melvin and Bruce W. Wilkinson, *Effective Protection in the Canadian Economy*, Economic Council of Canada, Special Study No. 9 (Ottawa: Queen's Printer, 1968), Table 1, p. 21, for nominal and effective tariff rates by industry.

Scale could also be a factor in explaining Can./U.S. price differences by industry. A large output relative to the United States could give rise to economies of scale resulting in increased productivity with the possibility of lower output prices. However, since relative productivity performance (gross output per total resource use Can./U.S.) will also be introduced as a separate independent variable and the effect of scale measured through this variable, it is not considered necessary to enter a separate scale variable. Of course it would be necessary and desirable to enter a separate variable related to the degree of commodity specialization by industry in Canada relative to the United States if one were available.

A "demand" variable was also introduced in the regression assuming that a high demand for the output of a Canadian industry relative to the United States could occasion higher output prices.[1]

Finally the rate of return on capital Can./U.S. was introduced as a proxy for market power. A high rate of return on capital in Canada relative to the United States on similar activity reflects market power through monopoly, restraints of trade, etc., since under ideal conditions of resource allocation it would be expected that the rate of return on different kinds of investment would be roughly similar.

The regression of the gross output price differential Can./U.S. on the five possible explanatory variables was then fitted in different combinations. This resulted in the rejection of both the nominal tariff rate and the "demand" variable. Both had small coefficients and were not significant at the 10 per cent level. The poor performance of the "demand" variable most likely reflects the difficulty in quantifying demand. A similar problem could apply to the Canadian nominal tariff rate, which has a high standard error and an unacceptable negative

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[1]To represent the demand factor, the gross output of each industry was calculated as a percentage of the total gross output for the sample in both countries, using Canadian prices. For each industry, the Canadian percentage divided by the American multiplied by 100 gave a relative of the degree of demand of each industry's output relative to the United States.

sign despite the combination of variables used. Since it was not possible to quantify the relevant variable, the Can./U.S. differential in the nominal tariff rate, the unexpected failure in this case certainly requires further study.[1] The final equation was therefore:

$$X_1 = 129.43^* + .46^*X_2 - 1.15^*X_3 + .41^*X_4$$

Student T (8.83) (3.14) (-8.36) (5.02)

$$\bar{R}^2 = .74 \quad N = 24$$

where X_1 = gross output price differential Can./U.S.

X_2 = input price differential Can./U.S.

X_3 = gross output per total resource use Can./U.S.

X_4 = rate of return on Capital Can./U.S.

With all the coefficients significant, 74 per cent of the variation in the Can./U.S. output price differential among industries has been explained by the differences in input price, productivity and market power differentials of different industries. Market power plays a significant role in higher output prices

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[1]The regression was also tested on secondary manufacturing industries only. Prices charged in Canada based on potential imports with the upper limit set as the U.S. price plus the Canadian tariff would relate only to secondary manufacturing. On the other hand, for products where Canada is an exporter, prices would be influenced by the U.S. price *less* the U.S. tariff. See D. J. Daly, *Uses of International Price and Output Data*, N.B.E.R. Conference on Income and Wealth, May 1970, and H. C. Eastman and S. Stykolt, *The Tariff and Competition in Canada* (Toronto: Macmillan, 1967), pp. 22-25. In the regression based only on secondary manufacturing industries, the coefficient for the nominal tariff became positive but remained small and not significant. Multicollinearity between the nominal tariff and other variables did not present a problem.

in Canada and is about equal in importance to higher input prices. However, both these factors are overshadowed in importance to the effect of lower Canadian productivity relative to the United States. In this case, an increase in Canadian productivity relative to the United States is associated with a more than proportional decrease in the gross output price differential Can./U.S.

The above relationship found between the manufacturing output price differential and the input price differential needs no clarification. However, the relationship between the output price differential and the rate of return on capital, our proxy for market power, requires further investigation in the future. In the United States, a significant relation has been found between the rate of return by industry in manufacturing and a concentration index.[1] Differences in the degree of monopolistic elements are thus assessed as having an influence on the earnings of capital. A similar regression is needed for Canada. A higher degree of concentration is known to exist in Canada: "the figures for the United States show lower concentration levels in almost all major industry groups ... 34.0 per cent of Canadian manufacturing shipments came from industries of VERY HIGH or HIGH concentration, compared with 13.7 per cent of U.S. manufacturing shipments."[2] "The overall lower concentration in the United States would seem to be related to the magnitude of that economy, much more pervasive antitrust enforcement, and a firmer commitment to maintaining small business -- a view less widely supported in Canada, perhaps because of considerations of efficiency. Ineffective Canadian merger law has also permitted higher concentration here as a result of mergers."[3] Thus, both through the influence of the

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[1]See B. S. Minhas, *An International Comparison of Factor Costs and Factor Use* (Amsterdam: North-Holland Publishing Co., 1963), p. 83, where 96 per cent of the variation in rates of returns among industries was explained by the differences in degree of concentration of different industries.

[2]Max D. Stewart, *Concentration in Canadian Manufacturing and Mining Industries*, Background Study to the Interim Report on Competition Policy (Ottawa: Economic Council of Canada, August 1970), p. 59.

[3]*Ibid.*, p. 62.

tariff where higher rates apply on highly manufactured goods relative to raw materials, and the higher degree of concentration in Canadian manufacturing, the scope for monopolistic practices must be considerably enhanced in Canada relative to the United States. These factors could account for the positive influence established above between market power and high manufacturing output prices in Canada.

However, it is lower relative productivity performance that has the most significance for the higher prices prevailing in our sample of manufacturing industries. Low performance industries in Canada have significantly higher price levels for factory output than in the United States. Moreover, an improvement in relative productivity performance is associated with a more than proportional decrease in such price level discrepancies. In fact, all the industries in Table 4-1 classed as high-performance industries have price levels for factory output lower than in the United States.

These findings on price performance are complementary to the discussion in the previous section on productivity performance. Based on the results of this analysis, a general expansion of output with increased specialization would be favourable to a marked improvement in productivity relative to the United States. Such an improvement would also be the most important factor, of those examined here, necessary to reduce the higher prices prevailing in Canadian manufacturing. The better productivity and price performance would provide a marked stimulative effect on the output of Canadian manufacturing industries. Such an impetus, in turn, would be in the direction of generally higher real incomes and a reduction of the income disparity with the United States.

APPENDIX A

MATCHING CANADIAN AND U.S. MANUFACTURING INDUSTRIES IN THE SAMPLE

Industry	Canadian S.I.C.	U.S. S.I.C.
Slaughtering and Meat Packing	1011 Slaughtering and Meat Packing Plants 1013 Sausage and Sausage Casing Manufacturers	2011 Meat Slaughtering Plants 2013 Meat Processing Plants
Poultry Processors	103 Poultry Processors	2015 Poultry Dressing Plants
Dairy Products	1051 Butter and Cheese Plants 107 Process Cheese Manufacturers 1053 Pasteurizing Plants 1055 Condenseries 1056 Ice Cream Manufacturers	2021 Creamery Butter 2022 Natural and Process Cheese 2023 Condensed and Evaporated Milk 2024 Ice Cream and Frozen Desserts 2026 Fluid Milk
Feed Manufacturers	123 Feed Manufacturers	2042 Prepared Animal Feeds
Bakeries	129 Bakeries	2051 Bread and Related Products
Confectionery	131 Confectionery Manufacturers	2071 Confectionery Products 2072 Chocolate and Cocoa Products 2073 Chewing Gum
Sugar Refineries	133 Sugar Refineries	2061 Raw Cane Sugar 2062 Cane Sugar Refining 2063 Beet Sugar
Soft Drinks	141 Soft Drink Manufacturers	2086 Bottled and Canned Soft Drinks 2087 Flavourings
Distilleries	143 Distilleries	2085 Distilled Liquor except Brandy
Breweries	145 Breweries	2082 Malt Liquors
Tobacco Products	153 Tobacco Products Manufacturers	2111 Cigarettes 2121 Cigars 2131 Chewing and Smoking Tobacco

APPENDIX A (cont'd.)

Industry	Canadian S.I.C.	U.S. S.I.C.
Rubber Industries	161 Rubber Footwear Manufacturers 163 Rubber Tire and Tube Manufacturers 169 Other Rubber Industries	3021 Rubber Footwear 3011 Tires and Inner Tubes 3031 Reclaimed Rubber 3069 Rubber Products, NEC
Shoe Factories	174 Shoe Factories	3141 Shoes, except Rubber 3142 House Slippers
Wool Yarn Mills	193 Wool Yarn Mills	2283 Wool Yarn Mills
Hosiery Mills	231 Hosiery Mills	2251 Women's Hosiery, except Socks 2252 Hosiery, NEC
Men's Clothing	2431 Men's Clothing Factories 2432 Men's Clothing Contractors	2311 Men's and Boys' Suits and Coats 2321 Men's Dress Shirts and Nightwear 2322 Men's and Boys' Underwear 2323 Men's and Boys' Neckwear 2327 Separate Trousers 2328 Work Clothing 2329 Men's and Boys' Clothing, NEC 2385 Waterproof Outer Garments 2386 Leather and Sheeplined Clothing
Sawmills	2511 Shingle Mills 2513 Sawmills except Shingle Mills	2421 Sawmills and Planing Mills 2429 Special Products Sawmills, NEC
Veneer and Plywood	252 Veneer and Plywood Mills	2432 Veneer and Plywood Plants
Pulp and Paper	271 Pulp and Paper Mills	2611 Pulp Mills 2621 Paper Mills, except Building 2631 Paperboard Mills 2661 Building Paper and Board Mills

APPENDIX A (concl'd.)

Industry	Canadian S.I.C.		U.S. S.I.C.	
Other Paper Converters	274	Other Paper Converters	2641	Paper Coating and Glazing
			2642	Envelopes
			2644	Wallpaper
			2645	Die Cut Paper and Board
			2646	Pressed and Molded Pulp Goods
			2647	Sanitary Paper Products
			2649	Converted Paper Products, NEC
Iron and Steel	291	Iron and Steel Mills	3312	Blast Furnaces and Steel Mills
			3313	Electrometallurgical Products
			3316	Cold Finishing of Steel Shapes
			3323	Steel Foundries
Fabricated Structural	302	Fabricated Structural Metal Industry	3441	Fabricated Structural Steel
Motor Vehicles and Parts	323	Motor Vehicle Manufacturers	3717	Motor Vehicles and Parts
	325	Motor Vehicle Parts and Accessories Manufacturers		
Battery Manufacturers	337	Battery Manufacturers	3691	Storage Batteries
			3692	Primary Batteries: Dry and Wet
Cement Manufacturers	341	Cement Manufacturers	3241	Cement, Hydraulic
Concrete Products	347	Concrete Products Manufacturers	3271	Concrete Block & Brick
			3272	Other Concrete Products
Ready-Mix Concrete	348	Ready-Mix Concrete Manufacturers	3273	Ready-Mix Concrete
Petroleum Refining	3651	Petroleum Refining	2911	Petroleum Refining
Paints and Varnishes	375	Paint and Varnish Manufacturers	2851	Paints and Allied Products
Soap and Cleaning Supplies	376	Manufacturers of Soap and Cleaning Compounds	2841	Soap and Other Detergents
			2819	Inorganic Chemicals, NEC

APPENDIX B

THE INDUSTRY APPROACH IN DETAIL

Limitations

Just as the problem of the constancy of quality for output measures is a limitation of temporal comparisons within one country, there is an analogous problem for spatial comparisons with only a different orientation. If a quantity index based on the number of physical units of specific products represents the output measure for an industry in a temporal comparison, it is necessary to assume that there is no change in quality of these units over time for the index to adequately reflect the real output growth. Similarly for the spatial comparison, the quantity differentials for specific products in a particular industry which are basic to the industry approach in spatial comparisons must be for equal quality products, otherwise it is not a valid comparison of real output between the two countries.

In the expenditure approach to spatial comparisons, care was taken with the price differentials to ensure a price comparison of identical products following rigid specifications so that quality differences would not affect the price comparison. With the industry approach, however, the problem is more difficult. The quantity ratios at the detailed level should also be for identical, equal-quality products, but in the majority of industries it is not known whether this comparability and homogeneity of output and input exists. The price ratios implicit in the industry approach that are the counterpart to the expenditure price ratios are the unit value price ratios (Pc/Pu) obtained by comparing unit values (census quantities divided into dollar values) for each item considered. In the shoe factory industry, for instance, unit values are calculated for men's shoes, slippers, youths' and boys' shoes, women's and misses' and children's. This is the finest level of detail at which products are given in quantity and value in census publications, relevant to the Canadian three-digit and U.S. four-digit industry level. Quality and its distribution within each item is assumed to be constant at the item level. Empirically, a large element of subjective judgment is

involved in choice of industry, specific products matched, etc. For instance, specific products may have to be rejected when the unit value price differential departs so far from the average that it is obvious that like qualities or quantities of resources are not being compared.

Another problem area for international comparisons, as well as for intertemporal comparisons, is differences in reporting practices. The Royal Commission on Farm Machinery,[1] which had access to individual company returns, discovered that respondents to the farm machinery industry in Canada tended to value interplant transfers at a lower pricing level than in the U.S. industry. These essentially artificial or bookkeeping prices are also a problem within a country through time as individual firms respond on a different basis and could change proportionally through time. While variations in pricing between firms in the farm machinery industry in each country were large, Canadian firms priced closer to factory cost while the U.S. firms priced between 53 per cent and 80 per cent of suggested retail price[2] even though the concept between the two countries is not substantially different. Based on an estimate in 1965 of U.S. pricing as 65 per cent of suggested retail price, Canadian data on value of shipments and the corresponding value added were adjusted upward substantially so that labour productivity was estimated at 80 to 85 per cent of the United States rather than 68 per cent.[3] This method of estimating international productivity differences was used in lieu of that recommended in this Study. If a direct survey of price differentials between the two countries had been made for specific tractors, combines, etc., price and volume comparisons would then have been possible utilizing the physical volume data presented in the census of manufacturers in each country.

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[1]See Christopher J. Maule in Donald Martinusen, *Productivity in the Farm Machinery Industry, A Comparative Analysis Between Canada and the United States*, Royal Commission on Farm Machinery (Ottawa: Queen's Printer, 1969).

[2]*Ibid.*, p. 9.

[3]*Ibid.*, p. 2.

The Maule study cautions that this statistical problem could apply in other industries where intra-firm shipments are made, although they do not conclude that their findings suggest a narrowing of the labour productivity gap between Canada and the United States in other industries. However, for the purposes of the present Study, it is difficult to know the direction of the error in other industries with large intra-firm shipments, as factors affecting distribution could differ substantially industry by industry. Without knowledge of specific industry pricing procedures, no specific adjustment has been made. This has the effect of assuming that the error is offsetting within manufacturing.

Procedures

The selection of industries comprising the 30-industry sample followed no strict criteria. The approach was to select a few industries within major groups in manufacturing that appeared amenable to the method and if possible having a large value added so that they could be assumed representative of the group. Although the analysis throughout most of this Study was directed towards the sample industries, a further objective was spatial price and volume comparisons for total manufacturing. Ideally, the latter would be based on a wider coverage of industries than was possible, for a variety of reasons, in this Study. Other estimating techniques, therefore, were required to arrive at estimates for total manufacturing.

The industries best adapted to spatial comparisons by the industry approach are ones in which quality differences in the products are unlikely to constitute a major problem. Confidence in the similarity of product quality exists, for instance, for the dairy products industry, since product detail refers to fluid whole milk, bulk in thousand pounds, fluid cream, fluid skim milk, etc. On the other hand, in industries such as machinery and electrical equipment, products are highly complex and have widely different characteristics. If such products are not sufficiently differentiated by characteristic in the census publications, quality differences could destroy the comparison. The sample was thus restricted to industries where a reasonable degree of confidence existed that like quantities and qualities were being compared.

Since the U.S. standard industrial classification is far more detailed and extensive than the Canadian, several U.S. four-digit industries are usually aggregated to match activity in the Canadian three-digit industry. Such matchings for the industries in the sample are shown in Appendix A and generally follow the presentation of the Canadian Department of Industry.[1]

The Canadian *Census of Manufactures* is an annual mail survey. In contrast, the U.S. system has, at five-year intervals, a complete census comparable to the annual Canadian census, and estimates the interim years on a sample survey basis. The year 1963 is the latest U.S. census available with the detail required to carry out the detailed industry spatial comparisons. Although 1963 lags the current period, this is not a significant factor for this Study since the productivity gap in manufacturing between Canada and the United States, a major concern of this Study, has not changed markedly, at least through 1957 to 1967.[2]

The procedure for each industry selected for comparison was to match like products covering as large a proportion of census gross output as possible in order to ensure a reliable real output comparison. Quantities in each country are valued with prices of the other, allowing price and output comparisons to be made for the matched items, using separately the weighting systems of each country. This is done separately for gross output and inputs. For fuels consumed, it was possible to match coal, fuel oil, gas, electricity and gasoline separately.[3] On average for the industries in the sample, approximately 75 per cent of output was covered with matched items and 55 per cent for inputs.[4]

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[1]Department of Industry, *Comparison of Canadian and United States Standard Industrial Classification of Manufacturing Industries*, July 1967.

[2]Daly, Keys and Spence, *Scale and Specialization*, p. 9.

[3]U.S. data on the use of fuels and electrical energy are obtained on a special sample survey for the year 1962. Price differentials and weights for the United States within fuels thus apply to 1962 and were assumed to be appropriate for 1963.

[4]See Appendix Table B-1 for detail by industry.

Appendix Table B-1

PERCENTAGE COVERAGE OF MATCHING ITEMS AND INPUT-OUTPUT RATIOS, BY INDUSTRY

	Percentage Coverage of Matching Items				Input-Output Ratio	
	Output		Input			
	U.S.	Can.	U.S.	Can.	U.S.	Can.
Slaughtering and Meat Packing	90.1	81.2	84.5	80.5	83.0	82.5
Poultry Processors	82.4	85.1	74.8	79.9	81.0	85.1
Dairy Products	78.2	78.6	68.7	75.2	71.6	75.5
Feed Manufacturers	90.4	80.7	25.4	31.7	74.6	81.3
Bakeries	42.6	52.6	47.5	44.8	46.7	53.0
Confectionery	90.5	88.5	52.1	50.1	55.7	55.9
Sugar Refineries	68.6	90.0	79.7	94.1	73.3	75.6
Soft Drinks	67.9	84.4	22.5	30.9	44.4	40.4
Distilleries	87.7	93.2	48.8	53.4	42.8	33.2
Breweries	97.6	97.1	36.2	61.8	44.5	29.3
Tobacco Products	92.6	88.2	73.5	67.3	50.0	53.4
Rubber Industries	48.0	50.2	58.3	62.3	49.7	53.5
Shoe Factories	94.6	97.1	43.0	49.7	46.1	50.5
Wool Yarn Mills	97.5	90.3	83.6	80.2	71.6	64.4
Hosiery Mills	84.5	88.7	46.5	61.2	53.8	52.5
Men's Clothing	59.9	61.8	--	-- (1)	54.9	52.3
Sawmills	78.6	84.0	30.9	54.1	56.4	57.4
Veneer and Plywood	88.1	82.9	78.3	77.5	58.3	58.4
Pulp and Paper	66.9	87.8	58.5	76.4	50.3	49.2
Other Paper Converters	36.3	47.8	64.3	52.7	56.1	58.4
Iron and Steel	70.9	87.8	46.0	60.1	54.3	48.9
Fabricated Structural	71.3	59.2	59.7	64.7	58.1	52.6
Motor Vehicles and Parts	53.9	58.6	--	-- (1)	65.9	65.0
Battery Manufacturers	61.9	72.2	31.9	26.7	49.7	57.8
Cement Manufacturers	92.9	92.9	46.8	50.2 (2)	33.2	28.9
Concrete Products	30.9	34.9	41.9	55.3	45.1	47.2
Ready-Mix Concrete	77.4	92.3	63.0	77.1	57.2	62.5
Petroleum Refining	81.1	89.1	81.3	88.9	81.0	80.4
Paints and Varnishes	75.7	85.5	33.7	37.3	54.7	52.4
Soap and Cleaning Supplies	28.3	55.3	28.1	32.3	45.9	51.2
Mean	72.9	77.9	53.9	59.9		

(1) Input quantities are not available for Canada.

(2) Fuel and Electricity only. United States has no input detail.

In order to cover all output and input, it was then generally assumed that the nonmatching portion of outputs and inputs would have the same average price differential as the matching items. Although other assumptions are possible, this one was accepted as the most plausible. However, it would have more justification for output than input, since prices for other inputs that come from a variety of sources could diverge from that of basic materials purchased.

Many industries had to be rejected for one reason or another. Often, insufficient detail of either output or input would not allow adequate coverage of the industry, or a major divergence of the input-output relationship for a particular industry between the two countries would indicate a major structural difference so that a productivity comparison would not be applicable.[1] Often it was impossible to convert to like quantity units when, say, the United States quoted in tons while Canada quoted in square feet or number. However, in aggregate, the industries in the sample comprised about half of total manufacturing in terms of gross output.[2]

Alcoholic Beverages and Tobacco Industries

The treatment of alcoholic beverages needs special comment. Applying the conventional industry approach gave high output prices in Canada relative to the United States for both distilleries and breweries, i.e., Canadian prices were about 80 per cent higher than U.S. prices. Little confidence could be put in these results because of the problem of comparing output of various liquors between the two countries. In Canada, both output and input are reported in proof gallons, while in the United States there is a mixture of proof, wine and tax gallons. As conversion to equal proof content was not possible, they were all assumed to be equal proof.

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[1] See Appendix Table B-1 for input-output ratios by industry.

[2] The sum of gross output for the industries in the sample as a percentage of total manufacturing was 39 per cent for the United States and 49 per cent for Canada.

A different line of approach was followed to check on the industry results. Given the Segal-Pratt study of the price difference at the retail level, it was possible to work back to the price difference at the factory once allowance was made for the incidence of indirect taxes on alcoholic beverages. Summing all the different indirect taxes on alcohol for both countries and expressing them as a percentage of sales allows a correction of market prices to factor prices (a crude factory price since indirect taxes are the major additional cost item between the factory and the retail store). Adjusting the Segal-Pratt alcoholic beverage price difference at retail back from 1965 to 1963, then correcting for the higher incidence of indirect taxes in the United States, gave a ratio of 130 for Can./U.S. prices at the factory. This figure was substituted for the combined industry, replacing the 180 price relative from the industry method.

A similar adjustment to the industry results was made for the tobacco products industries. The statistical problem with alcohol was to convert output to similar proof gallons; for tobacco it was to delete sales and excise duties from the value of shipments so as to derive the correct unit values for cigars, cigarettes and other tobacco products. Since the industry approach for these industries was suspect and since the correction for the difference in indirect tax incidence is only possible in these two areas where statistics exist, it was considered preferable to substitute the Segal-Pratt retail price survey adjusted to a factor or factory-price basis. Tobacco products in 1963 were 29 per cent more expensive in Canada than in the United States at the retail level. After allowing for the considerably higher taxes in Canada, the price difference drops to 19 per cent at the "factory". This output price difference was used in lieu of the 7 per cent difference given by the industry approach. Input price differentials for distilleries, breweries and the tobacco products industries were not changed.

Problems and Adjustments in Other Industries

The complete system of output, input and net measures was maintained with the two weighting systems throughout the 30 sample industries as a step in preparing the estimate for total manufacturing. However, a number of specific problems were encountered and adjustments made.

One difficulty arose, for example, with the men's clothing industry. Although output could be matched for 16 items of clothing, covering about 60 per cent of gross output, Canadian statistics gave no quantity detail of inputs. An estimate of the input price differential was made on the basis of aggregate statistics of suiting fabric.

In the pulp and paper industry, rather than rely on the unit value price differentials (*Pc/Pu*) from census material, specification prices from the Prices Division, Dominion Bureau of Statistics, were matched with similar U.S. statistics. This was done for certain types of sulphite, sulphate, ground wood and newsprint. These specification price differentials were substituted in the calculation in lieu of the unit values in the belief that specification pricing would be better able to hold the quality factor constant. This technique was tried in other industrial areas but had to be abandoned as it proved too difficult to match specifications between Canada and the United States.

For motor vehicle and parts manufacturers, the United States publishes only a total in quantity and value for passenger cars, whereas the Canadian detail covers seven categories of cars. From independent sources,[1] U.S. quantity information was derived, but U.S. prices for particular types were still lacking. The aggregate U.S. price differential for cars was used, but the full weighting system in each country was not possible. For trucks, even though the detail covered seven types of trucks by weight, two categories had to be deleted when the unit value price differential departed excessively from the average. For inputs, insufficient published detail prevented usual procedures. An attempt to work with a portion of the detail related to parts manufactures was rejected in favour of using the iron and steel output price differential as a substitute for the aggregate input price differential.

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[1]Automobile Manufacturers' Association, *Automobile Facts and Figures*, 1964 Edition.

The soap and cleaning compound industry is an illustration of an acute, general problem of grouping the correct U.S. four-digit S.I.C. industries for comparable activity in the Canadian three-digit S.I.C. group. An indication of lack of comparability arises when the distribution of output by different products or the distribution of inputs by different materials is significantly different in the two countries. The use of different processes and different materials to produce a quite different variety of output may render comparisons of two industries inappropriate for productivity analysis. For example, different quantity weights to the price differentials for inputs in the soap and cleaning compound industry gave an aggregate price differential of 120 with U.S. weights and 103 with Canadian weights because oils make up 50 per cent of the inputs covered in Canada but only 14 per cent in the United States. The U.S. industry tends to be much broader, containing some inorganic chemicals which perhaps are better classified to the industrial chemical industry. However, if they are deleted, the employee ratio Can./U.S. moves from 5 per cent to 19 per cent. On this basis, therefore, the industries would appear to be more comparable if these inorganic chemicals are left in rather than deleted. Since the wide spread between the two input price differentials under the two weighting systems was not considered realistic, the average was used.

The pulp and paper industry suffers from an analogous problem. Although the Canadian and U.S. industries produce the same products, they do so in different proportions which is reflected in the wide dispersion of the output price differential under the two weighting systems, i.e., 110 and 99. The United States produces little wood pulp and newsprint (15 per cent of output), but concentrates on paper and paperboard, etc. (85 per cent). Canada, on the other hand, concentrates on wood pulp and newsprint (72 per cent of output) with paper and paperboard playing only a relatively minor role (28 per cent). Since the production processes and equipment are so different for the various products, there is little point in making a productivity comparison for the pulp and paper industry *per se*.

APPENDIX C

DERIVATION OF TOTAL MANUFACTURING

Procedures

Given the data developed for the 30 industries in the sample and other price data, price and volume comparisons were made for total manufacturing. To do this, it was necessary to assume that the industries covered are representative of the groups into which they fall. More precisely, the price differentials between Canada and the United States for, say, the output of shoe factories and their input costs, were also considered applicable to leather tanneries, leather glove factories and other leather product industries, i.e., the other industries in the leather product industries. If the specific industry or industries chosen to represent the group have a small margin of error and make up a large proportion of value added of the total group, this method is acceptable. Some industry groups were well represented. Others lacked any coverage, and other means had to be utilized. Food and beverages, tobacco and leather, for instance, are well covered by specific industries that make up a good portion of value added. However, wool yarn mills had to represent the whole of the textile industries even though it is very small in terms of value added. Direct analysis of major industries in this group, such as cotton yarn and cloth and synthetic textiles, was not attempted because of the difficulties in properly matching products and in conversion to like quantity units: for example, the U.S. data are in terms of linear yards while Canada quotes in square yards. Similarly for the chemical industry, for instance, implicit output and input price differentials were derived by summing known price differentials within the group (pharmaceuticals, paints and varnishes and the soap and cleaning supplies industry) and then applied to the remaining industries. The procedure is analogous to the general price deflation method of using an implicit price to deflate a residual miscellaneous group.

In a major group, such as the furniture industry, resort was to the Segal-Pratt price study of consumer items for the output price differential. The industry

approach was not considered adequate for this group because of the broad categories covered. Since the unit value comparisons would not be meaningful as representative price differentials, the industry was better treated by an independent price survey.

The Segal-Pratt study was such an independent price survey; however, the price difference was measured at the retail rather than at the factory level. Aside from alcoholic beverages and tobacco mentioned previously, where the different tax incidence in the two countries was taken into account, the market price differential was assumed to apply at the factory level because of lack of data. All additions to price between factory and retail outlet, i.e., indirect taxes, transportation costs, mark-up, etc., are therefore assumed to have the same incidence in both countries. Retail price differences for appliances, radio and TV, furniture, drugs and newspapers, were therefore used as output price differentials for the electrical equipment, furniture, pharmaceuticals and printing and publishing industries; these represent, in total, about 10 per cent of gross output in manufacturing. Since these particular industries tended to have a higher price differential than the average, the effect was to raise the aggregate manufacturing output price differential by one percentage point.[1]

Price differentials were also required for the material input for such industries. These were usually available as output prices at a previous level of manufacturing, i.e., an average of price differentials for book paper and fine paper from the pulp and paper mill industry was used to approximate the input price differential for printing and publishing. Another source of data

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[1]Some upward bias may be present in this estimate if Canadian margins are in fact higher than in the United States. However, available information on distributive margins is inconclusive. See John H. Young, *Canadian Commercial Policy*, Royal Commission on Canada's Economic Prospects (Ottawa: Queen's Printer, 1957), pp. 164-166, where there does not appear to be any significant difference in average retail margins although, for electrical appliances, margins may be higher in Canada.

for material input costs was the survey results of the Daly, Keys and Spence study.[1] Such prices were used as input price differentials in textiles, major electrical appliances, radio and TV, communication equipment and electrical industrial equipment industries.

The machinery industry was also an exception to the industry approach. The only price differentials available were those developed for the expenditure study where agricultural implements were considered as having the same price on both sides of the border, and other machinery was estimated as 30 per cent more expensive in Canada than in the United States. The average of the iron and steel and metal fabricating industry output price differentials was used as the estimate for the materials input price differential for the machinery industry.

Adjustment to a National Accounts Basis

The derivation of price and output differentials with the United States for each of the 20 manufacturing industrial groups has been described above. It is now possible to sum to total manufacturing for similar price and output differentials for gross output, input and, by subtraction, census net value added. However, there is a final adjustment to put each country on a comparable basis. The census net value-added approach nets out only materials and fuel purchases. There are other intermediate business purchases that should be netted to arrive at the National Accounts concept of Gross Domestic Product. This adjustment is significant; intermediate business purchases amount to 15 to 20 per cent of value added and could differ proportionally between the two countries.

Moreover, the concept of industrial output differs in the two countries. The Canadian Gross Domestic Product at factor cost includes capital cost allowances which are excluded from the U.S. data on Net National Income by industry. If depreciation is added to the U.S. data they are comparable, except that the U.S. data remain national in concept while the Canadian concept is domestic. Since

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[1]Daly, Keys and Spence, *Scale and Specialization*, p. 96.

industrial comparisons of productivity based on domestic activity are preferred for this analysis to the national (which includes net international earnings), the U.S. data were adjusted to the domestic product concept. The total for each country now measures Gross Domestic Product at factor cost in manufacturing. This adjustment, reducing the census net value-added concept to Gross Domestic Product, results in a slightly larger adjustment for the United States than for Canada (17 per cent of census value added in the United States and 16 per cent in Canada).

A price differential between Canada and the United States is now required in order to revalue these other inputs in the prices of the other country. These payments constitute outside purchases of business services, e.g., contract costs in maintenance and repair, services of research firms, engineering and management consultants, advertising, telephone, insurance, royalties, etc. Unfortunately, no specific prices for such service charges are available; it is known, however, based on service items within the expenditure study and the Segal-Pratt study, that service prices are generally 20 per cent lower in Canada. Revaluation of other inputs on this basis provides an estimate of price and output differences for total manufacturing on a Gross Domestic Product basis.

A final adjustment concerns the derivation of total employment for manufacturing. Head office employees are not included at the individual industry level comparison of our sample since U.S. practice adds such personnel only at the industrial group level. As it was possible to delete head office employees from Canadian three-digit industries in our sample, the total head office personnel are included only at the total manufacturing level in each country. Since the relative use of head office personnel is not too different from that of other employees, it has a negligible effect on our total manufacturing labour input measure.

APPENDIX D

CAPITAL INPUT MEASURES FOR THE SAMPLE

The Giffen Method of Capital Stock Estimation

The "Giffen Method"[1] makes use of the relation $K = \frac{(v-wl)}{r}$ where K = capital stock, v = value added in the industry and wl = factor payments to labour. The rate of return on capital (r) is established from revenue and expenditure and from balance sheet information reported in the Canadian *Taxation Statistics* and the U.S. *Source Book, Statistics of Income, Corporation Income Tax Returns*.

Return on Capital

Since this formula makes use of two independent sources of information on the return to capital, it is important that the concepts should match as precisely as possible. In the formula (v-wl) represents the absolute amount of the return to capital derived from the census of manufacturing, while the numerator of the r (factor payments to capital) is the similar return derived from taxation statistics. By manipulating the formula, the capital stock estimate, derived from the taxation sample, is in effect blown up by the ratio of the return to capital from industry statistics to the return to capital from taxation statistics, i.e.,

$$k = \frac{\text{return to capital (industry statistics)}}{\text{return to capital (taxation statistics)}} \times \text{capital stock (taxation statistics)}$$

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[1] A. A. Walters, "Production and Cost Functions: An Econometric Survey", *Econometrica*, vol. 31, January-April 1963, pp. 1-66. See also K. J. Arrow, H. B. Chenery, B. S. Minhas, and R. M. Solow, "Capital-Labour Substitution and Economic Efficiency", *Review of Economics and Statistics*, August 1961, pp. 225-250, where this method was utilized.

With this in mind, the concept of return to capital from the two sources should be matched as closely as possible. However, the available data from industry statistics does not permit the derivation of a return to capital in a strict economic sense. The value added less factor payments to labour in industry statistics is simply a residual and includes much more than a true return to capital. This problem with the industry statistics is elaborated below. On the other hand, the data from taxation statistics would appear to allow a more accurate derivation to the required concept. For purposes of the formula, the aggregate should be total factor payments plus depreciation before taxes less factor payments to labour. It thus includes current profits, rent, bond, mortgage and other interest paid less that received, plus capital cost allowances. These items, therefore, could be summed from taxation statistics; however, since different expense items are allowed in each country before calculating profits, it is preferable to take the relevant revenue items and deduct the relevant expense items to derive the return to capital from taxation statistics.

While the value estimates of the return to capital from taxation statistic sources approach the desired concept, the residual nature of the industry statistics derivation does not permit the same degree of accuracy. The value added data in the census of manufacturers include intermediate service purchases. Census value added, therefore, is too gross; only materials and fuel inputs have been deleted. To derive Gross Domestic Product by industry, a deduction for intermediate service purchases is required; these include, for example, management consultant fees, advertising, telephone, etc. In the formula $(v\text{-}wl)$, the factor payments to capital from industry statistics tend to be overstated relative to the data from taxation statistics. At the total manufacturing level, the adjustment from census value added to GDP was roughly similar for both countries; however, this may not be the case at the industry level. To make the correction explicitly at the three- and four-digit level for Canada and the United States would require data from the 1961 Canadian, and the 1963 U.S. input-output tables. These were not available when the capital stock estimates were developed. Since the adjustment was not possible at the detailed level, the assumption was used that the equal proportional adjustment that applied at the total manufacturing level also applied at the industry level of our sample.

Gross Capital Stock

The concept for the capital stock was simply the sum of inventories, land, building and equipment as given in the balance sheet for the industry. A more inclusive concept of capital, taking in other working capital such as cash and securities, was not attempted having in mind the need to establish purchasing power equivalents, or Can./U.S. price differentials, for all components of capital, in order subsequently to revalue the assets of one country in the prices of the other. A price differential for the relatively small item of working capital aside from inventories was considered indeterminate. Since the compilation of the capital stock in each country is essentially adjusted assets as reported for taxation purposes, it has all the deficiencies of a measure from this source. The valuation of assets from taxation statistics is at original cost, i.e., all existing assets valued in terms of prices when they entered stock. The stock estimate was also left gross with no attempt made to subtract capital consumption allowances based on these original cost valuations. By avoiding these deductions, possible differences between the two countries in the tax treatment of depreciation do not affect the capital stock estimate.

An estimate of the gross stock of capital, based on original cost, might appear to be an inferior measure to either a gross or net stock estimate based on current or constant dollars, developed from the perpetual inventory method; however, it gives a rough indication of the *differences* in capital resources utilized in Canada and the United States by industry. Our interest is in these differences, not in absolute levels.[1]

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[1]See George J. Stigler, *Capital and Rates of Return in Manufacturing Industries* (Princeton: Princeton University Press, 1963), for different concepts of both capital and the return on capital where a primary concern was the dispersion of rates of return by industry. Pages 7-9 and appendices of that publication contain a fuller discussion of problems of data deficiencies in the use of taxation statistics. Chief among these are: (1) although the material is quite comprehensive in scope in both countries, it relates to corporations and, as a result, is weaker in areas where unincorporated business is significant, for

Noncorporate Adjustment

Since taxation statistics relate only to corporate tax returns, an adjustment was necessary throughout the sample of industries to account for the noncorporate sector. Even though dairy products, feed manufacturers and sawmills are the most acutely affected, the degree of corporate ownership also differed significantly between the two countries for other industries as well. A general adjustment throughout for each country is therefore appropriate. The method followed[1] for the return to capital was to make total profits, etc., proportional to the percentage of value added attributed to the corporate and noncorporate sector available from census data. Noncorporate assets were derived by converting noncorporate shipments to assets by multiplication by an asset/sales ratio computed from the smallest asset size of corporation. Noncorporate enterprises are generally small, and small corporate enterprises have a relatively low assets-to-receipts, or sales, ratio.

Rate of Return on Capital

With the return to capital and the capital stock as defined above, the rate of return on capital was calculated for three years (1962-64) and averaged to allow for profit variability between years. The degree of variability between years was found, in fact, to be relatively minor. Appendix Table D-1 shows, for the year 1963, selected ratios resulting from the application of the Giffen Method.

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example in dairy products, feed manufacturers and sawmills; (2) company data tend to relate to more than one three-digit industry classification, so that industrial boundaries are far less sharp than in establishment data. A related classification problem of interest to our intercountry comparison results from the more aggregative character of the Canadian taxation data. This, for example, forced the use of "men's, women's and children's clothing" as a proxy for men's clothing in each country and "cement, clay and stone products" as a proxy for the aggregation of cement, concrete products and ready-mix concrete.

[1] *Ibid.*, pp. 114-118.

Appendix Table D-1

SELECTED DATA RELATED TO GROSS CAPITAL STOCK, 1963

	Rate of Return on Capital			Can./U.S. Gross Capital Stock			Can./U.S. Employee Ratio	Can./U.S. Capital per Employee
	Canada	U.S.	Can./U.S.	Value	Price	Volume		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Slaughtering and Meat Packing	11.7	19.6	59.7	15.60	109.6	14.23	12.16	117.0
Dairy Products	13.8	22.0	62.7	12.58	106.9	11.77	12.64	93.1
Feed Manufacturers	14.6	21.3	68.5	10.39	112.0	9.27	15.00	61.8
Bakeries	18.2	22.0	82.7	9.86	108.1	9.12	13.22	69.0
Confectionery	13.2	30.4	43.4	15.66	108.4	14.44	12.90	112.0
Soft Drinks	19.8	29.4	67.3	11.08	108.3	10.23	11.27	90.8
Alcoholic Beverages	21.2	18.0	117.8	16.79	112.4	14.94	15.66	95.4
Tobacco Products	19.4	24.0	80.8	7.87	107.6	7.31	12.72	57.5
Rubber Industries	11.3	22.1	51.1	14.34	106.6	13.45	8.56	157.1
Shoe Factories	13.3	30.1	44.2	12.83	101.5	12.63	9.91	127.5
Wool Yarn Mills	10.7	16.2	66.0	12.24	116.2	10.53	12.57	83.8
Hosiery Mills	11.1	24.1	46.1	16.04	110.4	14.53	8.05	180.5
Men's Clothing	17.9	28.3	63.3	7.74	116.9	6.62	8.35	79.3
Sawmills	16.9	18.3	92.3	29.46	108.6	27.13	23.79	114.0
Veneer and Plywood	13.7	19.0	72.1	20.22	109.3	18.50	19.63	94.2
Pulp and Paper	12.8	14.1	90.8	30.72	109.7	28.02	29.40	95.2
Other Paper Converters	14.5	25.4	57.1	9.09	107.6	8.44	8.60	98.2
Iron and Steel	14.3	12.4	115.3	5.46	110.5	4.94	6.56	75.3
Motor Vehicles and Parts	26.1	35.7	73.1	8.88	106.7	8.32	8.29	100.4
Battery Manufacturers	13.7	28.2	48.6	12.82	105.3	12.18	7.71	157.8
Cement, Concrete Products and Ready-Mix	13.9	19.3	72.0	12.82	100.2	12.79	9.78	130.8
Petroleum Refining	8.5	14.3	59.4	15.70	100.0	15.70	8.16	192.4
Paints and Varnishes	15.3	28.2	54.3	14.61	109.2	13.37	10.80	123.8
Soap and Cleaning Supplies	20.4	37.0	55.1	5.76	110.6	5.21	4.52	115.2
Mean of Sample	15.3	23.3	68.5	13.69	108.4	12.65	12.09	109.3
Standard Deviation	4.0	6.6	20.0	6.2	4.1	5.7	5.6	35.2

Note: In column (4), Canadian gross capital stock as a percentage of the United States is in national currencies while in column (6) the U.S. gross capital stock has been revalued in Canadian dollars by division with the price differential (column (5)). The required price for this purpose in column (5) is a Can./U.S. price with U.S. quantity weights.

Source: United States and Canadian 1963 *Census of Manufactures* and estimates by Economic Council of Canada. Gross capital stock estimates derived from *Source Book Statistics of Income* for the United States (Washington: U.S. Treasury Department, Internal Revenue Service) and *Taxation Statistics* for Canada (Ottawa: Department of National Revenue).

Rates of return show a wide dispersion by industry in each country; this is consistent with other findings.[1] Theoretically, competitive forces should tend to bring the rates of return towards equality; numerous hypotheses have been brought forward to explain the disparities, but the question is far from resolved. Of interest is the lower rate of return in Canada.[2] Except for alcoholic beverages and iron and steel, the rate of return is significantly lower in Canada.

Price Adjustments to Capital Stock

The derivation of assets comprising the capital stock for each industry, as outlined above, requires a further adjustment since the valuation is still in terms of dollars of the respective country. For comparability, the stock in each country needs revaluation in terms of prices of one or the other country. Analogous to the concern of Chapter 2, purchasing power equivalents need to be developed for inventories, land, plant and equipment. This revaluation is particularly acute for plant and equipment since prices are significantly different in the two countries.

Derivation of the price differentials is as follows. For inventories, the average of the output price differential and the input price differential was used for each industry to take account of both raw materials and finished goods inventories. The price of land was assumed to be the same in the two countries. While this assumption may well be wrong, the weight of land in the stock for each industry in the sample is usually only 2 to 4 per cent, so no serious error is involved.

The price differentials for plant and equipment were developed separately, them combined, since only an aggregate is given on the balance sheet. For construction, the price differential established for the

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[1]See *ibid.*, pp. 54-71, and Minhas, *An International Comparison of Factor Costs and Factor Use*.

[2]Similar results were obtained by D. H. Fullerton and H. A. Hampson, *Canadian Secondary Manufacturing Industry*, Royal Commission on Canada's Economic Prospects (Ottawa: Queen's Printer, 1957), p. 262.

expenditure study for 1965 was extrapolated back to 1963 and assumed to be the same for all industries. For machinery and equipment, a separate estimate was made for each industry based on the premise that the price of Canadian machinery and equipment tends to meet the duty-paid cost in Canada of similar U.S. equipment. The rate of duty on imports of paper-making machinery, shoe-making machinery, etc., is used, to which is added 8 per cent for the exchange rate and 4 per cent for the Federal Sales Tax applicable in 1963. The two separate price differentials for plant and machinery and equipment were then combined using 1960 original cost gross stock weights at the relevant two-digit level from the DBS capital stock estimate.

Capital stock differentials by industry are shown in Appendix Table D-1. Although it would be possible to present the results according to either country's weighting system, again we restrict ourselves to the Canadian weighting system, i.e., the U.S. capital stock is revalued in Canadian prices. In this particular case, the purchasing power equivalents (the price factor, column (5)) show relatively minor differences according to the two weighting systems. This results from the similarity in the distribution of capital stock between inventories, land, and plant and equipment for comparable industries in each country. The price of capital averages 8 per cent higher in Canada; lower non-residential construction costs are more than offset by generally higher inventory prices and machinery and equipment prices.

The derivation of the price adjusted Can./U.S. gross capital stock ratio (column (6)) has been the primary objective of this Appendix. This series was used to represent the capital input in each industry and for combining with other inputs. Also of interest are the differentials for the gross capital stock per employee by industry. On average, capital per employee is higher in Canada for the sample,[1] but again the disparities between industries are marked.

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[1]See D. Walters, *Canadian Income Levels and Growth*, p. 83, for other evidence of higher capital stock per employee in Canadian manufacturing relative to the United States. Her considerably higher estimate (123 compared with 109 shown in Table D-1), refers to total manufacturing rather than to a sample of industries.

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*29. Sources of Growth in Canadian Industries, 1946-68 (EC22-1/29, $0.00)	Wolfgang M. Illing	†29. Sources de croissance dans les industries canadiennes, 1946-1968 (EC22-1/29F, $0.00)
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*31. An Analysis of Canadian Manufacturing Productivity: Some Preliminary Results (EC22-1/31, $2.50)	Harry H. Postner	†31. Analyse de la productivité dans les industries manufacturières canadiennes—Premiers résultats (EC22-1/31F, $2.50)
32. Canada-United States Price and Productivity Differences in Manufacturing Industries, 1963 (EC22-1/32, $1.50)	E. C. West	†32. Différences de prix et de productivité dans les industries manufacturières, Canada et États-Unis, 1963 (EC22-1/32F, $0.00)
*33. Development of Community Colleges in Canada (EC22-1/33, $0.00)	Max von Zur-Muehlen	†33. Développement des collèges communautaires au Canada (EC22-1/33F, $0.00)
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Special Studies	Author—Auteur	Études spéciales
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*21. Research and Experimentation in Labour Market Search Behaviour (EC22-2/21, $0.00)	Dennis R. Maki	†21. Recherches et expériences en matière de comportement des personnes cherchant un emploi (EC22-2/21F, $0.00)

Conference Papers and Reports	Author—Auteur	Documents et rapports de colloques
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Medium-Term Capital Investment Survey—1969 (EC21-2/1969)	B. A. Keys F. G. Thompson M. Heath	Relevé des projets d'investissement à moyen terme—1969 (EC21-2/1969F)
Medium-Term Capital Investment Survey—1970 (EC22-2/1970)	B. A. Keys F. G. Thompson M. Heath	Relevé des projets d'investissement à moyen terme—1970 (EC22-2/1970F)
A General Incentive Programme to Encourage Research and Development in Canadian Industry, A Report to the Economic Council of Canada (EC22-565, $.60)	Advisory Committee on Industrial Research and Technology—Comité consultatif sur la recherche industrielle et la technologie	Programme général de stimulation des travaux de recherche et de développement dans l'industrie canadienne, Rapport présenté au Conseil économique du Canada (EC22-565F, $.60)
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Background Papers (*Concluded*)	**Author—Auteur**
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*The Incidence of Selected Taxes, by Province and Income Groups	D. M. Paproski J. Cousin

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Canada-United States Price and Productivity Differences in Manufacturing Industries, 1963

by E. C. West

Economic Council of Canada