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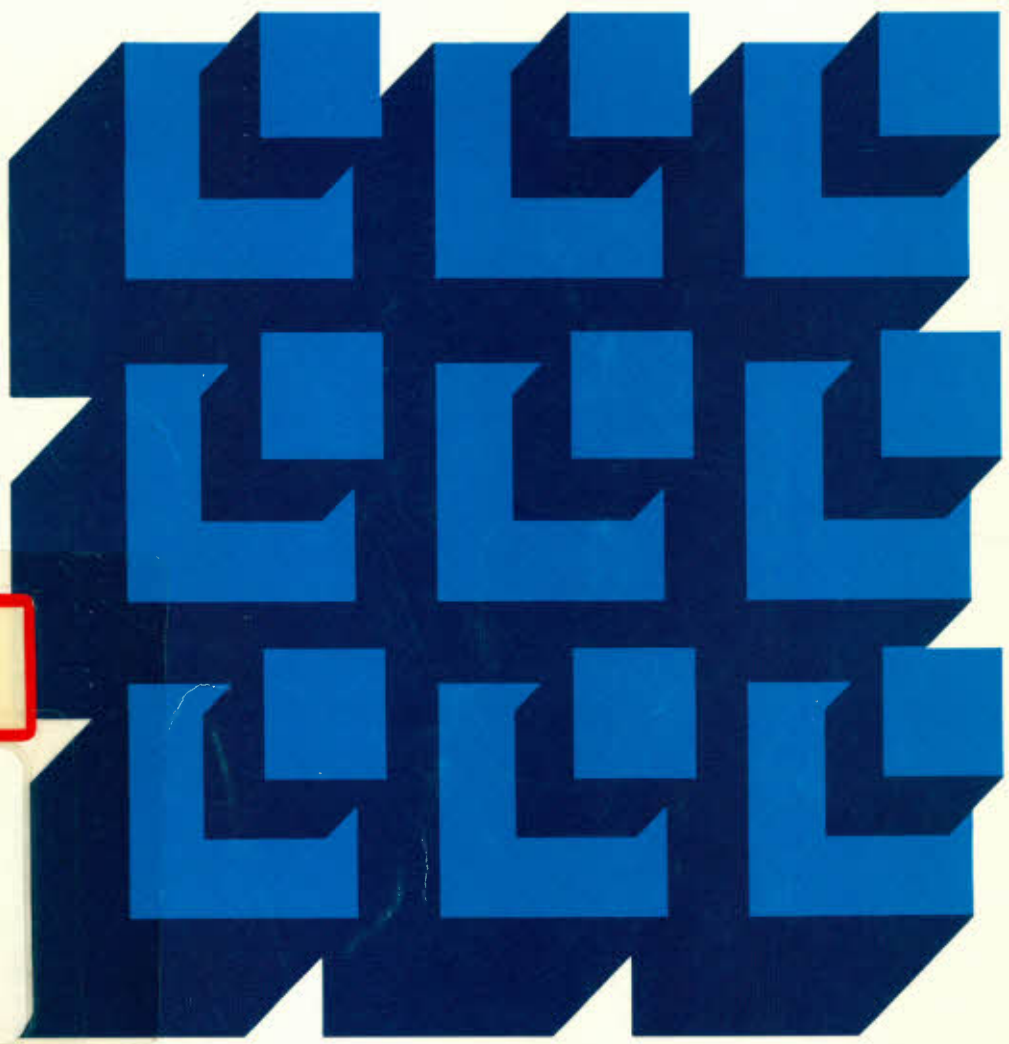

DISCUSSION PAPER NO. 339

Sources of Canadian Employment Change: A Decomposition Analysis

by

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RÉSUMÉ

L'étude a pour but d'analyser les sources de l'évolution de l'emploi au Canada entre 1971 et 1981. La méthode utilisée est l'analyse par décomposition factorielle, qui permet d'exprimer les modifications de l'emploi au Canada comme la somme d'un certain nombre de causes explicatives, dont chacune a une signification économique précise.

L'analyse par décomposition factorielle s'utilise pour divers aspects économiques. Elle peut être appliquée, notamment, à l'évolution de l'emploi par (1) industrie, (2) profession, (3) profession masculine, (4) profession féminine, (5) groupe d'âge et (6) niveau de scolarité. Dans chacun de ces domaines, la méthode par décomposition révèle les causes économiques fondamentales des modifications de l'emploi au Canada dans le secteur concerné. Celle que nous employons dans l'étude donne des résultats "non biaisés" dans un certain sens technique (expliqué dans le texte). Autant que nous sachions, cette méthodologie de base est originale, mais les calculs nécessaires sont généralement complexes.

Le mode de présentation de l'étude est entièrement pragmatique. Les travaux sont orientés de façon à produire des résultats détaillés, fondés sur une méthode complète, systématique et non biaisée. L'accent porte sur l'explication de la signification et de l'interprétation, du point de vue économique, des calculs et estimations effectivement effectués. Les auteurs ne tentent pas d'introduire dans leur analyse des concepts ou des raffinements théoriques économiques qui ne peuvent être mesurés dans les limites de l'étude. Ils s'attachent plutôt à expliquer leurs travaux et à fournir aux lecteurs suffisamment de données empiriques pour leur permettre de réaliser d'autres analyses économiques s'ils le désirent.

L'étude se termine par un certain nombre de propositions de recherches futures qui pourraient devenir réalisables grâce à de nouvelles données et aux améliorations des techniques méthodologiques. Les auteurs s'intéressent particulièrement au manque de cohérence des données entre les sources relatives aux professions, d'une part, et à l'emploi ainsi qu'à la production, d'autre part. Il s'agit là d'un problème statistique qui doit être résolu, car il est d'importance cruciale pour le Canada, peu importe qu'il se situe à l'intérieur ou à l'extérieur des limites de l'analyse par décomposition factorielle.

ABSTRACT

The purpose of the study is to present an analysis of sources of Canadian employment change for the time period 1971 to 1981. The technique used for this purpose is decomposition analysis. The analysis expresses Canadian employment change as the summation of a number of explanatory sources, each of which has a clear economic meaning.

The decomposition analysis is performed in various economic dimensions. There is an analysis of employment change by: (1) industries, (2) occupations, (3) male occupations, (4) female occupations, (5) age groups, and (6) education categories. In each dimension, the decomposition procedure reveals the basic economic sources that account for Canadian employment change in the particular dimension involved. The particular methodology of decomposition used in the study yields results that are "unbiased" in a certain technical sense (explained in the text). To our knowledge, this basic methodology is original, though the required calculations do tend to become complex.

The presentation approach of the study is entirely pragmatic. The orientation is towards making detailed results, based on a complete, systematic and unbiased methodology, available to a wide range of interested readers. The emphasis is on explaining the economic meaning and interpretation of the calculations and estimates actually performed. No attempt is made to introduce economic theoretical concepts or refinements that are not measurable within the scope of the study. So attention is directed to clarifying the work that has actually been done and providing the reader with sufficient empirical substance for further economic analysis if so desired.

The study concludes with a number of suggestions for future research that may well become feasible with additional data and improvements in methodological technique. Special concern is given to the statistical problem of resolving data inconsistencies between sources of occupational data, on the one hand, and employment and production data, on the other hand. This problem is of critical importance to Canada both within and outside the scope of decomposition analysis.

CONTENTS

FOREWORD

A central concern of the Economic Council of Canada's recent research on the labour market impacts of new technologies is the impact on employment. Accordingly, one component of the research effort was devoted to an investigation of the various sources of shifts in Canadian employment patterns in the period 1971-81, including the role of technological change.

This Discussion Paper provides detailed background material for two chapters of the Council's research report Innovation and Jobs in Canada. The particular chapters are Chapter 3, "Sources of Canadian employment change" and Chapter 10, "Special groups and technological change." Some aspects of the research report's Chapter 9, "Women and the new technologies," are also supported by the full contents of this Discussion Paper. The paper contains complete tabular presentations and detailed statements of data sources and methodology.

Judith Maxwell
Chairman

1 INTRODUCTION

The main purpose of this study is to perform an analysis of sources of Canadian employment change covering the time period 1971 to 1981. The particular technique used for this purpose is known as decomposition analysis. Our development of decomposition analysis is capable of expressing Canadian employment change as the summation of a number of explanatory sources -- all of which have a well-defined economic meaning. These particular sources are often the subject of economic discussion for policy purposes. It is, therefore, useful to have these sources spelled out in a complete and systematic framework. This, in essence, is what the study accomplishes.

Although the precise nature of our decomposition analysis will not be fully apparent until later in the study, it may be helpful to the reader to know how this study differs from other studies on similar topics. First, the decomposition analysis here is performed in various economic dimensions. There is a decomposition analysis of Canadian employment change by (1) industries, (2) occupations, (3) male occupations, (4) female occupations, (5) age groups, and (6) education categories. In each dimension, the decomposition analysis reveals the basic economic sources (or factors) that account for Canadian employment change in the particular dimension involved. Second, the decomposition sources

of employment change are all mutually exclusive and exhaustive; each source has individual economic meaning and all sources together (in any particular dimension) fully account for employment change. There is nothing "left over" to explain; our methodology has no "residuals". A third feature of our analysis concerns the treatment of Canadian international trade. Although this study does not emphasize international trade, it is still important to have a satisfactory treatment in order to avoid the ambiguity of assigning intermediate imports to a "domestic" decomposition source, or avoid claiming that all Canadian imports are of the nature of "final demand". We resolve this problem by introducing a special international trade (exchange) industry: all Canadian imports are, in effect, "produced" by Canadian exports. (Further details, including the treatment of the international trade "balance", can be found in the study's Appendix.)

There is one other important difference between this study and other Canadian research on the same topic (see references in Chapter 8). Our decomposition procedure yields results, i.e. sources of employment change, that are <u>unbiased</u> in a particular sense. For example, other studies use a decomposition methodology that exaggerates the role of "changes in technology" as a source of Canadian employment change (and that correspondingly diminishes the role of "final demand change" in this respect). These other studies overlook the fact that any decomposition procedure is not

unique; they select one decomposition procedure with particular weighting patterns and so yield results that are "biased" with respect to this selection. Our study explicitly recognizes the fact that decomposition can be performed in various ways, reflecting various patterns of weighting the two terminal years, 1971 and 1981, in the calculation procedure (explained in detail in the Appendix). We show that a particular decomposition selected yields results that are significantly different from any other decomposition procedure -- and there is no a priori economic reason for choosing one method over the other. In fact, we perform calculations based on all economically meaningful decomposition procedures, and then take the average of all such calculations as the study's major results. So we claim that the basic methodology of this study is unbiased and is, to our knowledge, also original. But the calculations do tend to become complex when the number of distinguished decomposition sources becomes more than four in number and when desired economic properties must be preserved. We have, nevertheless, succeeded in carrying out unbiased decomposition even with the distinction of as many as six different sources of Canadian employment change (along a particular dimension).

Before explaining the "spirit" in which this study is written, one more point should be made. The study gives some emphasis to statistical data problems that turn up in the course of the

analysis. One key problem concerns the "discovery" that Canadian occupational data, based on a household census, is seriously inconsistent with Canadian industry employment and production data, based on establishment surveys. All other Canadian studies have so far (simply) ignored this basic inconsistency -- which cannot be overcome by the usual "adjustment" methods. In fact, we also deploy the "usual adjustment methods", but we recognize the severe limitations of this approach and recommend concrete steps to rectify the present situation. Thus the study, in the conclusion Chapter 8 (see also Chapter 2), contains important statistical policy recommendations.

In this introduction we will not outline the contents of the study. Indeed, the study's contents are quite apparent from the preceding Table of Contents. It will, however, benefit the reader to know something about the "spirit" in which the study is presented and written. First, the main text is of a semi-technical nature. It is assumed that the reader has a general knowledge of economics and interest in the applied subject matter. So the study is not necessarily written only for specialists. In order to attract a wide audience, we have also omitted the use of mathematical formalisms in the main text. All mathematics is relegated to the Appendix -- which is essentially self-contained. Specialists may go directly to this Appendix if desired. The level of mathematics used in this Appendix is, nevertheless, kept

elementary because the basic results, once obtained, are easy to generalize.

Second, it should be noted that various chapters of the study are independent. Chapter 2 can be overlooked without loss of continuity. Chapters 3, 4 and 5 are best read in that sequence. Chapter 6 depends only on Chapter 3, while Chapter 7 depends on both Chapters 3 and 4. Some readers may even wish to look at the concluding Chapter 8 before reading the main text, and this is certainly possible. Chapter 8 contains references to the literature and a section on future research suggestions. It also has a major statistical policy recommendation as mentioned above. Finally, a reading of the Appendix, containing specification of the study's decomposition model and its properties, is necessary for a complete understanding of the whole study. But many of the mathematical proofs given in this Appendix are also translated into more intuitive language in the study's main chapters. The main text contains many tables, some of which are quite detailed. The tables present our estimates of sources of Canadian employment change over the period 1971-81 in various dimensions.

The third and final point with respect to the study's "spirit" is as follows. The basic approach of the study is entirely pragmatic. We are particularly concerned with making detailed results, based on a complete, systematic and unbiased methodology, available to the interested reader. Great emphasis is given to

explaining the economic meaning and interpretation of the calculations and estimates actually performed. On the other hand, we do not introduce economic theoretical concepts or refinements which are not measurable within the scope of the study. For example, the reader will not find extended discussions of such concepts as: embodied and disembodied technological change, price-induced effects of new technology, or even distinctions between labour-saving and capital-saving innovations. Some possibilities along these lines are briefly mentioned in Chapter 8. But we see no reason to confuse the reader with a multitude of conceptual distinctions that are not measured in the study's context. The emphasis, therefore, is on clarifying the work that has actually been done and providing the reader with sufficient empirical substance for further economic analysis if so desired.

2 DATA SOURCES AND PRELIMINARY TRANSFORMATIONS

This chapter provides background information on the data used as input to the decomposition model. It is divided into six sections. The first explains our choice of occupational aggregation and the second describes our choice of industrial aggregation. In the third, we identify the model data requirements, their sources, and preliminary calculations. Since the data are drawn from essentially two basic sources, there were problems with compatability; and these are addressed in section four. Finally, there is a brief section on data used to test the output of the model, followed by another brief section on our methodology for calculating percentage change.

SELECTION OF OCCUPATIONS

Our analysis distinguishes 85 occupations. The list corresponds to neither the three-digit nor the four-digit standard occupational classification (SOC). Rather, it is a mix with some occupations as detailed as the four-digit level and some as general as a combination of several at the three-digit level. The particular occupations were chosen in accordance with the purpose of the main research effort with which we were associated, i.e., to measure the impact of technological change on employment, and, to satisfy the limitations of the Input-Output framework. We

discuss the specific selection criteria in the following paragraphs.

We focus on occupations which are potentially at risk from computer-based technological change. Draughtsmen [occupation number 4], tool and die makers [56], and machinists [55] are predicted to feel the negative effects of CAD/CAM and CNC machines. Typists [22], bookkeepers [23], and telephone operators [31] are likely to experience negative repercusions from automated office equipment. Tellers and cashiers [24] and commodity sales clerks [37] may receive negative impacts from ATMs, debit cards and teleshopping. Welders, [58] painters, [63] assemblers of electrical and electronic equipment [60], material handlers and packagers [82] will be affected by robotics; as will auto mechanics [65] and electronic equipment installation and repair occupations [67] by computer diagnostic equipment; and shipping and receiving clerks [27] and other material recording and distribution occupations [28] by statistical inventory, storage and process control systems. The study looks at each of these occupations individually.

Wherever possible, we segregate occupations which are "high-tech". That is occupations requiring an in-depth knowledge of the theories and principles of science, engineering and mathematics and occupations which are less knowledge-intensive but have a high technology content. These include electrical

engineers [1], other engineers [2], engineering and architectural technicians [3], systems analysts and computer programmers [5], electronic data processing equipment operators [26], and electronic equipment installation and repair occupations [67].

We separate out occupations which are likely to provide the bulk of employment opportunities in the future. These are not necessarily the high tech occupations nor are they other occupations with anticipated large growth rates. Rather, they are occupations with only average, or in some cases less than average, growth rates. They are singled out because of the sheer number of people they entail. Each has a very large base and when even a small growth rate is applied to it, the result is a large absolute increase. Occupations selected on this basis include secretaries and stenographers [21], bookkeepers [23], truck drivers [77], accountants and auditors [19], janitors [44], and carpenters [69].

An important issue examined by the model is the differential impact of the decomposition factors on employment of females and of males. Consequently, several traditionally "female" occupations are considered. Clerical jobs are disaggregated more than what otherwise might have been done; sewing machine operators and textile processing occupations [61] are also shown separately.

The decomposition model relies extensively on Input-Output data but these data cover only the business sector. Establishments in the government sector (such as those relating to health, education, protection of persons and property, and social welfare) and establishments in the personal sector (such as households and private non-profit institutions, religious and welfare organizations, private clubs, and labour unions) are not included. Since information on those sectors is lacking, the model has little to teach us on occupations concentrated in them. Hence occupations in these industries are treated at very aggregate levels.

To illustrate, consider the case of university teachers, secondary teachers, and elementary teachers. Technically it is possible to separate the three occupations and, indeed, employment in each may have been subject to quite different forces over the period; but Input-Output data do not cover universities and public schools. The data are inadequate to justify differentiation of teachers and only the aggregate of teaching occupations [9] is considered. Another occupation which the SOC identifies individually is administrators unique to government. Our model omits completely this category because of the restricted Input-Output coverage.

Finally, we try as far as possible to prevent occupations from being industry-specific. In many cases, this was unavoidable.

Farmers [47] are concentrated in agriculture; fishing and forestry occupations [49] are concentrated in fishing and forestry; and mining occupations [50] are concentrated in mining. In several cases, however, it was possible to have occupations which were employed by several industries. Occupations in labouring and other elemental work [83] is one example. This category reflects occupations requiring little educational development or vocational preparation. It is found primarily in manufacturing but in many different types - metal processing, chemical processing, food and beverage processing, wood processing, textile processing, electrical and electronic assembling, and several others.

SELECTION OF INDUSTRIES

Initially, the analysis covered 77 distinct industries. As with the occupations, the industries were selected while bearing in mind our general objective to study the impact of technological change on industry employment and, also, while bearing in mind the limitations imposed by the Input-Output framework. Problems developed in reconcilling our two principal data sources at this level of industrial detail, however. The problems are described later in this chapter and reiterated again in Chapter 8 in connection with policy implications. It is sufficient to note here that these problems caused us to lose faith in the breakdown at the detailed 77-industry level and we resorted, instead, to a less detailed level of 39 industries.

The 39 industries correspond to Input-Output aggregation "M". (In fact, Input-Output aggregation M includes 43 industries but, for reasons which will become apparent later in the chapter, four industries were eliminated. We were left with the 39 industries appearing in Table 2-1 of Chapter 2.) Use of this aggregation has an added advantage. It puts our historical analysis on a comparable basis with the projections, which appear in a chapter of the main research report subsequent to the chapter containing our results.[1] With the same industry list, the reader can more easily compare past and future results.

CHOICE OF TIME PERIOD

The time period analyzed by the decomposition model extends from 1971 to 1981. The endpoint is 1981, since that was the most recent year for which detailed occupational employment data were available. Each item of data described in the next section was thus required for the two years 1971 and 1981. Where definitions changed over the period (for example, in the standard occupational classification), data were standardized to reflect 1971 definitions. To eliminate the effects of price change, all non-employment data were valued in 1971 constant prices.

DATA REQUIREMENTS AND SOURCES

We will now enumerate the data requirements and indicate their sources. The data will simply be listed and no attempt will be made to describe how they fit together within the model. This will be left to the Appendix.

The basic building blocks of the model are derived from the Input-Output system. Consequently, much of the input data were obtained either from Input-Output Division at Statistics Canada or from their publications.[2] To repeat, each item of data was requested at the M aggregation of 43 industries and 92 commodities, for the two years 1971 and 1981, and in 1971 constant prices where valuation was in dollar terms.

Three basic items of production data were received from Input-Output Division. The first consisted of the "domestic market share matrix" (or order 43 by 92). The I-O publications refer to this as the D matrix. The second consisted of the "industry technology matrix" (of order 100 by 43) -- the B matrix. The third was a "commodity competitive import coefficient vector" (of order 92). We gave it the symbol μ and defined it as the ratio of total competitive imports to total demand for domestic use. The denominator is calculated as current intermediate input demand plus personal expenditure on goods and services plus government and business fixed capital formation plus additions to inventories

plus government expenditures on goods and services less withdrawals from inventories less government production. In the notation of the Input-Output publications, μ is implicitly defined by:

$$m = \mu (Bg + e^{*} - v - a).^{3}$$

From the Input-Output publications, we were able to obtain the "commodity export vector" (of order 92). Each element of this vector corresponds to one of the 92 commodities in the M aggregation and is equal to the sum of domestic exports of the commodity plus re-exports of the commodity. Both domestic commodity exports and re-exports appear in the Final Demand Matrix. From the "commodity export vector", we derived the "commodity export pattern vector" (of order 92). Each element of the "commodity export pattern vector" is calculated as the corresponding element of the "commodity export vector" divided by the sum over all commodities of the "commodity export vector".

Also from the publications, we obtained the "industry non-competitive imports input vector" (of order 43). It appears as row 93 in the Use (Input) Matrix. The "domestic industry gross output vector" (of order 43) appears as the final row (Total) of the Make (Output) Matrix. Division of each element of the first vector by the corresponding element of the second vector yields a "non competitive imports input coefficient vector" (of order 43).

The "commodity final demand vector" (of order 92) is equal to final expenditure on GDP minus the total of domestic exports and re-exports net of imports for each of 92 commodities. These four series appear in the Final Demand Matrix.

Finally, it was necessary to evaluate two scalars. The first is a "trade balance scalar", equal to the difference between total exports and total (competitive and non-competitive) imports. Total exports is the sum of the components of the "commodity export vector". Total competitive and non-competitive imports is the sum over 93 commodities (92 competitive and 1 non-competitive) of the import column of the Final Demand Matrix.

The second scalar measures "final demand for non-competitive imports". It is calculated from row 93 (non-competitive imports) of the Final Demand Matrix and is equal to final expenditure on GDP minus the total of domestic exports and re-exports net of imports.

It will not be clear from the preceding paragraphs how these items of data relate one to another. The objective here has only been to enumerate the requirements and indicate their sources. As to how the data enter the model, the reader is again referred to the Appendix and, also, to an earlier study of the Economic Council of Canada. (See the 1983 study by Postner and Wesa cited in the Bibliography, especially Appendix A: Mathematics.) The

same interpretation of the Input-Output system is used in the current research as was used in the 1983 research. The assumptions, methodologies, and data inputs are the same -- with one exception. That single exception involves the treatment of fixed capital replacement expenditures. The present study considers these expenditures as part of final demand while the earlier study places these expenditures within intermediate demand. The decomposition analysis would probably improve by the inclusion of fixed capital replacement within intermediate demand; but limitations of Canadian data and the rather arbitrary assumptions which become necessary to overcome these limitations prompted us to handle fixed capital replacement in the traditional way. Concluding Chapter 8 elaborates further on this subject.

Before proceeding to describe the requisite employment data, one additional point must be made. Use of the production data listed above and in the manner described in the Appendix (and in the 1983 study) yields an "industry gross output vector" (of order 44). (The 44 elements correspond to 43 M aggregation Input-Output industries and one international trade industry.) This vector will serve as input to data transformations in a subsequent paragraph. The vector, in theory, should conform to a vector derived directly from the Input-Output publications. That vector would have as its elements the 43 column sums of the Make Matrix and, as element number 44, total competitive and non-competitive imports. The latter is the sum over 93 commodities (92

competitive and 1 non-competitive) of the import column of the Final Demand Matrix. The calculated vector (as described in the Appendix) and the vector directly from the publications turn out to be very close; but they are not identical. The differences arise from technical difficulties.[4]

The other essential ingredients of the decomposition model, besides the production data, are the employment data, in various forms. Input-Output Division provided data on labour employed (covering both paid and other than paid workers) for each of the 43 industries in the M aggregation. These data are completely consistent with the aforementioned production data. This consistency is of critical importance since it allowed us to compute an "industry labour coefficient vector".

An "industry labour employed vector" (of order 44) is formed by concatenating the employment observations corresponding to the 43 Input-Output industries with one employment observation for our international trade industry. This vector is divided, element by element, by the "industry gross output vector" (of order 44) which is calculated as described in the Appendix and the 1983 study. The result is the "industry labour coefficient vector" (of order 44). Four of its elements are equal to zero -- namely the elements corresponding to industry (34). Owner occupied dwellings, (41). Transportation margins, (42). Operating, office, lab and food, (43). Advertising and promotion, and (44).

International trade. This is so since labour employed in each of these industries is zero. The purpose of the decomposition model is to explain employment change by industry; but with employment in these four industries equal to zero, they were consequently removed from the industry list. We are thus left with an "industry labour coefficient vector" (of order 39).

In addition to data on total employment in each industry, the model requires data on occupational employment, employment by sex, employment by age group, and employment by educational attainment group in each industry. Unfortunately, Input-Output Division does not gather such employment data and we were compelled to turn to another source, namely the 1971 Census and the 1981 Census. We say "unfortunately", since Census data are derived from quite different sources and using quite different methodologies from the Input-Output data. The result is Census and Input-Output yield quite different values for supposedly the same items of data. This problem and its treatment are discussed in the following section of this chapter.

In more specific terms, Census Division at Statistics Canada provided an "occupation-industry total employment matrix" (of order 85 by 39). Each element shows the total number of persons employed in the particular occupation and industry. They also provided an "occupation-industry male employment matrix" (of order 85 by 39) and an "occupation-industry female employment matrix"

(of order 85 by 39). Each element shows the number of male and female employees, respectively, in the particular occupation and industry.

For the extension of the decomposition analysis along the educational attainment dimension (Chapter 7), Census Divison prepared an occupation-industry employment matrix for persons with less than grade 9. A typical element gives the numbers of persons without high school education in that particular occupation and industry. Census Division similarly prepared an occupation-industry employment matrix for persons with some high school but no university, and an occupation-industry matrix for persons with some university.

Finally, for the extension of the decomposition analysis along the age dimension (Chapter 6), it would have been useful to have an occupation-industry employment matrix for each of six age groups. The cost of acquiring such unpublished data was prohibitive. Consequently, we settled for published data[5] yielding an "age-industry employment matrix" (or order 6 by 39). Each element shows the number of persons employed in the particular age group (of which there were six) and industry.

These, then, are the employment data derived from Census sources. We turn now to the problems created and the adjustments

which became necessary by our attempt to merge data from Input-Output sources with data from Census sources.

LINKING INPUT-OUTPUT AND CENSUS DATA

Industry employment totals from Input-Output Division do not match industry employment totals from Census Division. Table 2-1 indicates the extent of the problem in 1981 for our initital set of 77 industries. Column (1) shows industry employment according to Census tabulations while column (2) shows industry employment according to Input-Output sources. Column (3) measures the difference in terms of thousands of persons and column (4) measures the relative difference in percentage terms.

Census total employment exceeds Input-Output total employment in these 77 industries by about 1,553,000 persons. This large difference can, in part, be explained by a difference in coverage of the two data sources. The Census covers all sectors (business, personal, and government) while Input-Output covers only the business sector. The consequent understatement of Input-Output data is most obvious in Other transport (including government highway and bridge maintenance) (industry (57)), Education and related (industry (68)) and Hospitals and health services (industry (69)). Together, these three industries explain about 1,315,000 of the difference. Another explanation for the discrepancy in total employment, although much less significant,

Table 2-1

Total Employment for 77 Detailed Industries According to Census and Input-Output Sources, 1981

	Industry	Census data	Input-output data	Difference (1) - (2)	Relative difference (3) * 100 / (1)
		(1)	(2)	(3)	(4)
		(Thousands of persons)			(Per cent)
1	Agriculture	457,505	500,467	-42,962	-9.3
2	Forestry	78,135	60,514	17,621	22.5
3	Fishing, hunting, trapping	31,745	36,182	-4,437	-13.9
4	Iron mines	12,435	10,976	1,459	11.7
5	Nonferrous metal ore mining	61,660	48,580	13,080	21.2
6	Coal mines	11,550	8,201	3,349	28.9
7	Crude petroleum and natural gas	47,405	30,013	17,392	36.6
8	Nonmetal mines, quarries, and sand	25,645	20,934	4,711	18.3
9	Services incidental to mining	35,250	39,464	-4,214	-11.9
10	Meat and poultry products	45,715	45,562	153	0.3
11	Fish products	48,355	27,362	20,993	43.4
12	Beverage industries	35,445	32,711	2,734	7.7
13	Other food	141,880	128,725	13,155	9.2
14	Tobacco	7,770	8,681	-911	-11.7
15	Rubber and plastics	63,635	61,451	2,184	3.4
16	Leather industries	29,045	26,212	2,833	9.7
17	Cotton, wool, and man-made fibre mills	33,785	31,861	1,924	5.6
18	Miscellaneous textile goods	39,535	35,728	3,807	9.6
19	Knitting mills	19,505	20,511	-1,006	-5.1
20	Clothing	110,740	96,153	14,587	13.1
21	Sawmills	79,250	64,694	14,556	18.3
22	Lumber and wood	56,070	48,399	7,671	13.6
23	Household furniture	42,470	30,914	11,556	27.2
24	Other furniture and fixtures	19,100	21,787	-2,687	-14.0
25	Paper and allied, except bags and boxes	111,705	103,436	8,269	7.4
26	Paper boxes and bags	25,125	25,079	46	0.1
27	Printing, publishing, and allied	126,310	108,164	18,146	14.3
28	Primary iron and steel manufacturing	84,325	71,315	13,010	15.4
29	Primary nonferrous metals	47,475	52,239	-4,764	-10.0
30	Metal fabricating - (fab. str. met.)	51,535	53,062	-1,527	-2.9
31	Metal stamping, pressing, and coating	34,225	32,444	1,781	5.2
32	Other fabricated metal products	66,925	59,043	7,882	11.7
33	Machine shops	24,170	14,460	9,710	40.1
34	Agricultural implements	17,150	15,996	1,154	6.7
35	Miscellaneous machinery and equipment manufacturing	76,655	76,247	408	0.5
36	Office and store machinery	20,235	16,162	4,073	20.1
37	Aircraft and parts	37,345	38,923	-1,578	-4.2
38	Motor vehicles, trucks, trailers	67,055	57,332	9,723	14.5
39	Motor vehicle parts and accessories	52,150	49,280	2,870	5.5
40	Other transportation equipment	37,040	32,766	4,274	11.5
41	Household appliances	17,985	18,217	-232	-1.2
42	Radio, T.V., and commercial equipment	52,950	49,600	3,350	6.3
43	Electrical industrial equipment	26,465	30,054	-3,589	-13.5
44	Electric wire and miscellaneous electric products	30,475	31,586	-1,111	-3.6
45	Glass and glass products	14,620	11,993	2,627	17.9
46	Stone and clay	50,065	43,258	6,807	13.5

Table 2-1 (Cont'd)

	Industry	Census data	Input-output data	Difference (1) - (2)	Relative difference (3) * 100 / (1)
		(1)	(2)	(3)	(4)
		(Thousands of persons)			(Per cent)
47	Petroleum refining and allied	26,975	22,753	4,222	15.6
48	Chemical and sel. chemical products	58,300	50,213	8,087	13.8
49	Drug, cleaning and toilet preparations	29,230	31,027	-1,797	-6.1
50	Paints and allied	7,705	7,142	563	7.3
51	Scientific and professional equipment	27,165	25,531	1,634	6.0
52	Miscellaneous manufacturing	50,515	41,233	9,282	18.3
53	Construction	663,655	687,196	-23,541	-3.5
54	Railway transport	104,740	88,891	15,849	15.1
55	Truck transport	143,420	149,644	-6,224	-4.3
56	Other passenger and freight transport and services	162,745	164,267	-1,522	-0.9
57	Other transport	88,745	48,219	40,526	45.6
58	Storage	20,530	17,397	3,133	15.2
59	Radio and television broadcasting	41,350	32,037	9,313	22.5
60	Communications industry, N.E.S.	121,650	112,808	8,842	7.2
61	Post office	74,340	68,515	5,825	7.8
62	Electric power, gas and water utilities	125,090	96,619	28,471	22.7
63	Wholesale trade	521,710	478,324	43,386	8.3
64	Retail trade	1,287,020	1,361,323	-74,303	-5.7
65	Insurance	98,130	85,268	12,862	13.1
66	Banks and other deposit-taking institutions	244,580	211,788	32,792	13.4
67	Other finance, insurance and real estate	250,840	255,753	-4,913	-1.9
68	Education related	730,885	24,001	706,884	96.7
69	Hospitals and health services	660,870	93,718	567,152	85.8
70	Amusement and recreation	113,345	84,066	29,279	25.8
71	Professional services to business	240,505	340,891	-100,386	-41.7
72	Advertising services	23,930	25,119	-1,189	-4.9
73	Laundries and cleaners	37,060	51,684	-14,624	-39.4
74	Accommodation and food services	567,980	513,775	54,205	9.5
75	Other personal services	102,550	153,735	-51,185	-49.9
76	Miscellaneous repair and maintenance	82,955	84,203	-1,248	-1.5
77	Miscellaneous business and personal services	277,985	205,255	72,730	26.1
	TOTAL	9,592,115	8,039,133	1,552,982	16.2

derives from the fact that the two data sources reflect different time periods. The Census relates to employment in June of 1981 while Input-Output represents average employment over the year 1981. Seasonal factors may bias Census employment upward relative to Input-Output employment.

Different sectoral and temporal coverage account for the large difference in employment reported by Census and Input-Output Divisions at the aggregate level and also in certain industries ((57), (68), and (69) as mentioned). But Table 2-1 indicates large differences, not only in aggregate employment, but in employment of several individual industries (besides (57, (68), and (69)). One source of the variation between Census and Input-Output data at the disaggregated industry level lies in the different interpretations of the construction industry. Input-Output Division defines the construction industry on an activity basis -- i.e., it includes all contract and own-account construction put in place. Hence, own-account construction workers (i.e., workers engaged in construction activity but employed by another industry) are included in construction industry employment. Census Division, by contrast, includes own-account construction workers with their respective industries.

In 1981, about 112,000 own-account construction workers were assigned to the construction industry by Input-Output Division, while Census Division distributed them over several industries.

It will be observed from Table 2-1 that the excess of Input-Output employment over Census employment in this industry is only about 24,000 persons. There are other counterbalancing factors which reduce the excess. In particular, the seasonal factors described in the preceding paragraph play a role. Sectors with a particularly large number of own-account construction workers in 1981, and with consequently larger employment numbers under Census Division procedures, include Transportation and Storage (industries (54) to (58)), Communication (industries (59) to (61)), Electric power, gas, and other utilities (62), Metal mines ((4) and (5)), and Mineral fuels ((6) and (7)).

Over and above the different coverage of Input-Output and Census data and their different treatment of own-account construction, there exists a more serious and fundamental difference in the two data sources. Input-Output data, although from a variety of sources, are essentially from surveys of establishments. Census data, by contrast, are from surveys of households. An employer, in responding to surveys of his establishment, adheres to strict Statistics Canada standard occupational and industrial classification codes. He is quite aware of the industry to which his establishment (and his head office) belong and he has realistic views of the occupations held by his employees. An employee, on the other hand, in responding to surveys of his household, may be inclined to interpret his occupation and industry quite loosely. He may well inflate the importance of his

occupation and may be quite unaware of the industry to which he belongs. The result is the two sources of data yield different measures of the same concepts. This, then, is the primary reason for the discrepancies between industry employment data as recorded by Input-Output methodologies and by Census methodologies in Table 2-1.

In fact, we judged the discrepancies in Table 2-1 too large to place much faith in the integration of Input-Output and Census employment data at that level of industrial detail (77 industries). We thought that by reducing the number of industries, and simultaneously increasing the size of each industry, some of the differences would be removed, or at least moderated. (The hope was that, with less detailed industry classifications, the establishment survey response might more closely match the household survey response). On this basis, we reduced the number of industries to 39 (corresponding to the Input-Output M level aggregation). Table 2-2 presents the same data as Table 2-1 but at the less detailed industry level. It shows that there are still large differences between Input-Output and Census observations in some industries, but they are somewhat less dramatic than in the case of 77 industries.

To make the Census employment data conform with Input-Output data (i.e., to remove the discrepancies shown in Table 2-2 and to make industry employment totals coincide), the Census data were

Table 2-2

Total Employment for 39 Aggregate Industries
According to Census and Input-Output Sources, 1981

Industry	Census data	Input-output data	Difference (1) - (2)	Relative difference (3) * 100 / (1)
	(1)	(2)	(3)	(4)
	(Thousands of persons)			(Per cent)
1 Agriculture	457,505	500,467	-42,962	-9.3
2 Forestry	78,135	60,514	17,621	22.5
3 Fishing, hunting, trapping	31,745	36,182	-4,437	-13.9
4 Metal mines	74,095	59,556	14,539	19.6
5 Mineral fuels	58,955	38,214	20,741	35.1
6 Non-metal mines and quarries	25,645	20,934	4,711	18.3
7 Services incidental to mining	34,250	39,464	-4,214	-11.9
8 Food and beverages	271,395	234,360	37,035	13.6
9 Tobacco products	7,770	8,681	-911	-11.7
10 Rubber and plastics	63,635	61,451	2,184	3.4
11 Leather industries	29,045	26,212	2,833	9.7
12 Textile industries	73,320	67,589	5,731	7.8
13 Knitting mills	19,505	20,511	-1,006	-5.1
14 Clothing industries	110,740	96,153	14,587	13.1
15 Wood industries	135,320	113,093	22,227	16.4
16 Furniture and fixtures	61,570	52,701	8,869	14.4
17 Paper and allied	136,830	128,515	8,315	6.0
18 Printing and publishing	126,310	108,164	18,146	14.3
19 Primary metal	131,800	123,554	8,246	6.2
20 Metal fabricating	176,855	159,009	17,846	10.0
21 Machinery	114,040	108,405	5,635	4.9
22 Transportation equipment	193,590	178,301	15,289	7.8
23 Electrical Products	127,875	129,457	-1,582	-1.2
24 Non-metallic mineral prod.	64,685	55,251	9,434	14.5
25 Petroleum and coal products	26,975	22,753	4,222	15.6
26 Chemical and chemical products	95,235	88,382	6,853	7.1
27 Miscellaneous manufacturing	77,680	66,764	10,916	14.0
28 Construction	663,655	687,196	-23,541	-3.5
29 Transportation and storage	520,180	468,418	51,762	9.9
30 Communication	237,340	213,360	23,980	10.1
31 Electric power, gas, other utilities	125,090	96,619	28,471	22.7
32 Wholesale trade	521,710	478,324	43,386	8.3
33 Retail trade	1,287,020	1,361,323	-74,303	-5.7
34 Other finance, insurance and real estate	593,550	552,809	40,741	6.8
35 Education and health services	1,391,755	117,719	1,274,036	91.5
36 Amusement and recreation services	113,345	84,066	29,279	25.8
37 Services to business management	542,420	571,265	-28,845	-5.3
38 Accommodation and food services	567,980	513,775	54,205	9.5
39 Other personal and misc. services	222,565	289,622	-67,057	-30.1
Total	9,592,115	8,039,133	1,552,982	16.2

adjusted by the factors in Table 2-3. There are 39 factors (one for each industry) for 1971 and 39 factors for 1981. Each is calculated as the ratio of Input-Output employment in the relevant industry to Census employment in the same industry. For example, the ratio of Input-Output employment in agriculture (industry (1)) to Census employment in agriculture in 1981 is 500,467 to 457,505. The adjustment factor, then, for agriculture is 1.09.

The adjustment process involves the multiplication of each element in the Census "occupation-industry total employment matrix" by an adjustment factor, where the adjustment factor is selected according to the industry in which the particular element of the Census matrix resides. Similarly, each element of the "occupation-industry male employment matrix", of the "occupation-industry female employment matrix", of the three occupation-industry employment matrices for the education categories, and of the "age-industry employment matrix" is multiplied by the appropriate adjustment factor.

Once the adjustment factors have been applied, the Census industry employment totals are identical with the Input-Output industry employment totals. In the case of agriculture in 1981, after all Census employment data in agriculture have been scaled by 1.09, the sum over all occupations in agriculture, the sum over both sexes in agriculture, the sum over three education categories in agriculture, and the sum over six age groups in agriculture are

Table 2-3

Adjustment Factors Applied to Census Employment Data, 1971 and 1981

	Industry	1971	1981
1	Agriculture	1.06	1.09
2	Forestry	0.96	0.77
3	Fishing, hunting, trapping	0.85	1.14
4	Metal mines	0.96	0.80
5	Mineral fuels	0.78	0.65
6	Nonmetal mines and quarries	0.93	0.82
7	Services incidental to mining	1.07	1.12
8	Food and beverages	0.98	0.86
9	Tobacco products	1.15	1.12
10	Rubber and plastics	1.07	0.97
11	Leather	1.07	0.90
12	Textiles	1.09	0.92
13	Knitting mills	1.44	1.05
14	Clothing	1.14	0.87
15	Wood	1.01	0.84
16	Furniture and fixtures	1.08	0.86
17	Paper and allied	1.03	0.94
18	Printing and publishing	0.88	0.86
19	Primary metal	1.01	0.94
20	Metal fabricating	1.10	0.90
21	Machinery	0.97	0.95
22	Transportation equipment	0.99	0.92
23	Electrical products	1.13	1.01
24	Nonmetallic mineral products	0.99	0.85
25	Petroleum and coal products	0.77	0.84
26	Chemical and chemical products	1.04	0.93
27	Miscellaneous manufacturing	1.00	0.86
28	Construction	1.15	1.04
29	Transportation and storage	0.95	0.90
30	Communication	0.92	0.90
31	Electric power, gas, other utilities	0.76	0.77
32	Wholesale trade	1.04	0.92
33	Retail trade	1.08	1.06
34	Other finance, insurance and real estate	0.98	0.93
35	Education and health services	0.08	0.08
36	Amusement and recreation services	0.68	0.74
37	Services to business management	1.05	1.05
38	Accommodation and food services	1.00	0.90
39	Other personal and miscellaneous services	0.95	1.30

Source Census and input-output data.

each equal to 500,467. This corresponds exactly to Input-Output's measure of employment in agriculture.

It should be noted that, although the occupational distribution of individual industries remains unaffected by application of the adjustment factor (all occupations within an industry are scaled by the same amount), the occupational distribution of the aggregation of all industries (the level of the total economy) will be changed. Similarly, the sex distribution, the age distribution, and the education distribution of employment at the total economy level will differ between raw Census data and adjusted Census data. The inconsistencies between Input-Output and Census data collection methods and the ensuing necessary "corrections" (adjustments) have thus introduced distortions into the data. Chapter 8 will return to the problems of reconcilling Census household-based occupational employment data with establishment-based industrial employment data.

OTHER DATA

There remains one last piece of data to be referenced. It is the price index variable for industry gross output and it appears in the correlations of Chapter 3. It is calculated as the ratio of gross industry output in 1981 measured in current dollars to gross industry output in 1981 measured in constant 1971 dollars. Both the numerator and the denominator are available for our 39

industries and both appear as the sums of the Make Matrix in the Input-Output publications.

CALCULATION OF PERCENTAGE CHANGES

The results of the decomposition analyses, along the various dimensions, are presented throughout the study as a pair of tables. The first table evaluates sources of employment change in terms of numbers of persons and the second table evaluates sources of employment change in terms of percentages. A guiding objective of our decomposition procedures has been the derivation of unbiased results (see the discussion in Chapter 1). This has implied that our final estimates of sources of employment change are, in fact, averages of several results. The "several results" are the outcome of all possible decomposition procedures, where each decomposition procedure is uniquely determined by its pattern of weighting the two end years, 1971 and 1981. Just as we took so much care to ensure unbiased results of the model when reported in levels (number of persons), we similarly took considerable care to ensure that the results were unbiased when measured in relative (percentage) terms. Hence, in converting level changes to percentage changes, the level changes are taken as a percentage of a specially constructed base. The base, like the level change itself, is an average of several bases. Each base in the average corresponds to a decomposition procedure (with its particular

weighting pattern of end years) that was used in evaluating the corresponding level change.

The reader can approximate any of the bases by averaging the 1971 employment observation with the 1981 employment observation, for any dimension. The value would be very close to our base but, being less rigorous in its construction, it would not coincide and would not yield precisely the same percentage changes. In particular, an important property of the decomposition model, which will be observed in following chapters and which relates to the impact of a decomposition factor called change in level of final demand, will not hold with the approximated base.

NOTES

1 The projections were performed by Professor T.H. McCurdy at Queen's University. They appear in Chapter 4 of the Economic Council of Canada Research Report.

2 The 1971 data appear in The Input-Output Structure of the Canadian Economy, 1971-80, Statistics Canada catalogue No. 15-201E. The 1981 data appear in The Input-Output Structure of the Canadian Economy in Constant Prices, 1979-81, Statistics Canada Cat. No. 15-202E.

3 See Chapter 4 of Statistics Canada Cat. No. 15-201E.

4 The technical difficulties involve the treatment of final demand item 78, Machinery and equipment: used cars, equipment and scrap, in the calculation of the competitive import coefficients by Input-Output Division.

5 See Employed Labour Force by Industry, Age and Sex, for Canada and Provinces, 1971 Census of Canada, Statistics Canada Cat. No. 94-747; and Labour Force - Industry by Demographic and Educational Characteristics, 1981 Census of Canada, Statistics Canada Cat. No. 92-921.

3 SOURCES OF EMPLOYMENT CHANGE BY INDUSTRY

This is the first of a series of chapters showing decomposition analyses of Canadian employment change for the time period 1971 to 1981. Each chapter involves a different aspect of the decomposition analyses. This chapter is concerned with sources of employment change by industry and provides, in effect, the foundations for further analysis in subsequent chapters. Once this chapter is understood it is easy to proceed to any of the other chapters. It should be noted, however, that we regard the decomposition analysis of employment change by occupation, in the next chapter, as being more important for purposes of labour market policy.

As already explained in Chapter 1, the main purpose of this study is to make available to economists the full background analysis to some of the chapters in the Economic Council's Research Report on Labour Markets and Technological Change. Not all readers, however, will have access to the Research Report. It, therefore, seems desirable to make the present study reasonably self-contained. So there is inevitably a degree of overlapping between this study and the Economic Council's Report. This study, however, is a little more technical -- a basic knowledge of economics is assumed. The main text, nevertheless, is completely non-mathematical; all mathematics, including the

specification of our decomposition model, is relegated to the Appendix. Also, some aspects of the decomposition analysis that are not even mentioned in the Economic Council's Report are spelled out in complete detail in the empirical chapters of this study. On the other hand, the Council Report contains more policy implications because it reflects a wide variety of empirical analysis and survey material relating to Canadian labour markets -- that are outside the scope of the present study.

TABULAR RESULTS OF DECOMPOSITION ANALYSIS

Perhaps the best way to approach our analysis is to observe its results. So in this chapter we begin by referring the reader to a series of tables which give the detailed results of decomposition analysis. The analysis by industry involves 39 distinct industries covering the complete business sector of the Canadian economy. (The justification for this industrial disaggregation has already been outlined in the previous chapter.)

The reader, therefore, is first referred to Table 3-1. The table contains a list of the 39 industries in the Canadian business sector followed by the industries' total (row 40). The first column shows the average employment in the year 1971 for each industry; the second column displays the change in employment over the period 1971 to 1981. Thus average employment in the year

Table 3-1

Decomposition Analysis of Change in Industry Employment, 1971-1981
(number of persons)

	Industry	Employment 1971	Change in employment 1971-1981	Change in employment due to change in: Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)
1	AGRICULTURE	502024	-1557	-105929	-16825	-80450	201647
2	FORESTRY	59799	715	-15474	-9482	1289	24382
3	FISHING, HUNTING, TRAPPING	20176	16006	8720	1096	-4782	10972
4	METAL MINES	61337	-1781	-2336	-18049	-5780	24384
5	MINERAL FUELS	21934	16280	12195	-4992	-2523	11600
6	NON-METAL MINES AND QUARRIES	20102	832	-2742	-3075	-1577	8226
7	SERVICES INCIDENTAL TO MINING	17923	21541	-11676	24400	-2062	10879
8	FOOD AND BEVERAGES	220694	13666	-41193	5991	-42324	91192
9	TOBACCO PRODUCTS	9582	-901	-2343	-743	-1509	3694
10	RUBBER AND PLASTICS	44928	16523	-9119	5782	-1149	21009
11	LEATHER INDUSTRIES	28017	-1805	-5599	-4252	-2923	10969
12	TEXILE INDUSTRIES	69487	-1898	-22765	-5440	-1561	27868
13	KNITTING MILLS	23948	-3437	-9652	-1983	-917	9115
14	CLOTHING INDUSTRIES	99516	-3363	-26545	-11874	-4630	39686
15	WOOD INDUSTRIES	93040	20053	-17042	-4231	237	41088
16	FURNITURE AND FIXTURES	44580	9743	-5957	-3820	-204	19724
17	PAPER AND ALLIED	119102	10714	-22065	-8458	-8599	49837
18	PRINTING AND PUBLISHING	85862	22302	-28051	12110	-459	38703
19	PRIMARY METAL	112889	10665	-11086	-21102	-4633	47486
20	METAL FABRICATING	138992	20017	-19500	-23284	2918	59883
21	MACHINERY	71441	36964	-27869	24141	5238	35454
22	TRANSPORTATION EQUIPMENT	150597	27704	-11897	-20952	-5077	65630
23	ELECTRICAL PRODUCTS	123450	4385	-49240	-11491	13126	51991
24	NON-METALLIC MINERAL PROD	51925	3326	-6354	-11874	-43	21597
25	PETROLEUM & COAL PRODUCTS	14056	7396	1047	1260	-1856	6945
26	CHEMICAL & CHEM PRODUCTS	77445	10937	-29328	7721	-791	33334
27	MISC MANUFACTURING	57971	8793	-9176	-9531	2344	25156
28	CONSTRUCTION	557774	129422	-63982	-11221	-42724	247350
29	TRANSPORTATION & STORAGE	376319	92099	-70637	6073	-11063	167726
30	COMMUNICATION	144003	69357	-93742	50550	40777	71772
31	ELEC POWER,GAS,OTHER UTILITIES	64523	32096	-18432	11595	7263	31670
32	WHOLESALE TRADE	343942	134382	-20484	-3585	-3136	161588
33	RETAIL TRADE	929854	431469	60457	-32107	-45172	448290
34	OTHER FIN, INS, REAL EST	336183	216626	-30001	43506	30804	172318
35	EDUCATION & HEALTH SERV	77310	40409	-9397	443	11258	38104
36	AMUSEMT & RECR SERVICES	45351	38715	-1843	-1099	16828	24829
37	SERV TO BUSINESS MANAGMT	267943	303322	-98392	201355	40887	159471
38	ACCOMM & FOOD SERVICES	297922	215853	47938	6494	5204	156217
39	OTHR PERSONAL & MISC SERV	158600	131022	58469	-4383	-9287	86223
40	TOTAL OF ALL INDUSTRIES	5940541	2098592	-711022	158664	-107057	2758007

1981 is equal to the total of the corresponding figures in the first two columns. Our ultimate purpose, then, is to express the employment change by industry, shown in column (2), as the summation of a number of decomposition factors (or sources) that have economic meaning and explanatory value. Table 3-1 accounts for four such decomposition sources, one source in each of the remaining columns of the table. This, in effect, means that the summation of columns (3), (4), (5) and (6) equals the corresponding employment change found in column (2). Let us now examine each of the decomposition factors in turn.

It is convenient to begin with the source embodied in column (6) -- "level of final demand". This merely represents the common indicator of Canada's overall economic activity -- total gross domestic product (GDP). So this factor shows the impact of changes in GDP (measured in constant prices) on employment change in each industry, assuming that all other sources remain unchanged. From Table 3-1 it is evident that the change in the level of final demand (1971-81) alone was responsible for increasing employment in Canadian agriculture by over 200,000 persons during the period 1971-81. This decomposition factor also raised employment in the total of all industries by about 2,758,000 persons. Indeed it is not surprising to learn that the change in GDP had a positive (and, as we shall see, uniform) impact on employment change in each and every industry of the Canadian business sector.

There is, however, an additional aspect to GDP that must be considered. GDP is the total of personal consumption expenditure, government net spending, gross fixed capital formation and the balance of international trade. These final demand components change in relative importance over the period 1971-81 and the commodity composition of each major component shifts over time. These aspects are accounted for in column (5) of Table 3-1 -- changes in the "pattern of final demand". Then column (5) measures the impact of this decomposition source of industry employment change, under the assumption that the GDP level remains unchanged. The results now shown in column (5) are more interesting. Changes in the pattern of final demand alone tend to decrease employment in Canadian agriculture by over 80,000 persons. On the other hand, for some industries the impact is positive, e.g., communications industry (no. 30) and services to business management (no. 37) -- in both cases the decomposition factor is responsible for raising employment by about 40,000 persons. For all industries taken together, changes in the pattern of final demand decrease Canadian employment by 107,000.

The two sources of employment change described by columns (5) and (6) can also be combined into one summary source called "changes in final demand". Even though the absolute impact of column (6) is always greater than that of column (5), the changes exposed by column (5) alone can still be important (see next table). It is of interest to see that employment changes in most

of the primary and manufacturing industries and construction are negatively affected by changes in pattern of final demand. Most Canadian service industries experience employment gains due to this particular decomposition factor.

We now examine a set of decomposition sources that are distinctly different from "final demand". Consider column (3) -- changes in employment due to changes in "direct labour coefficient". This factor essentially represents a measure of labour productivity for each industry. If labour productivity in an industry increases over time and all else remains the same (including industry total output), then employment in that industry will fall. So column (3) embodies the impact of changes in labour productivity 1971-81 on each and every industry's employment. As a result of this factor alone, employment in Canadian agriculture decreased by almost 106,000 persons. In fact, the labour productivity source of employment change had a negative impact in almost all industries. This decomposition factor alone is primarily responsible for employment displacement in most industries of the Canadian business economy (discussed again later). There are, however, some significant exceptions. Retail trade (no. 33), accommodation and food services (no. 38) and other personal and miscellaneous services (no. 39) all experienced employment gains due to changes in "direct labour coefficients". Totalled over all industries, the labour productivity factor alone diminished Canadian employment by some

710,000 persons during the period 1971 to 1981 (as seen in the last row of Table 3-1).

The decomposition factor discussed in the preceding paragraph ultimately reflects changes in Canadian methods of production (in contrast to the changes affecting "final demand"). There is, however, one more decomposition factor that reflects changes in production methods. The production of an industry's output requires not only labour input but also a wide variety of intermediate inputs purchased from other industries and measured by input-output statistics. When Canadian methods of production change, then this is usually evident from corresponding changes in intermediate demand (together with the labour productivity shifts already discussed). Consider, therefore, column (4) of Table 3-1. The results indicate that changes in the demand for intermediate inputs ("input-output coefficients") required for total industry production, are responsible for a decrease of Canadian agriculture employment equal to about 17,000 persons during 1971-81. So there has been a shift away from agricultural commodities as an intermediate input consumed by the Canadian business sector. On the other hand, communication services (no. 30) experienced a gain in employment of over 50,000 due to this decomposition source alone. This means that services related to communication have become a more important intermediate input during the time period. Indeed, most of the dramatic increase in employment in services to business management (no. 37), namely over 300,000 persons in

column (2), is due to the rising importance of these services as a purchased intermediate input by the Canadian business sector (see again column (4)). There are other outstanding changes as well.

Once more it is possible to simply combine columns (3) and (4) of Table 3-1 into a single source of employment change -- called "changes in production structure" (or "structural change", or simply "technological change"). Thus, the previous combined "changes in final demand" is responsible for raising Canadian employment over all industries by some 2,650,000 persons. In contrast, combined "structural change" diminishes Canadian employment by about 550,000 persons during the period 1971-81. As shown in the Appendix to this study, these respective estimates are significantly different than those of other investigators -- our estimates come from a more complex procedure that guarantees an unbiased calculation. It is also of the utmost importance to realize that the four disaggregated decomposition sources of employment change are mutually exclusive and exhaustive. Each source alone has a clear economic meaning, and the four sources together sum exactly to the change in employment for each and every industry (as well as the total of all industries). There is no "residual" and nothing "left over" to explain. This is another advantage of our decomposition procedures as explained in detail in the Appendix.

The reader is now referred to Table 3-2. This table is built upon the results of Table 3-1, but all results are now expressed in terms of "percentage changes" over the period 1971-81 (rather than "number of persons"). So while Table 3-1 highlights the relative importance of each industry, it is difficult to grasp the relative impacts of various decomposition factors, when comparing different industries, without transforming the basic results to a comparable standard. This, in effect, is what Table 3-2 accomplishes. From the last row of the table it is seen that total industry employment increased by almost 30 per cent during the period. The four decomposition factors then provide an explanation of this 30 per cent gain in employment. The change in the level of final demand accounts for a 39 per cent increase; the change in labour productivity (column (2)) is responsible for a 10 per cent decrease in employment; the other two factors are of minor importance at this total level. More generally, "structural change" accounts for a labour displacement equal to about 7.9 per cent of employment while "final demand change" accounts for labour re-employment (or absorption) equal to about 37.6 per cent of employment. All percentage changes are taken on a "base" that reflects both the years 1971 and 1981 (as explained in the Appendix).

The benefits of Table 3-2, however, are more clearly evident by examining the new set of results at the individual industry levels. It is a remarkable fact that the change in the level of

Table 3-2

Decomposition Analysis of Change in Industry Employment, 1971-1981
(percentage change)

	Industry	Change in employment 1971-1981	Change in employment due to change in: Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)
1	AGRICULTURE	-0.3	-20.5	-3.3	-15.6	39.1
2	FORESTRY	1.1	-24.8	-15.2	2.1	39.1
3	FISHING, HUNTING, TRAPPING	57.0	31.0	3.9	-17.0	39.1
4	METAL MINES	-2.9	-3.7	-28.9	-9.3	39.1
5	MINERAL FUELS	54.8	41.1	-16.8	-8.5	39.1
6	NON-METAL MINES AND QUARRIES	4.0	-13.0	-14.6	-7.5	39.1
7	SERVICES INCIDENTAL TO MINING	77.3	-41.9	87.6	-7.4	39.1
8	FOOD AND BEVERAGES	5.9	-17.6	2.6	-18.1	39.1
9	TOBACCO PRODUCTS	-9.5	-24.8	-7.9	-16.0	39.1
10	RUBBER AND PLASTICS	30.7	-17.0	10.7	-2.1	39.1
11	LEATHER INDUSTRIES	-6.4	-19.9	-15.1	-10.4	39.1
12	TEXILE INDUSTRIES	-2.7	-31.9	-7.6	-2.2	39.1
13	KNITTING MILLS	-14.7	-41.4	-8.5	-3.9	39.1
14	CLOTHING INDUSTRIES	-3.3	-26.1	-11.7	-4.6	39.1
15	WOOD INDUSTRIES	19.1	-16.2	-4.0	0.2	39.1
16	FURNITURE AND FIXTURES	19.3	-11.8	-7.6	-0.4	39.1
17	PAPER AND ALLIED	8.4	-17.3	-6.6	-6.7	39.1
18	PRINTING AND PUBLISHING	22.5	-28.3	12.2	-0.5	39.1
19	PRIMARY METAL	8.8	-9.1	-17.4	-3.8	39.1
20	METAL FABRICATING	13.1	-12.7	-15.2	1.9	39.1
21	MACHINERY	40.7	-30.7	26.6	5.8	39.1
22	TRANSPORTATION EQUIPMENT	16.5	-7.1	-12.5	-3.0	39.1
23	ELECTRICAL PRODUCTS	3.3	-37.0	-8.6	9.9	39.1
24	NON-METALLIC MINERAL PROD	6.0	-11.5	-21.5	-0.1	39.1
25	PETROLEUM & COAL PRODUCTS	41.6	5.9	7.1	-10.4	39.1
26	CHEMICAL & CHEM PRODUCTS	12.8	-34.4	9.0	-0.9	39.1
27	MISC MANUFACTURING	13.7	-14.2	-14.8	3.6	39.1
28	CONSTRUCTION	20.4	-10.1	-1.8	-6.7	39.1
29	TRANSPORTATION & STORAGE	21.4	-16.5	1.4	-2.6	39.1
30	COMMUNICATION	37.7	-51.0	27.5	22.2	39.1
31	ELEC POWER,GAS,OTHER UTILITIES	39.6	-22.7	14.3	9.0	39.1
32	WHOLESALE TRADE	32.5	-5.0	-0.9	-0.8	39.1
33	RETAIL TRADE	37.6	5.3	-2.8	-3.9	39.1
34	OTHER FIN, INS, REAL EST	49.1	-6.8	9.9	7.0	39.1
35	EDUCATION & HEALTH SERV	41.4	-9.6	0.5	11.5	39.1
36	AMUSEMT & RECR SERVICES	60.9	-2.9	-1.7	26.5	39.1
37	SERV TO BUSINESS MANAGMT	74.3	-24.1	49.3	10.0	39.1
38	ACCOMM & FOOD SERVICES	54.0	12.0	1.6	1.3	39.1
39	OTHR PERSONAL & MISC SERV	59.4	26.5	-2.0	-4.2	39.1
40	TOTAL OF ALL INDUSTRIES	29.7	-10.1	2.2	-1.5	39.1

final demand (our "first" decomposition factor) has the same percentage impact on employment in each and every industry. This is a highly convenient property because percentage changes in industry employment, when analyzed comparatively, are then entirely accounted for by the three remaining decomposition sources. Thus, for example, when we observe that amusement and recreation services (no. 36) experienced an employment gain equal to 61 per cent while knitting mills (no. 13) experienced an employment loss equal to almost 15 per cent, then this huge difference of 76 percentage points must be entirely accounted for by either: (1) direct labour coefficient source differences, (2) input-output coefficient differences, or (3) pattern of final demand differences. The transformation of all results into percentage changes, as indicated by Table 3-2, is also convenient for purposes of correlation analysis as performed in the next section of this chapter. In any event, Tables 3-1 and 3-2 together provide a complementary and complete picture of decomposition analysis for Canadian industry employment change. This complementary technique will be applied in the other chapters of this study featuring other aspects of the Canadian labour market.

Before continuing, however, there is one distinction between Tables 3-1 and 3-2 that must be noted. The last row of Table 3-1, the total of all industries, is just that -- the simple summation of the results in each column. In the case of Table 3-2, the last

row is actually a weighted average of all the respective results for the individual industries. The weights are proportional to the relative importance of each industry's employment in total employment of the Canadian business sector. Once again, the "weights" reflect the employment situations in both the beginning and end years of the time period analyzed.

Tables 3-1 and 3-2 together provide 39 distinct "stories" of employment change for the Canadian business sector. One way to approach these stories is to relate the influence of the various decomposition factors across the various industries -- this provides some revealing background material for further analytical purposes. It is also possible to provide references to the literature, not all of which is economics (Chapter 8).

CORRELATION AND OTHER ANALYSIS OF DECOMPOSITION FACTORS

It seems natural to ask whether the various decomposition sources of employment change across industries are related to each other. In order to answer this question, we set up a correlation analysis based on the percentage changes indicated by the previous Table 3-2. In this analysis there are six variables, namely the four familiar decomposition factors plus their total (which is the percentage change in employment by industry 1971-81). This accounts for the first five variables shown in the new Table 3-3. To this list we have added one more variable, namely the

Table 3-3

Correlation Analysis of Decomposition Factors: Change by Industry

Factor (variable)	(1)	(2)	(3)	(4)	(5)	(6)
(1) Employment	1.00	0.39	0.66	0.35	0.00	0.18
(2) Labour coefficients		1.00	-0.34	-0.27	0.00	0.58
(3) Input-output coefficients			1.00	0.20	0.00	-0.16
(4) Pattern of final demand				1.00	0.00	-0.37
(5) Level of final demand					1.00	0.00
(6) Price index of output						1.00

Source Based on results from Table 3-2 and data sources of Chapter 2.

percentage change in the price index of industry gross output, 1971-81. Thus Table 3-3 displays a matrix of correlation coefficients among the six variables (only the upper triangular portion of the symmetric matrix needs to be shown).

First note that all correlations involving the factor "change in level of final demand" equal zero -- this follows from the fact that the impact of this factor, when transformed into percentage change, becomes a constant for all individual industries (namely, 39.1 per cent from Table 3-2). Next, it is not surprising to learn that the employment change variable is positively correlated with the three other decomposition factors. The correlation, however, is significantly greatest with the input-output coefficient variable (0.66). So even though the impact of changes in intermediate demand are small at the total industry level (2.2 per cent), the variations in the impact of this decomposition factor across industries is very important in determining the variations of employment change across industries. Indeed, this can be intuitively recognized by comparing columns (1) and (3) of the previous Table 3-2.

Another noteworthy feature of the correlation table is the high degree of correlation (0.58) between the indicator of labour productivity change and the price index of industry output. So above-average gains in labour productivity which lead to above-average employment displacement (negative impact) by

industry are strongly associated with lower-than-average changes in industry output price indexes. This is, again, what one should expect. The pattern of final demand variable is negatively correlated with the price index variable as changes in the pattern of final demand can be expected to be influenced by related price changes in an inverse manner. The input-output coefficient variable is also negatively correlated with price indexes, but the correlation is less significant, probably because of the predominance of technological influences. A final feature of Table 3-3 is the negative correlation (-0.34) between the labour coefficient and the input-output coefficient decomposition factors. This means, in effect, that when industry employment displacement due to labour productivity growth is relatively high (percentage terms), then there is a tendency across industries for this displacement to be mitigated by shifts in intermediate demand. Once again, this result, revealed by correlation analysis, can also be intuitively recognized by comparing (the patterns of) columns (2) and (3) in the previous Table 3-2. In fact, there is an additional tendency (though weaker) for employment changes due to shifts in pattern of final demand to partly offset employment changes due to labour productivity growth.

Putting "it" all together, one may venture the hypothesis that changes in Canadian production methods, as evident from labour productivity growth, lead to favourable price change effects which

indirectly serve to mitigate the initial displacement of industry employment. The indirect effects are evident in changes in the pattern of final demand and (to a lesser extent) changes in intermediate demand. A further analysis of this hypothesis requires a more formal model and is outside the scope of the present study.

To close this chapter we present another set of tables, very closely related to the initial Tables 3-1 and 3-2. This new set of tables, namely Tables 3-4 and 3-5, contain a finer decomposition of two of the factors previously presented. Here, both the "input-output coefficient" source of employment change and the "level of final demand" source are split into domestic and international components. This can be seen in columns(4) and (5) and columns (7) and (8) of Table 3-4. The corresponding transformation into percentage changes is performed in the usual way in Table 3-5.

The methodology by which this further decomposition is accomplished can be found in the study's Appendix. It should be recalled (from Chapter 1) that Canadian international trade is given an endogenous treatment in our study: there is an international trade (exchange) "industry" where imports are "produced" by means of exports. As shown in the Appendix, this treatment helps resolve the problem of correctly handling Canadian intermediate imports -- which play an important role for the

Table 3-4

Decomposition Analysis of Change in Industry Employment, 1971-1981
(number of persons)

	Industry	Employment 1971 (1)	Change in employment 1971-1981 (2)	Change in employment due to change in: Direct labour coeff. (3)	Input-output coeff. Domestic (4)	Input-output coeff. Interntnl (5)	Pattern of final demand (6)	Level of final demand Domestic (7)	Level of final demand Interntnl (8)
1	AGRICULTURE	502024	-1557	-105929	294	-17119	-80450	221602	-19955
2	FORESTRY	59799	715	-15474	-10482	1000	1289	26795	-2413
3	FISHING, HUNTING, TRAPPING	20176	16006	8720	4	1092	-4782	12057	-1086
4	METAL MINES	61337	-1781	-2336	-6907	-11142	-5780	26797	-2413
5	MINERAL FUELS	21934	16280	12195	-1468	-3524	-2523	12748	-1148
6	NON-METAL MINES AND QUARRIES	20102	832	-2742	-1774	-1301	-1577	9040	-814
7	SERVICES INCIDENTAL TO MINING	17923	21541	-11676	25979	-1579	-2062	11955	-1077
8	FOOD AND BEVERAGES	220694	13666	-41193	6613	-622	-42324	100217	-9025
9	TOBACCO PRODUCTS	9582	-901	-2343	-506	-237	-1509	4059	-366
10	RUBBER AND PLASTICS	44928	16523	-9119	3279	2503	-1149	23088	-2079
11	LEATHER INDUSTRIES	28017	-1805	-5599	245	-4497	-2923	12055	-1086
12	TEXILE INDUSTRIES	69487	-1898	-22765	-7529	2089	-1561	30626	-2758
13	KNITTING MILLS	23948	-3437	-9652	-444	-1539	-917	10017	-902
14	CLOTHING INDUSTRIES	99516	-3363	-26545	-1202	-10672	-4630	43613	-3927
15	WOOD INDUSTRIES	93040	20053	-17042	-11035	6804	237	45154	-4066
16	FURNITURE AND FIXTURES	44580	9743	-5957	-2985	-835	-204	21676	-1952
17	PAPER AND ALLIED	119102	10714	-22065	-4650	-3808	-8599	54768	-4932
18	PRINTING AND PUBLISHING	85862	22302	-28051	8264	3846	-459	42533	-3830
19	PRIMARY METAL	112889	10665	-11086	-8891	-12210	-4633	52185	-4699
20	METAL FABRICATING	138992	20017	-19500	-22284	-1000	2918	65810	-5926
21	MACHINERY	71441	36964	-27869	6398	17743	5238	38962	-3509
22	TRANSPORTATION EQUIPMENT	150597	27704	-11897	-11976	-8976	-5077	72125	-6495
23	ELECTRICAL PRODUCTS	123450	4385	-49240	-367	-11125	13126	57136	-5145
24	NON-METALLIC MINERAL PROD	51925	3326	-6354	-10086	-1788	-43	23734	-2137
25	PETROLEUM & COAL PRODUCTS	14056	7396	1047	-616	1876	-1856	7633	-687
26	CHEMICAL & CHEM PRODUCTS	77445	10937	-29328	839	6882	-791	36633	-3299
27	MISC MANUFACTURING	57971	8793	-9176	-7190	-2341	2344	27646	-2489
28	CONSTRUCTION	557774	129422	-63982	-10809	-412	-42724	271828	-24478
29	TRANSPORTATION & STORAGE	376319	92099	-70637	-5131	11204	-11063	184324	-16598
30	COMMUNICATION	144003	69357	-93742	49227	1324	40777	78874	-7103
31	ELEC POWER,GAS,OTHER UTILITIES	64523	32096	-18432	7733	3862	7263	34804	-3134
32	WHOLESALE TRADE	343942	134382	-20484	-9580	5995	-3136	177579	-15991
33	RETAIL TRADE	929854	431469	60457	-30829	-1278	-45172	492653	-44363
34	OTHER FIN, INS, REAL EST	336183	216626	-30001	43645	-139	30804	189371	-17053
35	EDUCATION & HEALTH SERV	77310	40409	-9397	32	411	11258	41875	-3771
36	AMUSEMT & RECR SERVICES	45351	38715	-1843	-967	-132	16828	27287	-2457
37	SERV TO BUSINESS MANAGMT	267943	303322	-98392	177786	23569	40887	175253	-15782
38	ACCOMM & FOOD SERVICES	297922	215853	47938	6029	465	5204	171676	-15459
39	OTHR PERSONAL & MISC SERV	158600	131022	58469	-1650	-2732	-9287	94756	-8533
40	TOTAL OF ALL INDUSTRIES	5940541	2098592	-711022	167007	-8343	-107057	3030944	-272936

Table 3-5

Decomposition Analysis of Change in Industry Employment, 1971-1981
(percentage change)

	Industry	Change in employment 1971-1981	Change in employment due to change in: Direct labour coeff.	Input-output coeff. Domestic	Input-output coeff. Interntnl	Pattern of final demand	Level of final demand Domestic	Level of final demand Interntnl
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	AGRICULTURE	-0.3	-20.5	0.1	-3.3	-15.6	42.9	-3.9
2	FORESTRY	1.1	-24.8	-16.8	1.6	2.1	42.9	-3.9
3	FISHING, HUNTING, TRAPPING	57.0	31.0	0.0	3.9	-17.0	42.9	-3.9
4	METAL MINES	-2.9	-3.7	-11.1	-17.8	-9.3	42.9	-3.9
5	MINERAL FUELS	54.8	41.1	-4.9	-11.9	-8.5	42.9	-3.9
6	NON-METAL MINES AND QUARRIES	4.0	-13.0	-8.4	-6.2	-7.5	42.9	-3.9
7	SERVICES INCIDENTAL TO MINING	77.3	-41.9	93.3	-5.7	-7.4	42.9	-3.9
8	FOOD AND BEVERAGES	5.9	-17.6	2.8	-0.3	-18.1	42.9	-3.9
9	TOBACCO PRODUCTS	-9.5	-24.8	-5.3	-2.5	-16.0	42.9	-3.9
10	RUBBER AND PLASTICS	30.7	-17.0	6.1	4.7	-2.1	42.9	-3.9
11	LEATHER INDUSTRIES	-6.4	-19.9	0.9	-16.0	-10.4	42.9	-3.9
12	TEXILE INDUSTRIES	-2.7	-31.9	-10.6	2.9	-2.2	42.9	-3.9
13	KNITTING MILLS	-14.7	-41.4	-1.9	-6.6	-3.9	42.9	-3.9
14	CLOTHING INDUSTRIES	-3.3	-26.1	-1.2	-10.5	-4.6	42.9	-3.9
15	WOOD INDUSTRIES	19.1	-16.2	-10.5	6.5	0.2	42.9	-3.9
16	FURNITURE AND FIXTURES	19.3	-11.8	-5.9	-1.7	-0.4	42.9	-3.9
17	PAPER AND ALLIED	8.4	-17.3	-3.6	-3.0	-6.7	42.9	-3.9
18	PRINTING AND PUBLISHING	22.5	-28.3	8.3	3.9	-0.5	42.9	-3.9
19	PRIMARY METAL	8.8	-9.1	-7.3	-10.0	-3.8	42.9	-3.9
20	METAL FABRICATING	13.1	-12.7	-14.5	-0.7	1.9	42.9	-3.9
21	MACHINERY	40.7	-30.7	7.0	19.5	5.8	42.9	-3.9
22	TRANSPORTATION EQUIPMENT	16.5	-7.1	-7.1	-5.3	-3.0	42.9	-3.9
23	ELECTRICAL PRODUCTS	3.3	-37.0	-0.3	-8.4	9.9	42.9	-3.9
24	NON-METALLIC MINERAL PROD	6.0	-11.5	-18.2	-3.2	-0.1	42.9	-3.9
25	PETROLEUM & COAL PRODUCTS	41.6	5.9	-3.5	10.6	-10.4	42.9	-3.9
26	CHEMICAL & CHEM PRODUCTS	12.8	-34.4	1.0	8.1	-0.9	42.9	-3.9
27	MISC MANUFACTURING	13.7	-14.2	-11.2	-3.6	3.6	42.9	-3.9
28	CONSTRUCTION	20.4	-10.1	-1.7	-0.1	-6.7	42.9	-3.9
29	TRANSPORTATION & STORAGE	21.4	-16.5	-1.2	2.6	-2.6	42.9	-3.9
30	COMMUNICATION	37.7	-51.0	26.8	0.7	22.2	42.9	-3.9
31	ELEC POWER,GAS,OTHER UTILITIES	39.6	-22.7	9.5	4.8	9.0	42.9	-3.9
32	WHOLESALE TRADE	32.5	-5.0	-2.3	1.4	-0.8	42.9	-3.9
33	RETAIL TRADE	37.6	5.3	-2.7	-0.1	-3.9	42.9	-3.9
34	OTHER FIN, INS, REAL EST	49.1	-6.8	9.9	-0.0	7.0	42.9	-3.9
35	EDUCATION & HEALTH SERV	41.4	-9.6	0.0	0.4	11.5	42.9	-3.9
36	AMUSEMT & RECR SERVICES	60.9	-2.9	-1.5	-0.2	26.5	42.9	-3.9
37	SERV TO BUSINESS MANAGMT	74.3	-24.1	43.5	5.8	10.0	42.9	-3.9
38	ACCOMM & FOOD SERVICES	54.0	12.0	1.5	0.1	1.3	42.9	-3.9
39	OTHR PERSONAL & MISC SERV	59.4	26.5	-0.7	-1.2	-4.2	42.9	-3.9
40	TOTAL OF ALL INDUSTRIES	29.7	-10.1	2.4	-0.1	-1.5	42.9	-3.9

Canadian economy. So all international trade activity can be distinguished from purely domestic activity and this distinction provides an additional decomposition dimension for our purposes. In the context of our particular decomposition model, two of the basic factors are affected. Clearly, the direct labour coefficient factor is not affected by the international/domestic distinction; the pattern of final demand factor could be affected, but the distinction leads to complexities that are not handled in the present study (see Appendix).

The results of introducing the additional dimension are best observed from Table 3-5. Although the international trade factor in the input-output source is very small at the total industry level (row 40), this factor does become important in explaining inter-industry employment change variations. Also, once again the level of final demand factor, for international trade, is a constant across all industries -- actually representing the change in the (scalar) balance of Canadian international trade 1971-81. Since this balance was positive in 1971 and negative in 1981, the particular decomposition factor, as measured, is also negative. But the domestic aspect of final demand (percentage terms) is of much greater importance. It would be interesting to run a correlation analysis based on Table 3-5, but this has not yet been done -- a topic for future research.

4 SOURCES OF EMPLOYMENT CHANGE BY OCCUPATION

So far we have distinguished four prime sources of employment change by industry (i.e., abstracting from the domestic/international decomposition). One of the sources (changes in the level of final demand) turns out to be equal for all industries when measured in terms of percentage change. Therefore, for inter-industry comparative purposes, we reveal three essential decomposition sources of employment change. The discussion in the previous chapter, however, did not distinguish between the different types of employment in the various industries. In effect, we have implicitly assumed that the employment mix within each and every industry is the same. This assumption is not realistic. Moreover, the previous analysis neglects the fact that certain types of employment in different industries may be largely homogeneous. Problems of this nature can be resolved by considering a decomposition analysis of employment change by occupation -- the task of the present chapter.

In this chapter we distinguish 85 occupations which again cover all occupations in the Canadian business sector (see Chapter 2 for further details). Employment in each industry is composed of various occupations (sometimes as many as 30 to 40 occupations) while almost all occupations are to be found in more than one industry (often as many as 20 or 30 different industries). In

these conditions, then, it is natural to expect the decomposition sources of employment change by occupation to reflect the sources of employment change by industry -- depending on the distribution of occupational employment among the different industries. This "expectation" is, essentially, fulfilled in our decomposition model -- as spelled out in technical terms in the study's Appendix. But the decomposition of employment change by occupation also requires an additional source which has no counterpart in the decomposition by industry. This new source of employment change by occupation is called "changes in occupational staffing patterns".

Thus there are now five prime sources of employment change by occupation (again abstracting from a possible domestic/international decomposition). The first four decomposition sources are completely analogous to those presented in the previous chapter (see also further discussion below). The additional source reflects changes in the occupational mix over the period 1971 to 1981 within the Canadian business sector industries. All this is clarified in the following set of tabular results.

TABULAR RESULTS OF DECOMPOSITION ANALYSIS

Let us now turn to Table 4-1 (decomposition analysis of change in occupational employment measured in terms of "number of

Table 4-1

Decomposition Analysis of Change in Occupational Employment, 1971-1981
(number of persons)

	Occupation	Employment 1971	Change in employment 1971-1981	Change in employment due to change in:				
				Occup. staffing pattern	Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	ELECTRICAL ENGINEERS	12568	8720	2950	-5082	2603	1652	6597
2	OTHER ENGINEERS	48214	27090	4874	-10576	7672	1046	24074
3	ENG. & ARCH. TECHNICIANS & ARCHITECTS	39092	33392	10714	-11154	10021	2372	21440
4	DRAUGHTSMEN	21458	13017	519	-5661	5835	1416	10909
5	SYSTEM ANAL. & COMPUTER PROGRAMMERS	15562	17417	8695	-4120	2668	976	9198
6	OCC. IN NATURAL SCIENCES	28915	9952	-1564	-5765	4117	-235	13398
7	OCC. IN LAW	17704	18910	-417	-6147	12541	2578	10354
8	OCC. IN SOCIAL SCIENCES	10568	16058	6628	-2672	3692	1509	6901
9	TEACHING OCCUPATIONS	30515	20729	3362	-4494	1810	4213	15838
10	ARTISTIC, RECREATIONAL, & RELIGIOUS	58465	58806	18466	-13893	12929	7941	33364
11	HEALTH DIAGN. & OTH. MEDICAL PROF.	13316	7404	1662	-443	-203	-249	6637
12	NURSES,PHYSIOTH, HEALTH TECHNO	28458	25991	10903	-4235	822	2658	15844
13	SENIOR MANAGERS	39561	1394	-12672	-5061	2592	208	16327
14	SALES MANAGERS	12078	57111	45853	-3771	1054	-350	14324
15	FINANCIAL MANAGERS	6447	39468	29181	-1873	2038	1192	8930
16	PRODUCTION MANAGERS	6812	35299	31672	-4155	-359	-469	8610
17	OTHER MIDDLE MANAGERS	84122	128296	84586	-17773	7910	-1876	55449
18	PERSONNEL & OCC REL MGMNT & ADM	62226	19366	-8790	-11501	8871	2231	28556
19	ACCOUNTANTS, AUDITORS	87278	30985	-16891	-14513	17340	4277	40772
20	SUPERVISORS OF CLERICAL OCC.	71802	3081	-24312	-11603	6457	2652	29887
21	SECRETARIES & STENOGRAPHERS	154883	66277	-16521	-26558	28332	6872	74152
22	TYPISTS & CLERK-TYPISTS	51406	5096	-18184	-7950	6904	2474	21852
23	BOOKKEEPERS & ACCOUNTING CLERKS	167412	147602	64010	-24022	14178	1054	92382
24	TELLERS & CASHIERS	101778	111432	46726	2105	2450	475	59676
25	OTHER BOOKKEEPING & ACCOUNT-RECORDING	24195	20024	4203	-2889	3518	2097	13095
26	ELEC. DATA-PROCESS. EQUIP. OPER.	18782	30155	18552	-4559	2789	806	12565
27	SHIPPING & RECEIVING CLERKS	60029	18655	1987	-8365	-765	-1644	27442
28	OTH. MATERIAL RECORDING & DISTR.	62289	40478	18149	-7645	-781	-1259	32015
29	RECEPTIONISTS & INFO. CLERKS	23805	24429	9927	-3532	3441	914	13678
30	OTH. RECEPTION, MAIL,MESSENGER	54942	19919	-5025	-24663	13510	10001	26097
31	TELEPHONE OPERATORS	23460	1583	-9269	-8446	5564	3638	10096
32	GENERAL OFFICE CLERKS	85279	-88	-31591	-11178	6005	1847	34829
33	OTHER CLERICAL	85937	27871	-10909	-13096	9062	3200	39614
34	SUPERVISORS OF SALES OCC.	280355	8869	-99443	483	-940	-6540	115310
35	TECHNICAL SALESMEN, REL. ADVISORS	5563	3618	1420	-1183	389	132	2860
36	COMMERCIAL TRAVELLERS	53068	39390	21929	-9843	629	-1344	28019
37	SALES OCC.,COMMODITIES	392112	151089	-16304	8503	-7533	-17417	183840
38	SALES OCC.,SERVICES	67501	55232	10435	-8207	10342	6203	36459
39	SUPERVISORS OF SERV. OCC.	52807	43688	5110	7452	1688	838	28601
40	PROTECTIVE SERVICE	35358	17067	-5665	-7176	10510	2180	17219
41	CHEFS,COOKS,WAITERS,FOOD PREP.	172993	136710	12269	21915	5713	4223	92590
42	LODGING SERVICES	14085	7320	-1882	1757	307	223	6915
43	BARBERS,PERSONAL & APPAREL SERV	96517	35601	-27078	22144	-1297	-3304	45136
44	JANITORS	83888	41346	-4024	2497	1704	117	41052

Table 4-1 (Cont'd)

Decomposition Analysis of Change in Occupational Employment, 1971-1981
(number of persons)

	Occupation	Employment 1971	Change in employment 1971-1981	Change in employment due to change in: Occup. staffing pattern	Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
45	OTHER SERVICE OCCUPATIONS	36140	23341	660	2745	1042	393	18501
46	FOREMEN OF RES,MANUF,EQUIP. OP. OCC.	192840	31094	-13829	-29225	-3924	-5429	83501
47	FARMERS	248196	-1783	-1027	-52263	-8303	-39702	99513
48	NURSERY AND OTHER FARMING	238000	-35070	-45231	-42189	-6416	-30797	89563
49	FISHING,HUNTING,FORESTRY	56723	12171	-3855	-1311	-3272	-4548	25157
50	MINING OCCUPATIONS	33505	2174	-6779	-3215	1064	-2762	13866
51	METAL PROCESSING	29479	12765	8334	-4646	-4578	-427	14082
52	MEAT CUTTING & OTHER FOOD PROC.	81268	21582	6423	-9973	1004	-12383	36512
53	TEXTILE PROCESSING	23863	-4551	-3907	-7281	-1704	-575	8916
54	OTHER PROCESSING	74211	13937	654	-12852	-3469	-2766	32370
55	MACHINIST	34258	5325	-1825	-5996	-1627	-33	14806
56	TOOL & DIEMAKERS	9654	1097	-773	-1587	-821	156	4122
57	OTHER METAL MACHINING	27738	-7407	-12532	-3896	-1378	293	10106
58	WELDERS & FLAME CUTTERS	56468	27583	10811	-6847	-3082	-828	27529
59	OTHER MACHINING	73946	6325	-8430	-10266	-5642	-453	31117
60	ELECTRICAL & ELECTRONIC EQUIP.	29250	6415	3362	-10767	-1972	2655	13135
61	SEWING MACH OPER & TEXTILES	128644	4006	-5639	-25031	-12349	-5701	52726
62	METAL PRODUCTS	35483	18825	10026	-5177	-3102	-449	17527
63	PAINTERS- NOT CONSTRUCTION	11028	9281	5463	-1349	-712	-137	6017
64	OTHER FABRICATING	59779	26005	11056	-9788	-2622	-1201	28561
65	AUTO MECHANICS	108321	26368	-16099	1117	-2763	-4141	48254
66	INDUSTR, FARM, CONSTR MACH MECHANICS	53027	34275	21515	-9149	-2860	-2437	27206
67	ELECTRONIC EQUIP. INST. & REPAIR	3824	6031	4094	-2081	782	679	2556
68	OTHER MECHANICS & REPAIRMEN	69427	20433	-2123	-7910	-50	-1103	31619
69	CARPENTERS	92866	13531	-8409	-10528	-1758	-5632	39858
70	ELECTRICIANS	43006	4154	-5513	-5329	-970	-2168	18134
71	PLUMBERS & PIPEFITTERS	40236	2921	-6379	-4767	-485	-2218	16770
72	EXCAVATING, GRADING, PAVING	41216	19797	9070	-6307	-466	-2507	20007
73	ELEC.POW, LIGHT,WIRE COMM. EQ.INSTALL	27162	13207	1364	-13540	6697	5259	13428
74	OTHER CONSTRUCTION TRADES	106945	33616	6323	-12656	-2260	-6745	48954
75	FOREMAN, CONSTR TRADES	89939	19896	-3111	-12720	223	-4313	39816
76	LABOURING, CONSTR TRADES	71913	-2423	-18336	-7947	-813	-4002	28675
77	TRUCK DRIVERS	172360	41217	-7319	-22568	473	-6021	76652
78	BUS DRIVERS	22621	14055	7534	-4790	470	-656	11496
79	OTHER TRANSPORT	70646	13687	-4847	-12170	1686	-1831	30849
80	PRINTING TRADE CRAFT WORKERS	32438	11726	2555	-9962	4091	-113	15154
81	ELECTRO.COMM. EQ.OP, POW.STATION OPER	29878	4510	-4563	-5760	1309	627	12897
82	MATERIALS HANDLING,PACKAGING	145434	13520	-17904	-20072	-2902	-6757	61155
83	LABOURING & OTH. ELEMENTAL WORK	166496	9265	-22037	-26159	-6085	-5553	69098
84	INSPECT, TEST, GRADE & SAMPLE	56673	16134	5930	-12823	-2057	-661	25744
85	OCC N.E.C.,N.S.	152039	-16292	-58948	-17039	2136	-1597	59155
86	TOTAL OF ALL INDUSTRIES	5940541	2098592	0	-711022	158664	-107057	2758007

persons"). The format of this table is quite similar to that of Table 3-1 of the previous chapter. In fact, the results totalled over all occupations (row 86 of Table 4-1) are identical to the previous results totalled over all industries (row 40 of Table 3-1). This identity provides an important "check" on our calculations. On the basis of our introductory remarks and the mathematics of our Appendix, it is straightforward to understand the interpretation of the decomposition sources indicated by columns (4), (5), (6) and (7) of the new Table 4-1. Each of these decomposition sources already occur in the analysis by industry. So in the analysis by occupation, the familiar decomposition sources are merely transformed into an occupational dimension according to the observed distribution of occupational employment in the various industries. This distribution is, in effect, calculated as an average of both the 1971 and 1981 census of occupation statistics (see Chapter 2 and Appendix). However, the familiar decomposition sources of employment change, even after translation into occupational "space", do not tell the whole story. In fact, as we will see, a very important part of the "story" (i.e., for purposes of an "exhaustive" decomposition) is still missing!

During the period 1971 to 1981, the mix of occupations (i.e., the occupational staffing patterns) in each Canadian industry was subject to change (part of technological change, as discussed below). Some occupations become relatively more important and

other occupations become less important within the employed labour force of any industry. This factor, clearly, cannot be accounted for by a decomposition analysis by industry, even after transformation into occupational "space". The factor embodies a distinct source of employment change by occupation in order to yield an exhaustive analysis of employment change. This source is precisely accounted for by column (3) of Table 4-1.

There are three notable features of this additional decomposition factor. First, the summation of column (3) over all occupations is identically zero. So those occupations that gain in importance due to this decomposition source are always "balanced" by those occupations that lose importance. Indeed, this identity supplies another crucial "check" on our calculations. Second, it should be noted that column (3) is not a "residual"; the additional source has a clear and exclusive meaning apart from the other four decomposition sources. Finally, our analysis permits a distinction between occupational employment changes due to direct labour coefficient (or labour productivity) effects and changes due to occupational mix effects. In fact, we have succeeded in disentangling two factors that are often confounded and simply aggregated as changes due to "manpower coefficients" in other investigations. The reason why the two factors are often confounded stems from an alleged difficulty of defining changes in labour productivity on an occupational basis. But our methodology (see Appendix) resolves this difficulty and

the finer decomposition, as we shall see, has important consequences for an analysis of changes in occupational employment in the presence of technological change.

With this background we can now briefly highlight some of the results displayed in Table 4-1. Column (2) lists changes in Canadian employment by occupation over the period 1971-81. The managerial occupations (Nos. 14 to 17) report large absolute increases for this period, but see also discussion in Chapters 2 and 8 concerning possible reporting bias in the data. Changes in employment (number of persons) for some of the "high-tech" occupations (nos. 1 to 3, 5, 26, 35 and 67) are not large, but begin with relatively small employments in the base year 1971. This point will be further clarified by the next table. The previous decomposition sources of employment change, as shown by the results in columns (4), (5), (6) and (7), require no special comment, since they ultimately depend on Table 3-1 combined with our knowledge of the employment distribution of the various occupations across industries.

The additional decomposition source, as shown in column (3), is best interpreted as an additional aspect of Canadian structural change (or technological change). When Canadian methods of production change, this phenomenon is typically reflected by new occupational staffing patterns (i.e., column (3)), as well as by changes in occupational labour productivity (column (4)) and

changes in occupational demand as expressed through the demand for industrial intermediate inputs (column (5)). We will later comment on the impact of these three decomposition factors taken together. From Table 4-1 it is easily seen that all the "high-tech" occupations, listed above, exhibit a positive change (a rise in employment) due to changes in occupational mix 1971-81. On the other hand, the impact of the additional source is negative (a loss in employment) for some of the low-skilled occupations such as general office clerks (no. 32), barbers and personal service workers (no. 43), mining workers (no. 50), labourers in construction (no. 76), truck drivers (no. 77) and general labour (no. 83). So the impact of the additional decomposition source appears to be reasonable. The results, however, are not always so "clear cut" because changes in occupational mix are also affected by the change in product mix within each of the industries of our basic analysis. There is, indeed, some confounding of technological change and market mix effects in Canadian input-output statistics (see Appendix).

The results of Table 4-1 again become clearer once the unit of analysis is transformed to a more standard basis for comparison purposes. This is accomplished in Table 4-2 where all results are expressed in terms of percentage changes over the period 1971 to 1981. The summation of the five decomposition sources in this form (i.e., columns (2), (3), (4), (5) and (6)) yields the percentage change in occupational employment, in turn, for each

Table 4-2

Decomposition Analysis of Change in Occupational Employment, 1971-1981
(Percentage change)

	Occupation	Change in employment 1971-1981	Change in employment due to change in:				
			Occup. staffing pattern	Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)
1	ELECTRICAL ENGINEERS	51.6	17.5	-30.1	15.4	9.8	39.1
2	OTHER ENGINEERS	44.0	7.9	-17.2	12.4	1.7	39.1
3	ENG. & ARCH. TECHNICIANS & ARCHITECTS	60.8	19.5	-20.3	18.3	4.3	39.1
4	DRAUGHTSMEN	46.6	1.9	-20.3	20.9	5.1	39.1
5	SYSTEM ANAL. & COMPUTER PROGRAMMERS	74.0	36.9	-17.5	11.3	4.1	39.1
6	OCC. IN NATURAL SCIENCES	29.0	-4.6	-16.8	12.0	-0.7	39.1
7	OCC. IN LAW	71.3	-1.6	-23.2	47.3	9.7	39.1
8	OCC. IN SOCIAL SCIENCES	90.9	37.5	-15.1	20.9	8.5	39.1
9	TEACHING OCCUPATIONS	51.1	8.3	-11.1	4.5	10.4	39.1
10	ARTISTIC, RECREATIONAL, & RELIGIOUS	68.8	21.6	-16.3	15.1	9.3	39.1
11	HEALTH DIAGN. & OTH. MEDICAL PROF.	43.6	9.8	-2.6	-1.2	-1.5	39.1
12	NURSES,PHYSIOTH, HEALTH TECHNO	64.1	26.9	-10.4	2.0	6.6	39.1
13	SENIOR MANAGERS	3.3	-30.3	-12.1	6.2	0.5	39.1
14	SALES MANAGERS	155.7	125.0	-10.3	2.9	-1.0	39.1
15	FINANCIAL MANAGERS	172.6	127.6	-8.2	8.9	5.2	39.1
16	PRODUCTION MANAGERS	160.1	143.7	-18.8	-1.6	-2.1	39.1
17	OTHER MIDDLE MANAGERS	90.4	59.6	-12.5	5.6	-1.3	39.1
18	PERSONNEL & OCC REL MGMNT & ADM	26.5	-12.0	-15.7	12.1	3.1	39.1
19	ACCOUNTANTS, AUDITORS	29.7	-16.2	-13.9	16.6	4.1	39.1
20	SUPERVISORS OF CLERICAL OCC.	4.0	-31.8	-15.2	8.4	3.5	39.1
21	SECRETARIES & STENOGRAPHERS	34.9	-8.7	-14.0	14.9	3.6	39.1
22	TYPISTS & CLERK-TYPISTS	9.1	-32.5	-14.2	12.3	4.4	39.1
23	BOOKKEEPERS & ACCOUNTING CLERKS	62.4	27.1	-10.2	6.0	0.4	39.1
24	TELLERS & CASHIERS	72.9	30.6	1.4	1.6	0.3	39.1
25	OTHER BOOKKEEPING & ACCOUNT-RECORDING	59.7	12.5	-8.6	10.5	6.3	39.1
26	ELEC. DATA-PROCESS. EQUIP. OPER.	93.7	57.7	-14.2	8.7	2.5	39.1
27	SHIPPING & RECEIVING CLERKS	26.6	2.8	-11.9	-1.1	-2.3	39.1
28	OTH. MATERIAL RECORDING & DISTR.	49.4	22.1	-9.3	-1.0	-1.5	39.1
29	RECEPTIONISTS & INFO. CLERKS	69.8	28.3	-10.1	9.8	2.6	39.1
30	OTH. RECEPTION, MAIL,MESSENGER	29.8	-7.5	-36.9	20.2	15.0	39.1
31	TELEPHONE OPERATORS	6.1	-35.9	-32.7	21.5	14.1	39.1
32	GENERAL OFFICE CLERKS	-0.1	-35.4	-12.5	6.7	2.1	39.1
33	OTHER CLERICAL	27.5	-10.8	-12.9	8.9	3.2	39.1
34	SUPERVISORS OF SALES OCC.	3.0	-33.7	0.2	-0.3	-2.2	39.1
35	TECHNICAL SALESMEN, REL. ADVISORS	49.4	19.4	-16.2	5.3	1.8	39.1
36	COMMERCIAL TRAVELLERS	54.9	30.6	-13.7	0.9	-1.9	39.1
37	SALES OCC.,COMMODITIES	32.1	-3.5	1.8	-1.6	-3.7	39.1
38	SALES OCC.,SERVICES	59.2	11.2	-8.8	11.1	6.6	39.1
39	SUPERVISORS OF SERV. OCC.	59.7	7.0	10.2	2.3	1.1	39.1
40	PROTECTIVE SERVICE	38.7	-12.9	-16.3	23.8	4.9	39.1
41	CHEFS,COOKS,WAITERS,FOOD PREP.	57.7	5.2	9.2	2.4	1.8	39.1
42	LODGING SERVICES	41.4	-10.6	9.9	1.7	1.3	39.1
43	BARBERS,PERSONAL & APPAREL SERV	30.8	-23.4	19.2	-1.1	-2.9	39.1
44	JANITORS	39.3	-3.8	2.4	1.6	0.1	39.1

Table 4-2 (Cont'd)

Decomposition Analysis of Change in Occupational Employment, 1971-1981
(Percentage change)

	Occupation	Change in employment 1971-1981	Change in employment due to change in: Occup. staffing pattern	Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)
45	OTHER SERVICE OCCUPATIONS	49.3	1.4	5.8	2.2	0.8	39.1
46	FOREMEN OF RES,MANUF,EQUIP. OP. OCC.	14.5	-6.5	-13.7	-1.8	-2.5	39.1
47	FARMERS	-0.7	-0.4	-20.5	-3.3	-15.6	39.1
48	NURSERY AND OTHER FARMING	-15.3	-19.7	-18.4	-2.8	-13.4	39.1
49	FISHING,HUNTING,FORESTRY	18.9	-6.0	-2.0	-5.1	-7.1	39.1
50	MINING OCCUPATIONS	6.1	-19.1	-9.1	3.0	-7.8	39.1
51	METAL PROCESSING	35.4	23.1	-12.9	-12.7	-1.2	39.1
52	MEAT CUTTING & OTHER FOOD PROC.	23.1	6.9	-10.7	1.1	-13.2	39.1
53	TEXTILE PROCESSING	-19.9	-17.1	-31.9	-7.5	-2.5	39.1
54	OTHER PROCESSING	16.8	0.8	-15.5	-4.2	-3.3	39.1
55	MACHINIST	14.0	-4.8	-15.8	-4.3	-0.1	39.1
56	TOOL & DIEMAKERS	10.4	-7.3	-15.0	-7.8	1.5	39.1
57	OTHER METAL MACHINING	-28.6	-48.4	-15.1	-5.3	1.1	39.1
58	WELDERS & FLAME CUTTERS	39.1	15.3	-9.7	-4.4	-1.2	39.1
59	OTHER MACHINING	7.9	-10.6	-12.9	-7.1	-0.6	39.1
60	ELECTRICAL & ELECTRONIC EQUIP.	19.1	10.0	-32.0	-5.9	7.9	39.1
61	SEWING MACH OPER & TEXTILES	3.0	-4.2	-18.5	-9.1	-4.2	39.1
62	METAL PRODUCTS	42.0	22.3	-11.5	-6.9	-1.0	39.1
63	PAINTERS- NOT CONSTRUCTION	60.2	35.5	-8.8	-4.6	-0.9	39.1
64	OTHER FABRICATING	35.6	15.1	-13.4	-3.6	-1.6	39.1
65	AUTO MECHANICS	21.3	-13.0	0.9	-2.2	-3.4	39.1
66	INDUSTR, FARM, CONSTR MACH MECHANICS	49.2	30.9	-13.1	-4.1	-3.5	39.1
67	ELECTRONIC EQUIP. INST. & REPAIR	92.1	62.6	-31.8	12.0	10.4	39.1
68	OTHER MECHANICS & REPAIRMEN	25.2	-2.6	-9.8	-0.1	-1.4	39.1
69	CARPENTERS	13.3	-8.2	-10.3	-1.7	-5.5	39.1
70	ELECTRICIANS	8.9	-11.9	-11.5	-2.1	-4.7	39.1
71	PLUMBERS & PIPEFITTERS	6.8	-14.9	-11.1	-1.1	-5.2	39.1
72	EXCAVATING, GRADING, PAVING	38.6	17.7	-12.3	-0.9	-4.9	39.1
73	ELEC.POW, LIGHT,WIRE COMM. EQ.INSTALL	38.4	4.0	-39.4	19.5	15.3	39.1
74	OTHER CONSTRUCTION TRADES	26.8	5.0	-10.1	-1.8	-5.4	39.1
75	FOREMAN, CONSTR TRADES	19.5	-3.1	-12.5	0.2	-4.2	39.1
76	LABOURING, CONSTR TRADES	-3.3	-25.0	-10.8	-1.1	-5.5	39.1
77	TRUCK DRIVERS	21.0	-3.7	-11.5	0.2	-3.1	39.1
78	BUS DRIVERS	47.8	25.6	-16.3	1.6	-2.2	39.1
79	OTHER TRANSPORT	17.3	-6.1	-15.4	2.1	-2.3	39.1
80	PRINTING TRADE CRAFT WORKERS	30.2	6.6	-25.7	10.5	-0.3	39.1
81	ELECTRO.COMM. EQ.OP, POW.STATION OPER	13.7	-13.8	-17.4	4.0	1.9	39.1
82	MATERIALS HANDLING,PACKAGING	8.6	-11.4	-12.8	-1.9	-4.3	39.1
83	LABOURING & OTH. ELEMENTAL WORK	5.2	-12.5	-14.8	-3.4	-3.1	39.1
84	INSPECT, TEST, GRADE & SAMPLE	24.5	9.0	-19.5	-3.1	-1.0	39.1
85	OCC N.E.C.,N.S.	-10.8	-38.9	-11.3	1.4	-1.1	39.1
86	TOTAL OF ALL INDUSTRIES	29.7	0.0	-10.1	2.2	-1.5	39.1

and every occupation (namely, column (1)). Once again, all percentage changes reflect both the 1971 and 1981 levels -- according to the technical formulation spelled out in the Appendix. Indeed, this formulation is designed to possess appropriate properties and to preserve required identities. We could now comment on the results displayed in Table 4-2.

First note that the "final demand level" decomposition source (column (6)) has a uniformly equal percentage impact on each occupation and is, in fact, also equal to the corresponding column in the previous Table 3-2 (analysis by industry). This result, of course, is expected, but again serves as a "check" on our calculations. The occupations with the largest percentage change in employment are typically those with large and positive occupational mix effects and relatively small (in absolute value) labour productivity effects (see, e.g., occupation nos. 14 to 17, 24, 29, 63). Occupations with negative percentage changes in employment all experience corresponding negative occupational mix impacts (occupation nos. 32, 47, 48, 53, 57, 76 and 85). The high-tech occupations, listed earlier, all with large percentage changes in employment, are characterized by both large and positive occupational mix effects and intermediate demand effects and relatively large (in absolute value) percentage impacts from the displacement effect of labour productivity increases. So, growth of employment in these occupations ultimately comes from the reabsorption via the favourable occupational mix and

intermediate demand effects of new technologies. This is a key result of our decomposition analysis of sources of Canadian employment change by occupation.

Once again Tables 4-1 and 4-2 together imply 85 different stories regarding sources of employment change by occupation. Comparatively speaking, the stories are best told by means of Table 4-2. In this table, as already noted, the source called "level of final demand" has an equal percentage impact on all occupations (namely, 39.1 per cent). So the change in the level of final demand (1971-81) raises employment in each and every occupation by 39.1 per cent over the time period 1971-81. It is as if this particular decomposition factor becomes "factored out" for inter-occupation comparative purposes. Moreover, using Table 4-2 it is also convenient to compare the story behind any particular occupation with the total of all occupations (row no. 86). The latter acts as a sort of "average" occupation typifying the whole economy. However, since the typical occupational staffing pattern effect is zero, it turns out that the "average" occupation of Table 4-2 (row 86) equals the "average" industry of the previous Table 3-2 (row 40). In any event, the reader with special interests in particular occupations can easily follow the results.

There are other intimate connections between the two Tables 3-2 and 4-2 that are now revealed. It will be seen that the

percentage sources of employment change for the Canadian industry agriculture (Table 3-2, row 1) are identical to those for the Canadian occupation farmers (Table 4-2, row 47) except for the occupational mix source that has no counterpart by industry. This result essentially follows from the fact that all Canadian farmers are employed in agriculture (though the industry also employs other occupations). In such a condition, the identity result must follow -- acting as a further check on the calculations. Many other connections are also apparent, although not so clear cut because almost all occupations can be found in more than one industry (see comments in Chapter 8 concerning industrial disaggregation). The reader is encouraged to identify other connections on the basis of her/his prior knowledge of the distribution of occupations across different industries. But such an investigation can be aided by the correlation analysis and other remarks in the following section (see also Chapter 2 for occupation distribution data sources).

CORRELATION AND OTHER ANALYSIS OF DECOMPOSITION FACTORS

In the previous chapter (Table 3-3) we performed a correlation analysis of the various decomposition factors by industry. It is similarly possible to perform a correlation analysis based on the decomposition sources of Canadian employment change by occupation. The results of such an analysis are shown in the new Table 4-3 where the basic data ultimately come from Table 4-2 (percentage

Table 4-3

Correlation Analysis of Decomposition Factors: Change by Occupation

Factor (Variable)	(1)	(2)	(3)	(4)	(5)	(6)
(1) Employment	1.00	0.92	0.08	0.29	0.33	0.00
(2) Occupational mix		1.00	-0.05	0.02	0.10	0.00
(3) Labour coefficients			1.00	-0.34	-0.38	0.00
(4) Input-output coefficients				1.00	0.67	0.00
(5) Pattern of final demand					1.00	0.00
(6) Level of final demand						1.00

Source Based on results from Table 4-2 and data sources of Chapter 2.

changes). The new Table 4-3 exhibits six variables: namely the five decomposition sources (ordered as in Table 4-2) plus the occupational employment change variable which equals the simple summation of the five decomposition factors. So one should expect the employment change variable to be positively correlated with each of the decomposition sources. This expectation is satisfied, as seen in the first row of the correlation matrix, except for the factor called "level of final demand" which is zero-correlated with all other variables (as explained for the previous Table 3-3).

An outstanding result of Table 4-3 is the very high degree of positive correlation (0.92) between the employment change and the occupational staffing pattern variables. So changes in occupational mix play a vital role in "explaining" changes in occupational employment, even though the total of all changes in occupational mix is identically zero. Equally important is the result that the occupational mix variable has no significant correlation with the other decomposition sources. In particular, its correlation with the direct labour coefficient variable is close to zero. (This latter result is discussed again below.) There are, however, some significant correlations between the other decomposition variables which are reminiscent of the results in the previous chapter.

Both the input-output coefficient variable and the pattern of final demand variable are negatively correlated with the labour coefficient source of employment change. At the same time, there is a high degree of correlation (0.67) between the two variables, namely input-output coefficient and pattern of final demand. Indeed, comparing the correlation results in the two Tables 3-3 (by industry) and 4-3 (by occupation), shows that the transformation of industry "space" into occupation "space" tends to strengthen one of the consequences spelled out in the previous chapter. That is, there is a distinct tendency for employment displacement due to rising labour productivity to be mitigated by the counteracting effects of changes in intermediate demand and pattern of final demand. This tendency, which in the previous analysis was traced to the price mechanism (in industry "space"), cannot be so specifically traced in occupation "space" -- but the important consequence continues to hold a fortiori.

To close this chapter it is interesting to re-examine Table 4-2 with regard to the impact of technological change alone on occupational employment change. It will be recalled that technological change by occupation embodies: (1) labour productivity change, (2) intermediate demand change, and (3) changes in occupational mix. In fact, the impact of technological change can be measured as the simple summation of these three decomposition sources. So from Table 4-2 we find that in 42 per cent of the 85 occupational groups, technological change

per se has an employment-enhancing effect. This surprising effect often stems from the phenomenon of "favourable" changes in occupational staffing patterns. This typically means that the "potential" displacement of labour due to productivity gains is more than "offset" by a simultaneous reabsorption of labour due to changes in occupational mix. But a converse proposition also holds true. We know that the latter source of employment change, when summed over all occupations, equals zero. So if some occupations experience gains due to this source, then other occupations must experience losses. For these latter occupations, the potential displacement of labour due to productivity gains is "reinforced" by a simultaneous further displacement of labour due to the unfavourable occupational mix effects of technological change.

It is in the light of the remarks in the previous paragraph that the correlation results of Table 4-3 take on additional meaning. It now seems natural to ask: do those occupations experiencing the most rapid productivity increases tend to coincide with those occupations favourably (positively) impacted by changes in occupational staffing patterns (and conversely)? The answer to this question is clearly: no! And additional evidence with regard to this matter can be obtained once the occupations are further disaggregated with respect to a male/ female breakdown. This is the task of the next chapter. The lack of correlation between the two key decomposition factors (labour productivity and

occupational mix effects) also has consequences for economic projection purposes. This is discussed in the concluding Chapter 8.

Finally, it should be noted that it is also possible to produce tables similar to Tables 3-4 and 3-5 (which involve a domestic/international distinction) with an analysis by occupation. The steps to be taken in this regard are outlined in the study's Appendix, but have not yet been performed. This is a matter for future research, together with other related considerations also discussed in Chapter 8.

5 SOURCES OF EMPLOYMENT CHANGE BY MALE/FEMALE OCCUPATION

This chapter provides what we regard as the most interesting empirical results of the whole study. In effect, the decomposition sources of Canadian employment change 1971-81 by occupation, of the previous chapter, are disaggregated according to male employment and female employment. So all results (and more) of the previous chapter are now shown separately for male employment by occupation and female employment by occupation. In view of current policy emphasis on female employment, this disaggregation is of considerable interest. In fact, as we shall see, there are important differences (and similarities) between the decomposition results for male employment and those for female employment. To our knowledge, this is the first time that such a detailed decomposition analysis has been performed in a systematic framework. The full detailed results, shown in this chapter, provide statistical substance for additional investigation. Anyone with special interests in particular occupations and their Canadian male/female performance over the period 1971-81, will have these interests satisfied in the course of the chapter.

Before continuing, two points might be mentioned. It is also possible to make the male/female distinction by industry. In our view, this distinction, based on the analysis of Chapter 3, would be of less interest for labour market policy purposes than an

analysis by occupation. Indeed, it is even possible to perform a full cross-tabulation decomposition analysis by industry and occupation with the addition of the male/female distinction. However, it can be shown that such a complex and refined analysis does not yield significant substance because the occupational analysis already essentially embodies the industry analysis (see conceptual remarks in Chapter 4). The second point is that with the addition of yet another decomposition factor (to account for changes in the male/female mix), it becomes increasingly difficult to provide intuitive explanations of the following tabular results. So the reader is more than ever encouraged to consult the Appendix for the mathematical/technical accounts of the precise methodology together with formal proofs of some key identities useful for "checking" purposes.

TABULAR RESULTS OF DECOMPOSITION ANALYSIS

Let us now turn to a first set of tables, namely Table 5-1 showing the decomposition analysis of change in male occupational employment and Table 5-2 showing the decomposition analysis of change in female occupational employment. All the five familiar decomposition factors are apparent within each table, plus the addition of a new factor called "change in employment due to change in male/female mix" - seen in column (3) of each table. The explanation of this additional factor will be given shortly. For present purposes it is important to note that the two tables,

Table 5-1

Decomposition Analysis of Change in Male Occupational Employment, 1971-1981 (number of persons)

	Occupation	Employment 1971	Change in employment 1971-1981	Change in employment due to change in: Male-female mix	Occup. staffing pattern	Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	ELECTRICAL ENGINEERS	12508	8171	-388	2883	-4959	2537	1611	6487
2	OTHER ENGINEERS	48002	23956	-2324	4705	-10302	7412	987	23479
3	ENG. & ARCH. TECHNICIANS & ARCHITECTS	38532	28973	-2837	10139	-10669	9573	2275	20493
4	DRAUGHTSMEN	20303	8532	-2864	399	-4953	5021	1213	9715
5	SYSTEM ANAL. & COMPUTER PROGRAMMERS	13758	10225	-3523	6929	-3332	2097	759	7295
6	OCC. IN NATURAL SCIENCES	26082	5583	-2820	-1503	-4924	3547	-234	11516
7	OCC. IN LAW	16692	12397	-4051	-391	-5354	11021	2267	8905
8	OCC. IN SOCIAL SCIENCES	6941	5818	-2573	3448	-1477	1865	770	3785
9	TEACHING OCCUPATIONS	13119	9624	-361	2433	-2171	1069	1729	6925
10	ARTISTIC, RECREATIONAL, & RELIGIOUS	43565	28512	-11327	12419	-9813	8865	5920	22447
11	HEALTH DIAGN. & OTH. MEDICAL PROF.	11106	3229	-2500	1487	-432	-181	-193	5047
12	NURSES,PHYSIOTH, HEALTH TECHNO	7472	4915	-2642	4693	-1077	-197	286	3852
13	SENIOR MANAGERS	38512	606	-769	-12078	-4941	2443	176	15777
14	SALES MANAGERS	11775	46397	-4313	41194	-3515	673	-283	12440
15	FINANCIAL MANAGERS	6035	29321	-3558	24659	-1524	1640	958	7146
16	PRODUCTION MANAGERS	6766	32692	-1063	30341	-3897	-392	-463	8165
17	OTHER MIDDLE MANAGERS	58196	103327	3846	71341	-14261	4592	-2922	40732
18	PERSONNEL & OCC REL MGMNT & ADM	54351	2003	-12235	-6921	-9171	6336	1457	22538
19	ACCOUNTANTS, AUDITORS	74230	9651	-16069	-11877	-11860	14120	3324	32013
20	SUPERVISORS OF CLERICAL OCC.	49375	-13586	-12917	-15573	-7679	3267	1328	17988
21	SECRETARIES & STENOGRAPHERS	3295	-1666	-2819	-245	-382	568	130	1081
22	TYPISTS & CLERK-TYPISTS	1496	-677	-794	-395	-226	171	62	504
23	BOOKKEEPERS & ACCOUNTING CLERKS	52906	1201	-32810	14807	-6450	3627	275	21753
24	TELLERS & CASHIERS	7994	6856	-1152	3399	48	123	58	4380
25	OTHER BOOKKEEPING & ACCOUNT-RECORDING	5932	653	-2860	622	-618	643	340	2527
26	ELEC. DATA-PROCESS. EQUIP. OPER.	4962	4614	-1943	4100	-1079	582	177	2776
27	SHIPPING & RECEIVING CLERKS	54076	11347	-4505	1613	-7329	-741	-1507	23816
28	OTH. MATERIAL RECORDING & DISTR.	49632	21945	-6903	12530	-5823	-727	-953	23821
29	RECEPTIONISTS & INFO. CLERKS	1466	690	-560	477	-150	155	58	709
30	OTH. RECEPTION, MAIL,MESSENGER	36931	5230	-8176	-2723	-16516	9363	6967	16315
31	TELEPHONE OPERATORS	532	332	321	-267	-216	137	86	272
32	GENERAL OFFICE CLERKS	31174	-15055	-14512	-8868	-3392	1251	228	10238
33	OTHER CLERICAL	33329	-1050	-11324	-2089	-4348	2634	670	13408
34	SUPERVISORS OF SALES OCC.	236039	-28550	-30025	-83385	-1479	-105	-4696	91140
35	TECHNICAL SALESMEN, REL. ADVISORS	5505	3061	-409	1359	-1129	369	124	2747
36	COMMERCIAL TRAVELLERS	52005	31167	-5459	20381	-9132	475	-1339	26240
37	SALES OCC.,COMMODITIES	208300	38051	-28575	-12299	-335	-2720	-8634	90614
38	SALES OCC.,SERVICES	57466	23931	-17420	7655	-6229	7854	4694	27378
39	SUPERVISORS OF SERV. OCC.	34812	21536	-5341	3050	4773	999	386	17668
40	PROTECTIVE SERVICE	33399	11142	-4123	-5150	-6736	9743	1942	15466
41	CHEFS,COOKS,WAITERS,FOOD PREP.	57421	36154	-7068	3760	6509	2324	1382	29248
42	LODGING SERVICES	3329	1133	24	-705	202	52	23	1536
43	BARBERS,PERSONAL & APPAREL SERV	33870	4601	-6843	-8667	7233	-659	-984	14522
44	JANITORS	57753	15872	-7126	-3717	-274	835	-22	26176

Table 5-1 (Cont'd)

Decomposition Analysis of Change in Male Occupational Employment, 1971-1981 (number of persons)

	Occupation	Employment 1971	Change in employment 1971-1981	Change in employment due to change in: Male-female mix	Occup. staffing pattern	Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
45	OTHER SERVICE OCCUPATIONS	22955	16506	2052	239	1277	712	201	12024
46	FOREMEN OF RES,MANUF,EQUIP. OP. OCC.	185368	22564	-6752	-13923	-27043	-3650	-5123	79055
47	FARMERS	240072	-14974	-13464	-966	-49150	-7832	-37471	93909
48	NURSERY AND OTHER FARMING	137009	-10166	6592	-25732	-24018	-3539	-16858	53388
49	FISHING,HUNTING,FORESTRY	56117	10536	-1211	-3891	-1350	-3247	-4393	24627
50	MINING OCCUPATIONS	33380	1861	-263	-6764	-3192	1057	-2739	13762
51	METAL PROCESSING	28390	11731	-375	7843	-4351	-4391	-462	13465
52	MEAT CUTTING & OTHER FOOD PROC.	61337	8211	-7251	3567	-6372	524	-8395	26137
53	TEXTILE PROCESSING	13751	-3616	-1153	-2189	-4007	-940	-303	4976
54	OTHER PROCESSING	66400	8846	-2553	173	-11587	-3215	-2343	28371
55	MACHINIST	33178	5680	285	-1627	-5817	-1550	-36	14425
56	TOOL & DIEMAKERS	9575	944	-95	-794	-1557	-826	151	4065
57	OTHER METAL MACHINING	26167	-7195	-290	-11744	-3671	-1245	259	9497
58	WELDERS & FLAME CUTTERS	54109	26611	-383	10589	-6190	-2845	-959	26398
59	OTHER MACHINING	68591	2966	-2670	-7989	-9277	-4967	-513	28383
60	ELECTRICAL & ELECTRONIC EQUIP.	13676	3063	-305	1542	-4752	-706	1135	6149
61	SEWING MACH OPER & TEXTILES	36022	-6250	-8455	-2027	-5032	-2914	-1360	13538
62	METAL PRODUCTS	30401	14284	-1612	8299	-4170	-2491	-452	14711
63	PAINTERS- NOT CONSTRUCTION	10246	7931	-616	5034	-1192	-633	-139	5478
64	OTHER FABRICATING	47307	19039	-2353	9312	-7309	-1977	-981	22347
65	AUTO MECHANICS	107643	29760	-444	-15928	1088	-2728	-4106	47878
66	INDUSTR, FARM, CONSTR MACH MECHANICS	52974	33928	-229	21434	-9119	-2855	-2429	27127
67	ELECTRONIC EQUIP. INST. & REPAIR	3773	5266	-331	3673	-1939	795	654	2414
68	OTHER MECHANICS & REPAIRMEN	68451	19545	-658	-2025	-7725	5	-1126	31074
69	CARPENTERS	92487	12998	-488	-8330	-10463	-1740	-5596	39615
70	ELECTRICIANS	42772	3987	-170	-5453	-5280	-957	-2162	18009
71	PLUMBERS & PIPEFITTERS	40098	2845	-62	-6356	-4748	-483	-2208	16701
72	EXCAVATING, GRADING, PAVING	41044	19516	-152	9002	-6274	-462	-2489	19891
73	ELEC.POW, LIGHT,WIRE COMM. EQ.INSTALL	27087	11509	-1508	1298	-13192	6612	5161	13137
74	OTHER CONSTRUCTION TRADES	105859	31189	-1858	6225	-12432	-2214	-6638	48106
75	FOREMAN, CONSTR TRADES	89474	18983	-763	-3063	-12563	197	-4301	39477
76	LABOURING, CONSTR TRADES	71299	-2919	-504	-18158	-7843	-802	-3955	28344
77	TRUCK DRIVERS	170670	37891	-2428	-7240	-22295	392	-5954	75416
78	BUS DRIVERS	20404	7382	-4326	6296	-3941	397	-538	9494
79	OTHER TRANSPORT	68896	9325	-3123	-5065	-11564	1442	-1792	29426
80	PRINTING TRADE CRAFT WORKERS	25490	5063	-3458	1806	-7379	2972	-104	11226
81	ELECTRO.COMM. EQ.OP, POW.STATION OPER	29563	3304	-1000	-4485	-5515	1199	527	12578
82	MATERIALS HANDLING,PACKAGING	111428	8025	-423	-16407	-14908	-2373	-4351	46486
83	LABOURING & OTH. ELEMENTAL WORK	142708	251	-6114	-21699	-20536	-4962	-4385	57946
84	INSPECT, TEST, GRADE & SAMPLE	41332	10262	-1344	2721	-8427	-958	-253	18522
85	OCC N.E.C.,N.S.	106624	-12025	139	-41802	-11658	1278	-1340	41358
86	TOTAL OF ALL INDUSTRIES	4255069	923519	-355805	-20636	-544864	72542	-107728	1880009

Table 5-2

Decomposition Analysis of Change in Female Occupational Employment, 1971-1981 (number of persons)

	Occupation	Employment 1971	Change in employment 1971-1981	Change in employment due to change in: Male-female mix	Occup. staffing pattern	Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	ELECTRICAL ENGINEERS	60	549	388	67	-123	65	41	110
2	OTHER ENGINEERS	212	3134	2324	170	-275	260	60	595
3	ENG. & ARCH. TECHNICIANS & ARCHITECTS	560	4419	2837	575	-485	448	97	947
4	DRAUGHTSMEN	1155	4485	2864	120	-708	813	202	1194
5	SYSTEM ANAL. & COMPUTER PROGRAMMERS	1803	7192	3523	1766	-787	572	217	1903
6	OCC. IN NATURAL SCIENCES	2833	4369	2820	-61	-841	570	-0	1881
7	OCC. IN LAW	1012	6513	4051	-25	-793	1521	311	1449
8	OCC. IN SOCIAL SCIENCES	3627	10239	2573	3180	-1195	1827	739	3116
9	TEACHING OCCUPATIONS	17396	11105	361	929	-2322	741	2484	8912
10	ARTISTIC, RECREATIONAL, & RELIGIOUS	14900	30295	11327	6046	-4080	4064	2020	10917
11	HEALTH DIAGN. & OTH. MEDICAL PROF.	2210	4175	2500	174	-11	-22	-56	1589
12	NURSES,PHYSIOTH, HEALTH TECHNO	20985	21076	2642	6210	-3158	1019	2371	11992
13	SENIOR MANAGERS	1049	788	769	-594	-119	149	32	551
14	SALES MANAGERS	303	10714	4313	4659	-256	181	-67	1884
15	FINANCIAL MANAGERS	412	10147	3558	4522	-349	398	234	1784
16	PRODUCTION MANAGERS	46	2608	1063	1330	-258	33	-6	445
17	OTHER MIDDLE MANAGERS	25926	24969	-3846	13245	-3512	3318	1047	14717
18	PERSONNEL & OCC REL MGMNT & ADM	7875	17363	12235	-1869	-2330	2535	774	6018
19	ACCOUNTANTS, AUDITORS	13048	21334	16069	-5014	-2653	3220	953	8759
20	SUPERVISORS OF CLERICAL OCC.	22427	16667	12917	-8739	-3924	3190	1325	11899
21	SECRETARIES & STENOGRAPHERS	151588	67943	2819	-16276	-26176	27764	6742	73071
22	TYPISTS & CLERK-TYPISTS	49909	5773	794	-17789	-7724	6733	2412	21348
23	BOOKKEEPERS & ACCOUNTING CLERKS	114505	146401	32810	49203	-17572	10551	780	70629
24	TELLERS & CASHIERS	93784	104576	1152	43327	2058	2327	417	55296
25	OTHER BOOKKEEPING & ACCOUNT-RECORDING	18263	19371	2860	3581	-2271	2875	1757	10568
26	ELEC. DATA-PROCESS. EQUIP. OPER.	13820	25541	1943	14452	-3479	2207	629	9789
27	SHIPPING & RECEIVING CLERKS	5953	7308	4505	374	-1036	-24	-137	3626
28	OTH. MATERIAL RECORDING & DISTR.	12657	18533	6903	5619	-1822	-55	-306	8194
29	RECEPTIONISTS & INFO. CLERKS	22339	23739	560	9451	-3382	3285	856	12969
30	OTH. RECEPTION, MAIL,MESSENGER	18011	14689	8176	-2302	-8147	4146	3033	9782
31	TELEPHONE OPERATORS	22928	1251	-321	-9002	-8229	5426	3552	9825
32	GENERAL OFFICE CLERKS	54104	14967	14512	-22722	-7786	4754	1620	24590
33	OTHER CLERICAL	52608	28921	11324	-8820	-8748	6428	2529	26206
34	SUPERVISORS OF SALES OCC.	44315	37419	30025	-16059	1962	-835	-1844	24170
35	TECHNICAL SALESMEN, REL. ADVISORS	57	558	409	61	-54	20	8	113
36	COMMERCIAL TRAVELLERS	1063	8223	5459	1548	-712	154	-6	1779
37	SALES OCC.,COMMODITIES	183812	113038	28575	-4005	8837	-4813	-8783	93227
38	SALES OCC.,SERVICES	10035	31300	17420	2780	-1978	2488	1509	9081
39	SUPERVISORS OF SERV. OCC.	17996	22152	5341	2060	2679	689	452	10933
40	PROTECTIVE SERVICE	1959	5925	4123	-516	-440	767	238	1753
41	CHEFS,COOKS,WAITERS,FOOD PREP.	115572	100557	7068	8509	15407	3389	2842	63342
42	LODGING SERVICES	10756	6188	-24	-1177	1555	255	200	5379
43	BARBERS,PERSONAL & APPAREL SERV	62647	30999	6843	-18411	14911	-638	-2320	30614
44	JANITORS	26135	25474	7126	-307	2771	869	140	14876

Table 5-2 (Cont'd)

Decomposition Analysis of Change in Female Occupational Employment, 1971-1981 (number of persons)

	Occupation	Employment 1971	Change in employment 1971-1981	Change in employment due to change in: Male-female mix	Occup. staffing pattern	Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
45	OTHER SERVICE OCCUPATIONS	13185	6836	-2052	421	1468	330	192	6477
46	FOREMEN OF RES,MANUF,EQUIP. OP. OCC.	7472	8529	6752	93	-2182	-274	-306	4446
47	FARMERS	8124	13191	13464	-61	-3113	-471	-2231	5604
48	NURSERY AND OTHER FARMING	100991	-24904	-6592	-19499	-18171	-2877	-13939	36175
49	FISHING,HUNTING,FORESTRY	606	1635	1211	36	38	-25	-155	530
50	MINING OCCUPATIONS	125	314	263	-15	-23	7	-22	104
51	METAL PROCESSING	1089	1034	375	490	-295	-187	34	616
52	MEAT CUTTING & OTHER FOOD PROC.	19931	13372	7251	2856	-3601	480	-3989	10375
53	TEXTILE PROCESSING	10112	-935	1153	-1718	-3275	-764	-272	3940
54	OTHER PROCESSING	7811	5091	2553	481	-1265	-254	-423	3999
55	MACHINIST	1080	-356	-285	-198	-178	-77	3	381
56	TOOL & DIEMAKERS	79	152	95	21	-30	5	4	57
57	OTHER METAL MACHINING	1571	-212	290	-788	-225	-132	34	609
58	WELDERS & FLAME CUTTERS	2360	972	383	222	-657	-237	131	1131
59	OTHER MACHINING	5354	3358	2670	-441	-989	-674	60	2734
60	ELECTRICAL & ELECTRONIC EQUIP.	15574	3352	305	1821	-6015	-1266	1520	6987
61	SEWING MACH OPER & TEXTILES	92622	10256	8455	-3612	-19999	-9435	-4341	39188
62	METAL PRODUCTS	5083	4541	1612	1728	-1007	-611	3	2816
63	PAINTERS- NOT CONSTRUCTION	782	1350	616	429	-157	-79	2	539
64	OTHER FABRICATING	12472	6966	2353	1745	-2479	-646	-221	6213
65	AUTO MECHANICS	678	608	444	-171	29	-35	-35	376
66	INDUSTR. FARM. CONSTR MACH MECHANICS	52	347	229	82	-30	-5	-8	79
67	ELECTRONIC EQUIP. INST. & REPAIR	51	764	331	421	-143	-13	25	142
68	OTHER MECHANICS & REPAIRMEN	975	887	658	-98	-185	-55	23	545
69	CARPENTERS	379	534	488	-79	-65	-18	-35	243
70	ELECTRICIANS	234	167	170	-60	-48	-14	-6	125
71	PLUMBERS & PIPEFITTERS	138	76	62	-23	-19	-2	-10	69
72	EXCAVATING, GRADING, PAVING	171	281	152	69	-34	-4	-19	117
73	ELEC.POW. LIGHT,WIRE COMM. EQ.INSTALL	76	1698	1508	66	-348	84	97	291
74	OTHER CONSTRUCTION TRADES	1086	2427	1858	98	-224	-47	-107	848
75	FOREMAN, CONSTR TRADES	466	913	763	-48	-156	26	-12	339
76	LABOURING, CONSTR TRADES	614	496	504	-178	-103	-11	-47	330
77	TRUCK DRIVERS	1690	3325	2428	-79	-274	82	-67	1235
78	BUS DRIVERS	2217	6673	4326	1239	-849	73	-118	2001
79	OTHER TRANSPORT	1750	4362	3123	218	-606	245	-39	1422
80	PRINTING TRADE CRAFT WORKERS	6948	6662	3458	750	-2584	1119	-9	3928
81	ELECTRO.COMM. EQ.OP. POW.STATION OPER	315	1206	1000	-77	-245	110	99	320
82	MATERIALS HANDLING,PACKAGING	34006	5495	423	-1497	-5163	-530	-2406	14669
83	LABOURING & OTH. ELEMENTAL WORK	23788	9014	6114	-339	-5620	-1123	-1168	11153
84	INSPECT. TEST. GRADE & SAMPLE	15341	5872	1344	3209	-4397	-1099	-408	7222
85	OCC N.E.C.,N.S.	45415	-4267	-139	-17146	-5381	858	-257	17797
86	TOTAL OF ALL INDUSTRIES	1685472	1175074	355805	20636	-166159	86122	671	877998

Tables 5-1 and 5-2, when simply added element by corresponding element (recall that the two tables are in terms of "number of persons") yield the original Table 4-1 in the previous chapter. This, of course, is to be expected. But this "expectation" has certain consequences that are worth noting.

We know that changes in occupational staffing patterns, when analyzed as a decomposition factor, must sum to zero over all occupations. But this identity need not hold for male and female occupational employment when considered separately. Indeed the total of column (4) in Table 5-1 equals a negative number of male persons (-20,636). The total of column (4) in Table 5-2 equals a positive number of female persons (20,636). The two totals together are zero. So changes in occupational staffing patterns are a positive source of employment change for the Canadian female employment taken as an aggregate (further discussed below). A second noteworthy consequence concerns the new decomposition factor accounting for changes in the male/female mix. Not only does the summation of column (3) in Table 5-1 (male employment) plus the summation of column (3) in Table 5-2 (female employment) equal zero, as expected, but the zero identity holds true with respect to each and every individual occupation. Intuitively this is again what one should "expect" - providing a powerful check on all calculations.

The interpretation of the decomposition factor accounting for changes in the male/female mix is rather analogous to that of the occupational mix factor discussed in Chapter 4. Here, however, we are concerned with changes in the male/female proportions 1971-81 within each occupation (or, within each industry when the analysis is on an industry basis). If the proportion of females has risen over the period within a particular occupation, then the male/female mix decomposition factor would indicate a gain in female occupational employment due to this source alone. In fact, it is clear from Tables 5-1 and 5-2 that the new decomposition factor is a positive source of employment change for almost all occupations within the realm of female employment. The opposite, of course, holds true for male employment. When observed at the total level (row 86 of Table 5-2), it is seen that changes in the male/female mix alone are responsible for adding over 355,000 persons to Canadian female employment over the period 1971-81. Indeed this factor alone offsets the loss of employment due to female labour productivity gains (-166,000) by a multiple of more than two. Many other additional results are also apparent from the male/female distinction (discussed further in the context of the next two tables and the next section on correlation analysis).

Before continuing, it should be noted that the new decomposition source of employment change by occupation and by sex must not be considered as part of "structural change" (or, simply

"technological change"). The new source is certainly not part of "final demand change." What, then, does this decomposition factor represent? The additional source, in effect, reflects the influence of particular aspects of Canadian labour supply and other behavioural-demographic aspects of the changing Canadian economy. A more detailed analysis of these aspects for the historical period 1971-81 is outside the scope of this study.

Once again, our decomposition analysis is enhanced by transforming the two above tables into an analysis based on percentage changes over the period concerned. This is done in the familiar manner and shown in a new set of tables, Table 5-3 (male occupational employment) and Table 5-4 (female occupational employment). It seems natural to ask: How are these two tables related to the previous Table 4-2 which was also in terms of percentage changes, but where the male/female distinction was not drawn (based on total employment for each occupation)? First note that the simple "rule" relating Tables 5-1 and 5-2 to the previous chapter's Table 4-1 certainly does not hold true. Once results are transformed into percentage changes, a new "rule" is required: Table 4-2, element by element, equals a weighted average of the new Tables 5-3 and 5-4, with corresponding element by element. The weights are merely the relative importance of male and female employment within each occupation - so the weights are the same for each element across an occupation. Again, the weights take account of (relative) male and female employment in both end years

Table 5-3

Decomposition Analysis of Change in Male Occupational Employment, 1971-1981
(Percentage change)

	Occupation	Change in employ. 1971-81	Change in employment due to change in: Male/ female mix	Occup. staffing pattern	Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	ELECTRICAL ENGINEERS	49.2	-2.3	17.4	-29.9	15.3	9.7	39.1
2	OTHER ENGINEERS	39.9	-3.9	7.8	-17.1	12.3	1.6	39.1
3	ENG. & ARCH. TECHNICIANS & ARCHITECTS	55.2	-5.4	19.3	-20.3	18.2	4.3	39.1
4	DRAUGHTSMEN	34.3	-11.5	1.6	-19.9	20.2	4.9	39.1
5	SYSTEM ANAL. & COMPUTER PROGRAMMERS	54.7	-18.9	37.1	-17.8	11.2	4.1	39.1
6	OCC. IN NATURAL SCIENCES	18.9	-9.6	-5.1	-16.7	12.0	-0.8	39.1
7	OCC. IN LAW	54.4	-17.8	-1.7	-23.5	48.3	9.9	39.1
8	OCC. IN SOCIAL SCIENCES	60.0	-26.6	35.6	-15.2	19.2	7.9	39.1
9	TEACHING OCCUPATIONS	54.3	-2.0	13.7	-12.2	6.0	9.7	39.1
10	ARTISTIC, RECREATIONAL, & RELIGIOUS	49.6	-19.7	21.6	-17.1	15.4	10.3	39.1
11	HEALTH DIAGN. & OTH. MEDICAL PROF.	25.0	-19.3	11.5	-3.3	-1.4	-1.5	39.1
12	NURSES,PHYSIOTH, HEALTH TECHNO	49.8	-26.8	47.6	-10.9	-2.0	2.9	39.1
13	SENIOR MANAGERS	1.5	-1.9	-29.9	-12.2	6.0	0.4	39.1
14	SALES MANAGERS	145.7	-13.5	129.3	-11.0	2.7	-0.9	39.1
15	FINANCIAL MANAGERS	160.3	-19.4	134.8	-8.3	9.0	5.2	39.1
16	PRODUCTION MANAGERS	156.4	-5.1	145.1	-18.6	-1.9	-2.2	39.1
17	OTHER MIDDLE MANAGERS	99.1	3.7	68.4	-13.7	4.4	-2.8	39.1
18	PERSONNEL & OCC REL MGMNT & ADM	3.5	-21.2	-12.0	-15.9	11.0	2.5	39.1
19	ACCOUNTANTS, AUDITORS	11.8	-19.6	-14.5	-14.5	17.2	4.1	39.1
20	SUPERVISORS OF CLERICAL OCC.	-29.5	-28.0	-33.8	-16.7	7.1	2.9	39.1
21	SECRETARIES & STENOGRAPHERS	-60.2	-101.9	-8.8	-13.8	20.5	4.7	39.1
22	TYPISTS & CLERK-TYPISTS	-52.4	-61.4	-30.6	-17.5	13.2	4.8	39.1
23	BOOKKEEPERS & ACCOUNTING CLERKS	2.2	-58.9	26.6	-11.6	6.5	0.5	39.1
24	TELLERS & CASHIERS	61.1	-10.3	30.3	0.4	1.1	0.5	39.1
25	OTHER BOOKKEEPING & ACCOUNT-RECORDING	10.1	-44.2	9.6	-9.6	9.9	5.3	39.1
26	ELEC. DATA-PROCESS. EQUIP. OPER.	64.9	-27.3	57.7	-15.2	8.2	2.5	39.1
27	SHIPPING & RECEIVING CLERKS	18.6	-7.4	2.6	-12.0	-1.2	-2.5	39.1
28	OTH. MATERIAL RECORDING & DISTR.	36.0	-11.3	20.5	-9.5	-1.2	-1.6	39.1
29	RECEPTIONISTS & INFO. CLERKS	38.0	-30.8	26.3	-8.3	8.6	3.2	39.1
30	OTH. RECEPTION, MAIL,MESSENGER	12.5	-19.6	-6.5	-39.5	22.4	16.7	39.1
31	TELEPHONE OPERATORS	47.7	46.1	-38.3	-31.1	19.7	12.3	39.1
32	GENERAL OFFICE CLERKS	-57.4	-55.4	-33.8	-12.9	4.8	0.9	39.1
33	OTHER CLERICAL	-3.1	-33.0	-6.1	-12.7	7.7	2.0	39.1
34	SUPERVISORS OF SALES OCC.	-12.2	-12.9	-35.7	-0.6	-0.0	-2.0	39.1
35	TECHNICAL SALESMEN, REL. ADVISORS	43.5	-5.8	19.3	-16.1	5.2	1.8	39.1
36	COMMERCIAL TRAVELLERS	46.4	-8.1	30.3	-13.6	0.7	-2.0	39.1
37	SALES OCC.,COMMODITIES	16.4	-12.3	-5.3	-0.1	-1.2	-3.7	39.1
38	SALES OCC.,SERVICES	34.1	-24.9	10.9	-8.9	11.2	6.7	39.1
39	SUPERVISORS OF SERV. OCC.	47.6	-11.8	6.7	10.6	2.2	0.9	39.1
40	PROTECTIVE SERVICE	28.1	-10.4	-13.0	-17.0	24.6	4.9	39.1
41	CHEFS,COOKS,WAITERS,FOOD PREP.	48.3	-9.4	5.0	8.7	3.1	1.8	39.1
42	LODGING SERVICES	28.8	0.6	-17.9	5.1	1.3	0.6	39.1
43	BARBERS,PERSONAL & APPAREL SERV	12.4	-18.4	-23.3	19.5	-1.8	-2.6	39.1
44	JANITORS	23.7	-10.6	-5.5	-0.4	1.2	-0.0	39.1
45	OTHER SERVICE OCCUPATIONS	53.6	6.7	0.8	4.1	2.3	0.7	39.1

Table 5-3 (Cont'd)

Decomposition Analysis of Change in Male Occupational Employment, 1971-1981
(Percentage change)

	Occupation	Change in employ. 1971-81	Change in employment due to change in: Male/ female mix	Occup. staffing pattern	Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
46	FOREMEN OF RES,MANUF,EQUIP. OP. OCC.	11.1	-3.3	-6.9	-13.4	-1.8	-2.5	39.1
47	FARMERS	-6.2	-5.6	-0.4	-20.4	-3.3	-15.6	39.1
48	NURSERY AND OTHER FARMING	-7.4	4.8	-18.8	-17.6	-2.6	-12.3	39.1
49	FISHING,HUNTING,FORESTRY	16.7	-1.9	-6.2	-2.1	-5.2	-7.0	39.1
50	MINING OCCUPATIONS	5.3	-0.7	-19.2	-9.1	3.0	-7.8	39.1
51	METAL PROCESSING	34.0	-1.1	22.8	-12.6	-12.7	-1.3	39.1
52	MEAT CUTTING & OTHER FOOD PROC.	12.3	-10.8	5.3	-9.5	0.8	-12.5	39.1
53	TEXTILE PROCESSING	-28.4	-9.1	-17.2	-31.5	-7.4	-2.4	39.1
54	OTHER PROCESSING	12.2	-3.5	0.2	-16.0	-4.4	-3.2	39.1
55	MACHINIST	15.4	0.8	-4.4	-15.8	-4.2	-0.1	39.1
56	TOOL & DIEMAKERS	9.1	-0.9	-7.6	-15.0	-7.9	1.5	39.1
57	OTHER METAL MACHINING	-29.6	-1.2	-48.3	-15.1	-5.1	1.1	39.1
58	WELDERS & FLAME CUTTERS	39.4	-0.6	15.7	-9.2	-4.2	-1.4	39.1
59	OTHER MACHINING	4.1	-3.7	-11.0	-12.8	-6.8	-0.7	39.1
60	ELECTRICAL & ELECTRONIC EQUIP.	19.5	-1.9	9.8	-30.2	-4.5	7.2	39.1
61	SEWING MACH OPER & TEXTILES	-18.0	-24.4	-5.8	-14.5	-8.4	-3.9	39.1
62	METAL PRODUCTS	37.9	-4.3	22.0	-11.1	-6.6	-1.2	39.1
63	PAINTERS- NOT CONSTRUCTION	56.6	-4.4	35.9	-8.5	-4.5	-1.0	39.1
64	OTHER FABRICATING	33.3	-4.1	16.3	-12.8	-3.5	-1.7	39.1
65	AUTO MECHANICS	21.0	-0.4	-13.0	0.9	-2.2	-3.4	39.1
66	INDUSTR, FARM, CONSTR MACH MECHANICS	48.9	-0.3	30.9	-13.1	-4.1	-3.5	39.1
67	ELECTRONIC EQUIP. INST. & REPAIR	85.2	-5.4	59.4	-31.4	12.9	10.6	39.1
68	OTHER MECHANICS & REPAIRMEN	24.6	-0.8	-2.5	-9.7	0.0	-1.4	39.1
69	CARPENTERS	12.8	-0.5	-8.2	-10.3	-1.7	-5.5	39.1
70	ELECTRICIANS	8.6	-0.4	-11.8	-11.5	-2.1	-4.7	39.1
71	PLUMBERS & PIPEFITTERS	6.7	-0.1	-14.9	-11.1	-1.1	-5.2	39.1
72	EXCAVATING, GRADING, PAVING	38.3	-0.3	17.7	-12.3	-0.9	-4.9	39.1
73	ELEC.POW. LIGHT,WIRE COMM. EQ.INSTALL	34.2	-4.5	3.9	-39.2	19.7	15.3	39.1
74	OTHER CONSTRUCTION TRADES	25.3	-1.5	5.1	-10.1	-1.8	-5.4	39.1
75	FOREMAN, CONSTR TRADES	18.8	-0.8	-3.0	-12.4	0.2	-4.3	39.1
76	LABOURING, CONSTR TRADES	-4.0	-0.7	-25.0	-10.8	-1.1	-5.5	39.1
77	TRUCK DRIVERS	19.6	-1.3	-3.7	-11.5	0.2	-3.1	39.1
78	BUS DRIVERS	30.4	-17.8	25.9	-16.2	1.6	-2.2	39.1
79	OTHER TRANSPORT	12.4	-4.1	-6.7	-15.3	1.9	-2.4	39.1
80	PRINTING TRADE CRAFT WORKERS	17.6	-12.0	6.3	-25.7	10.3	-0.4	39.1
81	ELECTRO.COMM. EQ.OP, POW.STATION OPER	10.3	-3.1	-13.9	-17.1	3.7	1.6	39.1
82	MATERIALS HANDLING,PACKAGING	6.7	-0.4	-13.8	-12.5	-2.0	-3.7	39.1
83	LABOURING & OTH. ELEMENTAL WORK	0.2	-4.1	-14.6	-13.8	-3.3	-3.0	39.1
84	INSPECT, TEST, GRADE & SAMPLE	21.6	-2.8	5.7	-17.8	-2.0	-0.5	39.1
85	OCC N.E.C.,N.S.	-11.4	0.1	-39.5	-11.0	1.2	-1.3	39.1
86	TOTAL	19.2	-7.4	-0.4	-11.3	1.5	-2.2	39.1

Table 5-4

Decomposition Analysis of Change in Female Occupational Employment, 1971-1981
(Percentage change)

	Occupation	Change in employ. 1971-81	Change in employment due to change in: Male/ female mix	Occup. staffing pattern	Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	ELECTRICAL ENGINEERS	194.8	137.6	23.9	-43.7	23.3	14.7	39.1
2	OTHER ENGINEERS	205.7	152.5	11.1	-18.0	17.1	3.9	39.1
3	ENG. & ARCH. TECHNICIANS & ARCHITECTS	182.3	117.0	23.7	-20.0	18.5	4.0	39.1
4	DRAUGHTSMEN	146.7	93.7	3.9	-23.2	26.6	6.6	39.1
5	SYSTEM ANAL. & COMPUTER PROGRAMMERS	147.7	72.3	36.3	-16.2	11.7	4.4	39.1
6	OCC. IN NATURAL SCIENCES	90.7	58.5	-1.3	-17.5	11.8	-0.0	39.1
7	OCC. IN LAW	175.6	109.2	-0.7	-21.4	41.0	8.4	39.1
8	OCC. IN SOCIAL SCIENCES	128.4	32.3	39.9	-15.0	22.9	9.3	39.1
9	TEACHING OCCUPATIONS	48.7	1.6	4.1	-10.2	3.2	10.9	39.1
10	ARTISTIC, RECREATIONAL, & RELIGIOUS	108.4	40.5	21.6	-14.6	14.5	7.2	39.1
11	HEALTH DIAGN. & OTH. MEDICAL PROF.	102.6	61.5	4.3	-0.3	-0.5	-1.4	39.1
12	NURSES,PHYSIOTH, HEALTH TECHNO	68.7	8.6	20.2	-10.3	3.3	7.7	39.1
13	SENIOR MANAGERS	55.9	54.6	-42.1	-8.5	10.6	2.2	39.1
14	SALES MANAGERS	222.1	89.4	96.6	-5.3	3.8	-1.4	39.1
15	FINANCIAL MANAGERS	222.2	77.9	99.0	-7.6	8.7	5.1	39.1
16	PRODUCTION MANAGERS	228.7	93.2	116.7	-22.6	2.9	-0.5	39.1
17	OTHER MIDDLE MANAGERS	66.3	-10.2	35.2	-9.3	8.8	2.8	39.1
18	PERSONNEL & OCC REL MGMNT & ADM	112.7	79.4	-12.1	-15.1	16.5	5.0	39.1
19	ACCOUNTANTS, AUDITORS	95.1	71.7	-22.4	-11.8	14.4	4.3	39.1
20	SUPERVISORS OF CLERICAL OCC.	54.7	42.4	-28.7	-12.9	10.5	4.3	39.1
21	SECRETARIES & STENOGRAPHERS	36.3	1.5	-8.7	-14.0	14.8	3.6	39.1
22	TYPISTS & CLERK-TYPISTS	10.6	1.5	-32.5	-14.1	12.3	4.4	39.1
23	BOOKKEEPERS & ACCOUNTING CLERKS	81.0	18.1	27.2	-9.7	5.8	0.4	39.1
24	TELLERS & CASHIERS	73.9	0.8	30.6	1.5	1.6	0.3	39.1
25	OTHER BOOKKEEPING & ACCOUNT-RECORDING	71.6	10.6	13.2	-8.4	10.6	6.5	39.1
26	ELEC. DATA-PROCESS. EQUIP. OPER.	101.9	7.8	57.7	-13.9	8.8	2.5	39.1
27	SHIPPING & RECEIVING CLERKS	78.7	48.5	4.0	-11.2	-0.3	-1.5	39.1
28	OTH. MATERIAL RECORDING & DISTR.	88.3	32.9	26.8	-8.7	-0.3	-1.5	39.1
29	RECEPTIONISTS & INFO. CLERKS	71.5	1.7	28.5	-10.2	9.9	2.6	39.1
30	OTH. RECEPTION, MAIL,MESSENGER	58.7	32.6	-9.2	-32.5	16.6	12.1	39.1
31	TELEPHONE OPERATORS	5.0	-1.3	-35.8	-32.7	21.6	14.1	39.1
32	GENERAL OFFICE CLERKS	23.8	23.1	-36.1	-12.4	7.6	2.6	39.1
33	OTHER CLERICAL	43.1	16.9	-13.1	-13.0	9.6	3.8	39.1
34	SUPERVISORS OF SALES OCC.	60.5	48.5	-26.0	3.2	-1.4	-3.0	39.1
35	TECHNICAL SALESMEN, REL. ADVISORS	193.2	141.8	21.3	-18.6	6.8	2.8	39.1
36	COMMERCIAL TRAVELLERS	180.6	119.9	34.0	-15.6	3.4	-0.1	39.1
37	SALES OCC.,COMMODITIES	47.4	12.0	-1.7	3.7	-2.0	-3.7	39.1
38	SALES OCC.,SERVICES	134.6	74.9	12.0	-8.5	10.7	6.5	39.1
39	SUPERVISORS OF SERV. OCC.	79.1	19.1	7.4	9.6	2.5	1.6	39.1
40	PROTECTIVE SERVICE	132.0	91.8	-11.5	-9.8	17.1	5.3	39.1
41	CHEFS,COOKS,WAITERS,FOOD PREP.	62.0	4.4	5.2	9.5	2.1	1.8	39.1
42	LODGING SERVICES	44.9	-0.2	-8.5	11.3	1.9	1.5	39.1
43	BARBERS,PERSONAL & APPAREL SERV	39.6	8.7	-23.5	19.0	-0.8	-3.0	39.1
44	JANITORS	66.9	18.7	-0.8	7.3	2.3	0.4	39.1
45	OTHER SERVICE OCCUPATIONS	41.2	-12.4	2.5	8.9	2.0	1.2	39.1

Table 5-4 (Cont'd)

Decomposition Analysis of Change in Female Occupational Employment, 1971-1981
(Percentage change)

	Occupation	Change in employ. 1971-81	Change in employment due to change in: Male-Female mix	Occup. staffing pattern	Direct labour coeff.	Input-output coeff.	Pattern of final demand	Level of final demand
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
46	FOREMEN OF RES,MANUF,EQUIP. OP. OCC.	74.9	59.3	0.8	-19.2	-2.4	-2.7	39.1
47	FARMERS	91.9	93.8	-0.4	-21.7	-3.3	-15.6	39.1
48	NURSERY AND OTHER FARMING	-26.9	-7.1	-21.1	-19.6	-3.1	-15.1	39.1
49	FISHING,HUNTING,FORESTRY	120.4	89.2	2.6	2.8	-1.8	-11.5	39.1
50	MINING OCCUPATIONS	117.9	99.0	-5.7	-8.7	2.6	-8.4	39.1
51	METAL PROCESSING	65.5	23.8	31.1	-18.7	-11.9	2.2	39.1
52	MEAT CUTTING & OTHER FOOD PROC.	50.3	27.3	10.8	-13.6	1.8	-15.0	39.1
53	TEXTILE PROCESSING	-9.3	11.4	-17.0	-32.5	-7.6	-2.7	39.1
54	OTHER PROCESSING	49.7	24.9	4.7	-12.4	-2.5	-4.1	39.1
55	MACHINIST	-36.5	-29.3	-20.3	-18.3	-7.9	0.3	39.1
56	TOOL & DIEMAKERS	104.4	65.2	14.4	-20.5	3.3	2.9	39.1
57	OTHER METAL MACHINING	-13.6	18.6	-50.5	-14.4	-8.5	2.2	39.1
58	WELDERS & FLAME CUTTERS	33.6	13.2	7.7	-22.7	-8.2	4.5	39.1
59	OTHER MACHINING	48.0	38.1	-6.3	-14.1	-9.6	0.9	39.1
60	ELECTRICAL & ELECTRONIC EQUIP.	18.7	1.7	10.2	-33.6	-7.1	8.5	39.1
61	SEWING MACH OPER & TEXTILES	10.2	8.4	-3.6	-19.9	-9.4	-4.3	39.1
62	METAL PRODUCTS	63.0	22.4	24.0	-14.0	-8.5	0.0	39.1
63	PAINTERS- NOT CONSTRUCTION	97.8	44.7	31.1	-11.4	-5.7	0.2	39.1
64	OTHER FABRICATING	43.8	14.8	11.0	-15.6	-4.1	-1.4	39.1
65	AUTO MECHANICS	63.2	46.2	-17.7	3.0	-3.6	-3.6	39.1
66	INDUSTR, FARM, CONSTR MACH MECHANICS	170.8	112.7	40.1	-14.7	-2.5	-3.9	39.1
67	ELECTRONIC EQUIP. INST. & REPAIR	210.0	91.1	115.8	-39.2	-3.6	7.0	39.1
68	OTHER MECHANICS & REPAIRMEN	63.6	47.1	-7.0	-13.3	-3.9	1.6	39.1
69	CARPENTERS	85.8	78.4	-12.7	-10.4	-2.9	-5.7	39.1
70	ELECTRICIANS	52.1	53.0	-18.5	-15.0	-4.3	-2.0	39.1
71	PLUMBERS & PIPEFITTERS	43.5	35.4	-13.1	-10.9	-1.0	-6.0	39.1
72	EXCAVATING, GRADING, PAVING	94.0	50.7	23.0	-11.3	-1.3	-6.2	39.1
73	ELEC.POW. LIGHT,WIRE COMM. EQ.INSTALL	227.7	202.1	8.8	-46.7	11.3	13.1	39.1
74	OTHER CONSTRUCTION TRADES	111.7	85.5	4.5	-10.3	-2.1	-4.9	39.1
75	FOREMAN, CONSTR TRADES	105.0	87.8	-5.5	-18.0	3.0	-1.3	39.1
76	LABOURING, CONSTR TRADES	58.6	59.6	-21.0	-12.2	-1.3	-5.6	39.1
77	TRUCK DRIVERS	105.1	76.8	-2.5	-8.7	2.6	-2.1	39.1
78	BUS DRIVERS	130.2	84.4	24.2	-16.6	1.4	-2.3	39.1
79	OTHER TRANSPORT	119.8	85.7	6.0	-16.6	6.7	-1.1	39.1
80	PRINTING TRADE CRAFT WORKERS	66.2	34.4	7.5	-25.7	11.1	-0.1	39.1
81	ELECTRO.COMM. EQ.OP, POW.STATION OPER	147.4	122.2	-9.4	-30.0	13.4	12.1	39.1
82	MATERIALS HANDLING,PACKAGING	14.6	1.1	-4.0	-13.7	-1.4	-6.4	39.1
83	LABOURING & OTH. ELEMENTAL WORK	31.6	21.4	-1.2	-19.7	-3.9	-4.1	39.1
84	INSPECT, TEST, GRADE & SAMPLE	31.8	7.3	17.4	-23.8	-5.9	-2.2	39.1
85	OCC N.E.C.,N.S.	-9.4	-0.3	-37.6	-11.8	1.9	-0.6	39.1
86	TOTAL	52.3	15.8	0.9	-7.4	3.8	0.0	39.1

of the period analyzed (see Appendix for technical details). So for those occupations dominated by male employment, the results shown in Tables 4-2 and 5-3 are quite similar, except for the decomposition factor accounting for changes in male/female mix (by occupation) which is entirely absent from Table 4-2. Conversely, for those occupations dominated by female employment, the results of Tables 4-2 and 5-4 are similar (with the one noted exception).

The two new tables display a marked contrast between the decomposition performance of male and female employment at the respective total levels (row 86 of each table). First, it is not surprising to learn that the percentage change for female employment (52.3 per cent) is much larger than that for male employment (19.2 per cent) for the 1971-81 period. Much of this difference stems from the decomposition source accounting for changes in male/female mix (15.4 per cent and -7.4 per cent, respectively). All other decomposition sources measured by the rules of the two tables (total levels) are quite similar, except for the decomposition factor accounting for changes in direct labour coefficients (or, labour productivity). Here, gains in female labour productivity alone result in a loss of total Canadian female employment equal to 7.4 per cent (negative impact). The corresponding result for Canadian male employment equals 11.3 per cent (negative impact). Does this signify that male employment has experienced significantly greater labour productivity increases relative to female employment?

To answer this question, we must recall that each of the figures in the final rows of Tables 5-3 and 5-4 are themselves a weighted average of the individual occupational results in their corresponding columns. So total female employment exhibits lower productivity gains (and smaller employment displacement) than total male employment because total female employment is more heavily weighted by those individual occupations found in particular industries where labour productivity growth is relatively stagnant. Indeed, we can see that the individual occupational productivity results, measured as a percentage change decomposition factor, are very similar for males and females occupation by occupation (compare columns (4) in Tables 5-3 and 5-4). The individual results, however, are not identical because male occupational employment has a slightly different industry distribution than female occupational employment - for each occupation individually. Somewhat similar interpretations are applicable to the other decomposition factors, except for the male/female mix factor which has a unique interpretation in this context. These matters are further clarified in the course of a correlation analysis performed in the following section.

CORRELATION ANALYSES OF DECOMPOSITION FACTORS

Tables 5-3 and 5-4 each contain 85 different stories analyzing the sources of occupational employment change for Canadian male and Canadian female employment respectively. Again, the reader

with particular interests in special occupations, male or female, will have her/his interests satisfied. Rather than merely repeat what is already evident in the two tables, it is once again more revealing to subject the empirical results to a correlation analysis in the usual way. There are, however, two differences. The additional analysis now contains a new decomposition factor (changes in the male/female mix), so the correlation is performed for male employment by occupation and female employment by occupation separately. These results are reported in Tables 5-5 and 5-6 which are based on Tables 5-3 and 5-4 respectively. But there is also the possibility of correlating the decomposition factors (percentage changes) for male employment with those for female employment. This is done in Table 5-7 to follow. First we comment on the set of two tables, Tables 5-5 and 5-6.

We should expect Table 5-5 (male employment) to be reminiscent of the results in Table 4-3 (total employment) since males have dominated total employment in most occupations over the period 1971-81. This expectation is, indeed, fulfilled upon comparison. In fact, the most important properties of Table 4-3, discussed and rationalized in the previous chapter, continue to hold and will not be repeated here. There is, however, a new element in Table 5-5, namely changes in male employment due to changes in the male/female mix (item no. 2 in the correlation table). This item has a fairly strong positive correlation with total male employment change (0.32) as expected. It is also negatively

Table 5-5

Correlation Analysis of Decomposition Factors:
Change by Male Occupations

Factor (Variable)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Employment	1.00	0.31	0.88	0.02	0.13	0.21	0.00
(2) Male/female mix		1.00	-0.05	-0.06	-0.29	-0.20	0.00
(3) Occupational mix			1.00	-0.05	0.01	0.10	0.00
(4) Labour coefficients				1.00	-0.38	-0.43	0.00
(5) Input-output coefficients					1.00	0.69	0.00
(6) Pattern of final demand						1.00	0.00
(7) Level of final demand							1.00

Source Based on results from Table 5-3 and data sources of Chapter 2.

Table 5-6

Correlation Analysis of Decomposition Factors: Change by Female Occupations

Factor (Variable)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Employment	1.00	0.85	0.66	-0.21	0.43	0.26	0.00
(2) Male/female mix		1.00	0.24	-0.36	0.35	0.13	0.00
(3) Occupational mix			1.00	-0.04	0.01	0.10	0.00
(4) Labour coefficients				1.00	-0.21	-0.36	0.00
(5) Input-output coefficients					1.00	0.58	0.00
(6) Pattern of final demand						1.00	0.00
(7) Level of final demand							1.00

Source Based on results from Table 5-4 and data sources of Chapter 2.

Table 5-7

Correlation Analysis of Decomposition Factors: Change by Male Occupations and Change by Female Occupations

Female factor/Male factor	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Employment	0.63	0.03	0.59	-0.20	0.39	0.26	0.00
(2) Male/female mix	0.23	0.16	0.17	-0.33	0.30	0.11	0.00
(3) Occupational mix	0.83	-0.02	0.94	-0.10	0.02	0.13	0.00
(4) Labour coefficients	0.02	-0.12	-0.06	0.94	-0.25	-0.35	0.00
(5) Input-output coefficients	0.14	-0.27	0.03	-0.32	0.92	0.59	0.00
(6) Pattern of final demand	0.23	-0.14	0.11	-0.38	0.59	0.93	0.00
(7) Level of final demand	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Source Based on results from Tables 5-3 and 5-4 and data sources of Chapter 2.

correlated with the two decomposition factors, input-output coefficient change and changes in the pattern of final demand (-0.29 and -0.20 respectively). So those (male) occupations for which changes in male/female mix are most depressing, tend to be occupations where shifts in intermediate demand and pattern of final demand stimulate employment among males. We could now turn to Table 5-6 (female employment) which offers more novel results.

We should not expect Table 5-6 to be so reminiscent of the previous Table 4-3 because female employment, though growing at a rate above that of total employment, is still of lesser importance compared to male employment. This also, in effect, means that the distribution of female employment by occupation among industries (for each occupation in turn) is liable to be significantly different than that of total employment by occupation. The reader will recall that the basic decomposition procedure by occupations ultimately stems from the basic decomposition procedure by industries - at least for most of the decomposition factors. (The exceptions are changes in occupational mix and changes in male/female mix.) With this background we can now examine Table 5-6.

First note the very high degree of correlation between the male/female mix factor and total female employment growth (namely, 0.85). In this particular sense, the factor is the most important source of inter-occupation employment growth differentials for

female employment (see also discussion in concluding Chapter 8). There is a surprising negative correlation (-0.21) between the direct labour coefficient factor (item no. 4) and total employment growth. This means that female employment has tended to grow faster in those particular occupations where female labour productivity (as measured) has experienced above-average changes in terms of percentage change. It should not, however, be surprising to learn that the correlation of the male/female mix factor with the other individual decomposition factors is significantly different among female employment as compared to the situation among male employment of the previous Table 5-5. What female employment gains from changes in male/female mix the male employment must lose, at least in terms of number of persons (see next table for further discussion). But this countervailing relationship does not necessarily carry over to the other decomposition sources of occupational employment change. Putting these interpretations all together helps to understand the major differences between Table 5-5 and Table 5-6. The major differences all stem from the inter-correlation results embodying the male/female mix factor. When the latter decomposition factor does not enter the comparison, then the inter-correlation results of Tables 5-5 and 5-6 are reasonably similar. For example, in both tables, the correlation between changes due to intermediate demand and changes due to pattern of final demand is significantly positive (0.69 and 0.58 respectively). The reader can easily note other significant similarities.

It is possible, however, to carry our analysis one step further. In Table 5-7 each of the correlation variables for male occupational employment are correlated, not with each other, but with each of the correlation variables for female occupational employment. Indeed, the diagonal elements of Table 5-7 show the correlation between corresponding variables, usually corresponding decomposition sources of employment change (the only exception is the first variable which ultimately represents the total of all decomposition sources - total change in employment). Note that Table 5-7 is no longer a symmetric matrix, so the complete array of correlation coefficients must be shown.

The most important results of Table 5-7 involve the diagonal elements. All the diagonal elements are close to unity (correlations equal to about 0.92) except for total change correlation (equal to 0.63) and correlation of male/female mix factors (equal to 0.16). So both male and female employments by occupation tend to grow together, but their different growth rates, in percentage change terms, stem almost exclusively from the differential impact of the male/female mix decomposition factor. The countervailing impact of this factor, though, is not necessarily negative after translation into percentage terms.

Finally note that the correlation between the other corresponding decomposition factors is not perfect (i.e., not equal to unity). The less-than-perfect correlation is due

entirely to differences in the industrial distribution of male occupational employment for each occupation as compared to female occupational employment for each occupation. Indeed, the reader could refer back to the original Tables 5-3 and 5-4 to see individual cases where a particular decomposition factor may have, say, a positive impact for male employment and a negative impact for female employment. These cases, however, are relatively rare. The fact that such cases do occur can be explained in the context of our decomposition methodology. These (rare) cases do not contradict our method, but merely serve to highlight the analysis. The fact that the correlation diagonal elements of Table 5-7 are close to unity (with two exceptions) explains why the complete table of correlation coefficients is nearly symmetric, but not perfectly symmetric.

6 SOURCES OF EMPLOYMENT CHANGE BY AGE GROUP

We have seen in Chapter 3 that there are 39 distinct "stories" of employment change for the Canadian business sector -- one story for each of the 39 industries. Although young people, middle-aged workers, and older persons are employed by each of the 39 industries, particular age groups do have some tendency to gravitate toward particular industries. This unequal representation in industries prompts the question: do the different "stories" associated with each industry imply significantly different "stories" for age groups? That is, do the decomposition factors (which comprise the stories) play greater or lesser roles in explaining employment change in individual age groups?

It is the purpose of the present chapter to address these questions by evaluating the sources of employment change over 1971-81 by age group. The main findings of the analysis appear in Chapter 10 of the Economic Council's Research Report on Labour Market Impacts and Technological Change. Additional findings and background material are given in this study.

INDUSTRY CONCENTRATION OF AGE GROUPS

An important determinant of the outcome of the decomposition model applied to age groups is the industry concentrations of those age groups. Table 6-1 sheds some light on this matter. It distributes employment in each of 39 industries over six age groups. The six age groups are 15-19 years, 20-24 years, 25-44 years, 45-54 years, 55-64 years, and 65 years and over.

The final row of the table shows the distribution of employment for the total of all industries. Workers 15-19 years, for example, constitute 8.1 per cent of total employment; workers 20-24 years constitute 15.5 per cent. Comparison of the share an age group assumes in any of the 39 industries relative to its share in the total of all industries indicates where the age group is over- and under-represented.

Workers 15-19 years are strongly represented in retail trade (comprising 16.8 per cent of that industry's employment) and in services, especially amusement and recreation services and accommodation and food services (23.1 and 25.8 per cent of those industries' employment). Workers 20-24 years have greater than average representation in mineral fuels industries (20.7 per cent of mineral fuels as opposed to 15.5 per cent of all industry employment), in services incidental to mining, in wood products industries, and in finance, insurance and real estate. They are

poorly represented in agriculture, tobacco product manufactures, and education and health services. The reader can discern, for the other age groups, industries in which over- and under-representation occurs.

In some cases, the difference in participation in a particular industry and in overall employment is quite marked. In other cases, the difference is less dramatic. But even where differences are small, they can compound to make larger differences in combinations of industries. It is these differences which will translate into age groups being diversely affected by the decomposition factors within our model.

TABULAR RESULTS OF DECOMPOSITION ANALYSIS

We turn now to the tables which by this point in the report have become quite familiar. Table 6-2 presents the results of the decomposition exercise applied to the same six age groups as in Table 6-1 and measured in terms of numbers of workers. The first column indicates average employment in 1971 for each age group and the second column shows the change in employment over 1971-81. Workers 15-19 years numbered about 525,000 in the Canadian business sector in 1971 and they increased by 228,000 in the ten years to 1981. The sum of the components of column (1) of course equals total business sector employment and the sum of the components of column (2) equals the change in total employment.

Table 6-1

Distribution of Industry Employment Over Six Age Groups, 1981

Industry	Age group[1] 15-19	20-24	25-44	45-54	55-64	65 and over
	(Per cent)					
1 Agriculture	10.4	10.4	36.6	18.3	15.4	8.6
2 Forestry	6.6	17.3	50.3	15.5	8.9	1.0
3 Fishing, hunting, trapping	7.7	13.6	49.4	15.8	10.9	2.4
4 Metal mines	3.5	15.8	54.1	16.1	9.7	0.5
5 Mineral fuels	4.3	20.7	55.6	12.7	6.1	0.3
6 Nonmetal mines and quarries	4.9	13.9	50.4	17.7	11.9	0.8
7 Services incidental to mining	7.7	27.2	48.5	10.9	4.6	0.7
8 Food and beverages	8.3	17.3	46.7	16.0	10.4	1.0
9 Tobacco products	1.5	7.1	52.6	22.6	14.8	1.1
10 Rubber and plastics	6.9	18.9	50.5	14.8	7.8	0.8
11 Leather industries	9.3	18.7	43.9	15.7	10.3	1.9
12 Textile industries	6.6	17.3	46.4	16.7	11.5	1.1
13 Knitting mills	8.9	15.6	46.9	17.3	9.4	1.6
14 Clothing industries	6.6	15.2	47.6	18.2	9.6	2.4
15 Wood industries	9.6	19.6	45.3	14.7	9.4	1.2
16 Furniture and fixtures	7.6	16.6	47.7	16.7	9.2	1.9
17 Paper and allied	3.9	14.9	49.5	18.1	12.4	0.8
18 Printing and publishing	7.5	16.8	48.8	15.9	8.5	2.2
19 Primary metal	3.7	15.7	48.8	18.2	12.9	0.5
20 Metal fabricating	5.8	17.1	48.9	16.4	10.3	1.2
21 Machinery	4.2	15.9	52.4	15.5	11.0	0.8
22 Transportation equipment	3.4	14.2	51.5	18.4	11.3	0.8
23 Electrical products	4.2	15.3	50.7	17.3	11.6	0.5
24 Nonmetallic mineral products	4.3	15.0	48.6	19.0	12.0	0.8
25 Petroleum and coal products	3.4	15.2	52.2	18.0	10.5	0.4
26 Chemical and chemical products	3.7	15.1	52.3	16.5	11.3	0.9
27 Miscellaneous manufacturing	6.6	16.9	48.7	16.1	9.5	1.9
28 Construction	6.1	15.8	50.2	17.5	8.8	1.3
29 Transportation and storage	3.9	13.8	50.1	18.6	12.1	1.1
30 Communication	3.7	16.6	53.8	15.5	9.5	0.7
31 Electrical power, gas, other utilities	2.8	13.7	53.5	17.5	11.7	0.5
32 Wholesale trade	6.8	17.3	49.1	15.1	9.2	2.2
33 Retail trade	16.8	17.2	39.6	14.5	9.5	2.2
34 Other finance, insurance, real estate	4.9	19.3	51.7	13.3	8.3	2.3
35 Education and health services	2.8	11.0	57.7	16.5	10.1	1.6
36 Amusement and recreation services	23.1	19.0	37.1	10.0	7.7	2.9
37 Services to business management	5.1	16.8	53.6	12.9	8.6	2.7
38 Accommodation and food services	25.8	18.5	34.8	12.2	6.9	1.5
39 Other personal and miscellaneous services	10.7	16.5	45.9	14.4	9.3	2.9
Total all industries	8.1	15.5	48.3	15.7	10.1	2.1

1 The sum across the rows constitutes 100 per cent of industry employment.

Source 1981 Census

Table 6-2

Decomposition Analysis of Employment Change in Selected Age Groups, 1971-81

Age group	Employment 1971 (1)	Change in employment 1971-81 (2)	Change in employment due to change in: Age mix (3)	Direct labour coefficient (4)	Input-output coefficient (5)	Pattern of final demand (6)	Level of final demand (7)
			(Number of persons)				
15-19 years	524,816	227,991	19,742	-30,502	4,400	-15,776	250,128
20-24 years	885,230	431,174	81,508	-107,913	33,722	-7,528	431,385
25-44 years	2,598,454	1,148,752	202,953	-347,664	85,977	-36,745	1,244,231
45-54 years	1,097,655	152,956	-185,064	-128,346	18,730	-23,313	470,948
55-64 years	678,740	118,335	-89,607	-80,114	10,793	-17,621	294,883
Over 65 years	155,645	19,384	-29,533	-16,484	5,043	-6,075	66,433
Total of all age groups	5,940,541	2,098,592	0	-711,022	158,664	-107,057	2,758,007

It is the items in column (2) which the decomposition model must explain.

Four of the decomposition factors we have seen before -- change in employment due to change in level of final demand, due to change in pattern of final demand, due to change in direct labour coefficients, and due to change in input-output coefficients. One of the decomposition factors is new. This new source of employment change is called "change in age mix".

Change in employment of a particular age bracket will depend on change in employment in industries in which that age bracket resides (and consequently the customary four decomposition factors) but also on shifts in the age structure of the labour supply. "Change in age mix" is meant to capture these changes in labour supply. The age mix factor, itself, is the age distribution of each individual industry's employment. Intuitively the age mix factor (or age staffing pattern) is similar to the occupational staffing pattern. But, unlike the occupational staffing pattern which is industry-determined and part of the production structure, the age staffing pattern is primarily determined by the demography of the labour supply. With the passage of time, workers within an industry grow older, some retire and leave, and young new workers join. The age structure or mix of the industry changes simply as the characteristics of its employees change.

To further clarify the interpretation, it would be useful to consult column (3) of Table 6-2. It can be seen that change in the age mix of industry (following from shifts in the age structure of the labour supply) and no change anywhere else (in final demand or in production structure) implied 19.7 thousand more jobs were held by persons 15-19 years, 81.5 thousand more jobs by persons 20-24 years, and 202.9 thousand more jobs by persons 25-44 years. Correspondingly, 185.1 thousand jobs were "lost" by persons 45-54 years, 89.6 thousand by persons 55-64 years, and 29.5 thousand by persons over 65 years. Over the period 1971-81, young and middle-aged persons increased their share of the general population relative to older persons (45 years and over); they assumed a large proportion of the labour supply; and they consequently filled proportionately more jobs.

The sum of column (3) is zero. This is as it should be. Nothing in final demand or the production structure has changed and so, on balance, total employment should not change. There has merely been a shifting of existing jobs between age groups.

To say that the jobs of older workers were "lost" is not completely accurate. Under the original age structure, older workers would have held these jobs but, under the revised age structure, those workers are absent and cannot hold them.

The age mix factor is not of particular interest in this study. It is the differential impact of the other four factors on employment change in age groups that is of primary concern. The age mix factor is included only because it allows us to explain 100 per cent of employment change within age groups. It should be noted that it has not been calculated residually, but rather, has been calculated quite independently from the other factors.

We turn now to the four "customary" decomposition factors in Table 6-2. Change in the level of final demand had the largest impact on each age group and was positive in all cases. Change in the pattern of final demand affected each negatively but in much smaller numbers. Labour productivity change substantially reduced employment and intermediate demand change increased employment, in all age brackets. The sum of change in each of columns (4), (5), (6) and (7) equals change in total business sector employment due to the respective factors. The column sums correspond to the values appearing in similar tables in earlier chapters.

Table 6-2 shows the number of workers affected but conveys little about the relative impact of decomposition factors on age groups. For this we turn to Table 6-3, which expresses the changes as percentages. Change in the level of final demand has had a uniform impact of 39.1 per cent on all age groups. Change in the pattern of final demand has affected workers 20-24 years the least, as many have likely completed their education and

Table 6-3

Decomposition Analysis of Employment Change in Selected Age Groups, 1971-81

Age group	Change in employment 1971-81 (1)	Change in employment due to change in: Age mix (2)	Direct labour coefficient (3)	Input-output coefficient (4)	Pattern of final demand (5)	Level of final demand (6)
			(Percentage change)			
15-19 years	35.6	3.1	-4.8	0.7	-2.5	39.1
20-24 years	39.0	7.4	-9.8	3.0	-0.7	39.1
25-44 years	36.1	6.4	-10.9	2.7	-1.1	39.1
45-54 years	12.7	-15.3	-10.6	1.5	-1.9	39.1
55-64 years	15.7	-11.9	-10.6	1.4	-2.3	39.1
Over 65 years	11.4	-17.4	-9.7	3.0	-3.6	39.1
Total of all age groups	29.7	0.0	-10.1	2.2	-1.5	39.1

joined industries which are growing and benefiting from shifting patterns in final demand. Older workers reside more in industries that are loosing in this respect.

Labour productivity change has reduced employment by about 10 per cent in all age groups, with the exception of persons 15-19 years. They have a heavier representation in service industries where recorded productivity advance has been comparatively less.

Columns (3) and (4) can be combined to indicate employment change due to change in production structure and columns (5) and (6) can be combined to indicate emplcyment change due to change in final demand. When this is done, we see that the negative impact of change in production structure on employment increases gradually for the respective age groups (-4.1 for 15-19 years, -6.8 for 20-24 years, -8.2 for 25-44 years, -9.1 for 45-54 years, -9.2 for 55-64 years). The differential impact of change in production structure (or technological change) between workers 15-19 years and those 45-64 years is about 5 percentage points. The difference is not large enough to suggest that workers in any particular age group have experienced stronger negative repercussions from technological change than any other age groups.

7 SOURCES OF EMPLOYMENT CHANGE BY EDUCATIONAL ATTAINMENT GROUPS

This chapter takes the decomposition analysis one final step further. It evaluates sources of employment change over 1971-81 for workers in the business sector grouped according to their highest level of schooling. The data readily available allowed three educational attainment groups to be distinguished -- less than grade 9, some high school but no university, and some university. The decomposition factors are the same five that appear in Chapter 4, plus one additional factor representing the "education mix" of the labour supply.

OCCUPATIONAL AND INDUSTRIAL CONCENTRATION OF EDUCATION GROUPS

Although workers in each education group run the gamut of most occupations, they often are heavily represented in a particular few. Individuals with at least some university, for example, are inclined to the professional categories -- engineers, architects, systems analysts, occupations in natural sciences, in law, in social sciences, in teaching, in health diagnosing, and in management. Individuals with less than grade 9 appear in many occupations, but predominantly resource-related occupations, certain manufacturing occupations (especially textile processing), excavating, grading and paving, motor transport occupations, and labourers.

Similarly, workers in each education group are employed by all industries but are represented in some more strongly than others. The proportion of university-educated in education and health services and services to business management is higher than average while the proportion without any high school in resource industries is higher than average.

The occupational and industrial concentrations of education groups will bear heavily on their sources of employment change. The decomposition factors which affect engineers, architects, or persons in the education and health service industries will affect employees in the university-educated group. The factors which affect labourers or persons in resource industries will affect employees in the least-well-educated group.

TABULAR RESULTS OF DECOMPOSITION ANALYSIS

Table 7-1 shows the results of the decomposition exercise applied to the three education groups and measured in terms of numbers of workers. Column (1) indicates average employment in 1971 for each education group and column (2) indicates the change in employment over 1971-81. There were about 1.6 million workers with less than grade 9 in the business sector in 1971 and they decreased to about 1.1 million by 1981. The sum over all items in column (1) yields total business sector employment at the beginning of the period and the sum over all items in column (2)

Table 7-1

Decomposition Analysis of Employment Change in Three Educational Attainment Groups, 1971-81

Educational attainment	Employment 1971 (1)	Change in employment 1971-81 (2)	Change in employment due to change in: Education mix (3)	Occupational staffing pattern (4)	Direct labour coefficient (5)	Input-output coefficient (6)	Pattern of final demand (7)	Level of final demand (8)
			(Number of persons)					
Less than grade 9	1,608,069	-486,200	-767,159	-48,195	-149,900	-26,247	-64,744	570,044
Some high school	3,668,611	1,942,174	548,777	-15,053	-442,563	97,305	-58,777	1,812,485
Some university	663,855	642,617	218,382	63,248	-118,559	87,606	16,465	375,475
Total	5,940,541	2,098,592	0	0	-711,022	158,664	-107,057	2,758,007

yields the change in that employment. It is the changes recorded in column (2) that the model must explain.

Employment change within an education group is determined by changes in the level and pattern of final demand, in input-output coefficients, in direct labour coefficients, and in occupational staffing patterns. It is also determined by "change in the education mix" of employed workers. The education mix (or education staffing pattern) is the distribution of employees over three educational attainment levels within each occupation of each industry. To illustrate, the education mix of material recording, scheduling and distribution occupations (occ. 27 and 28) in the wholesale trade industry in 1971 was 20 per cent of employees with less than grade 9, 70 per cent of employees with some high school, and 10 per cent of employees with some university. By 1981, the education mix had changed to 10 per cent of employees with less than grade 9, 79 per cent with some high school, and 11 per cent with some university. Quite independently of changes in final demand, intermediate demand and labour productivity which affect employment in wholesale trade and quite independently of changes in occupational mix which affect recording and distribution occupations, this change in education mix implies a reduction of employment in the less-than-grade 9 category and an increase in employment of the some-high-school category.

Change in the education mix arises from two forces. It can result from an employer re-evaluating the educational requirements of an occupation and assigning it to an appropriately-educated worker (i.e. an "upskilling" or "deskilling" of the job). Alternatively, it can result from an occupation being filled by a better- (poorer-)educated person simply because the bulk of the applicants have that level of education. This would be a reflection of change in the educational attainment of the general population. This study does not differentiate between the two forces.

Column (3) of Table 7-1 says that shifts in the education mix over 1971-81 have reduced employment of persons with less than grade 9 by 767,000; increased employment of persons with some high school by 549,000; and increased employment of persons with some university by 218,000. These observations are consistent with the general increase in education levels which has occurred in Canada. The sum of column (3) is zero. Neither final demand nor the production structure has changed and, thus, total employment does not change. Existing jobs have simply been shifted between education groups.

The education mix factor allows us to completely explain employment change within each education group. It is calculated independently of the other factors and is not calculated residually.

Turning to the other decomposition factors in Table 7-1, we see that change in the level of final demand has a large positive impact on employment change in each group. Change in the pattern of final demand has large negative implications for jobs held by the least-well-educated and smaller positive implications for jobs held by the university-educated. Columns (4), (5), and (6)show the impact of change in the three factors associated with production structure on employment in the education groups.

The more informative table is Table 7-2 since it expresses the impacts in percentage terms. Jobs held by persons with less than grade 9 declined by a third while jobs held by persons with some university increased by two thirds. The reader can discern for himself the role played by the decomposition factors. Suffice it to say that the impact of certain of the factors varied quite markedly from one education group to another. A noteworthy result is their impact on employees lacking any high school. This group benefited the least from final demand changes and lost the most from production structure changes. The latter had a differential impact of 19 percentage points between the most-poorly and the best-educated groups.

Table 7-2

Decomposition Analysis of Employment Change in Three Educational Attainment Groups, 1971-81

Educational attainment	Change in employment 1971-81 (1)	Change in employment due to change in: Education mix (2)	Occupational staffing pattern (3)	Direct labour coefficient (4)	Input-output coefficient (5)	Pattern of final demand (6)	Level of final demand (7)
				(Percentage change)			
Less than grade 9	-33.3	-52.6	-3.3	-10.3	-1.8	-4.4	39.1
Some high school	41.9	11.8	-0.3	-9.5	2.1	-1.3	39.1
Some university	66.9	22.7	6.6	-12.3	9.1	1.7	39.1
Total	29.7	0.0	0.0	-10.1	2.2	-1.5	39.1

8 CONCLUSION

This concluding chapter has various purposes. First, we wish to tie together some loose ends that permeate the study. Most of these "loose ends" are related to the study's limitations. An explicit and detailed acknowledgement of these limitations leads naturally to suggestions for future work. It will be noted that future work requires both methodological and statistical advances in order to make the endeavour worthwhile. Second, we wish to present some references to the literature which the reader could follow up to advantage. The main text of the study does not provide these references because the emphasis is on statements of our tabular results and their economic interpretation. The text also emphasizes the (mathematical) properties of our decomposition procedures and the intimate connections between decomposition along the various dimensions (e.g., industry dimension vis à vis occupation dimension).

A third purpose of a conclusion is normally to highlight the study's main empirical findings and point to economic policy implications. This third purpose is not really developed in this concluding chapter. It is difficult to highlight the main findings because the findings are so numerous and occur along different dimensional aspects of decomposition. Also our particular views as to what is an "important" finding (or result)

may not coincide with that of most readers. Indeed we suspect that readers will have divergent and very particular interests that are best satisfied by detailed inspection of the many statistical tables embodied in the study. There is, however, one main finding that we feel deserves emphasis, and this will be briefly outlined in the next section of this chapter.

As for economic policy implications, we feel that the scope of the study is too limited for that purpose. As mentioned earlier (see Chapters 2 and 3), the study is one input of many inputs to an Economic Council of Canada Research Report. It is the unification of these inputs that provides the economic policy implications spelled out in the Report of the Economic Council. Our main goal here is to supply the full background material for the "one input" which is summarized in the main body of the Economic Council's Report. In supplying the full background material, the reader has the opportunity to form a more complete judgment concerning the Council's Report, and the researcher is provided with substance for further analysis.

A KEY RESULT OF DECOMPOSITION ANALYSIS

A key result of the study concerns the relationship between two of the decomposition factors, along the occupational dimension, that are part of "technological change". The factors are: changes in labour productivity and changes in occupational mix.

These two particular sources of change in Canadian employment by occupation are often confounded in other studies that do not utilize a correct decomposition procedure. Moreover, it is often difficult to identify changes in labour productivity along an occupational dimension. These technical problems have been resolved in this study with important consequences.

First it is clear that changes in labour productivity is the primary source of employment displacement in Canada during the period 1971-81. However, at the occupational level, this source is often counterbalanced by changes in occupational mix, so that the two sources together may have a positive impact on employment change. It is this particular combination of events which is mainly responsible for "technological change" having an employment-enhancing effect on many Canadian occupations (about 40 per cent of the 85 occupations analyzed). So in analyzing the impact of technological change on occupational employment, one must have a sufficiently deep framework in order to reveal the complete story. In fact, there is another side to the story. Since all changes in occupational mix, as a decomposition source of employment change, must sum to zero, then there are also many occupations where the employment-displacement impact of labour productivity growth is reinforced by the negative effect of unfavourable changes in occupational mix. These two sides of the coin can be seen both at the level of total employment within individual occupations (Chapter 4) and at the levels of male

employment and female employment within the various occupations (Chapter 5).

But the correlation analyses of the previous chapters shows even more. There is no tendency for occupations with relatively high labour productivity growth to also be the occupations most favourably impacted by changes in occupational mix. Indeed, the correlation coefficient between the two decomposition sources (expressed in terms of percentage changes) is close to zero over the "space" of all occupations. This result continues to hold when the occupational space is limited to male employment only and to female employment only. The combination, then, of the zero-sum mathematical constraint of occupational mix impacts ("zero sum" is also approximately satisfied by male employment alone and female employment alone) plus the near-zero economic correlation result expressed above, has repercussions for future projections of occupational employment in Canada. This combination implies that there are no significant historical guidelines whereby such projections can be performed. For example, a projection of relatively high labour productivity growth for a particular occupation does not provide any indication for future employment in that occupation (considering only the context of technological change and not final demand change). We still have no indication (based on historical evidence) as to what would happen to changes in occupational mix with respect to the particular occupation. We do know, however, that the latter decomposition factor could have

an important impact on employment -- positive or negative. The conclusion, then, is that there are no "short-cuts" for successful projections of Canadian occupational employment. Indeed, as we shall see, the problems are even more severe due to the poor quality and inconsistency of Canadian occupational data based on historical census methods.

SUGGESTIONS FOR FUTURE RESEARCH

Various hints have been given in the study as to how the results could be improved by further work and better data. Here we spell out our ideas in more detail, but the exposition is still kept brief. The ordering of the following ideas is essentially arbitrary, though it will be seen that the suggestions for future research are often interdependent.

First, a decomposition analysis of sources of Canadian employment change should be based on a fine level of industrial disaggregation. This study is certainly limited by the 39 industries that are distinguished within the Canadian business sector. We really need at least 60 or 70 industries in order to obtain the necessary distinctions to fulfill the potentials of decomposition analysis. Many of the results along the industry dimension are "blurred" by aggregation effects and are, therefore, sometimes difficult to interpret. While the occupational dimension features 85 individual occupations (and this number

seems to be adequate), it must be remembered that most of the decomposition sources along the occupational dimension are merely weighted averages of decomposition sources along the original industry dimension. So once again the results along the occupational dimension become "blurred". In order to draw finer distinctions between individual occupations in a decomposition analysis, then we need to base the analysis on finer distinctions between industries where the occupations are employed. In other words, we really need further industrial disaggregation. This would aid in the interpretation of results along the occupational dimension (and for both male and female occupations). Chapter 2 already explained why this study was limited to 39 industries. Later in this section we will show how more industries could be distinguished with better data.

A second suggestion for further research concerns the role of fixed capital replacement expenditures. In this study, these expenditures are considered to be part of final demand. A more sophisticated treatment would place these expenditures within intermediate (inter-industry) demand, so making fixed capital replacement spending an endogenous variable (see, e.g., the treatment of this variable in Postner and Wesa (1983)). This is not a trivial matter, since fixed capital replacement is an important aspect of technological change and is also subject to international trade. The decomposition analysis would definitely be affected by the alternative treatment, although for many

industries (and occupations) the impact would probably be small. We did not deploy the "endogenous" treatment of these expenditures because available Canadian data do not distinguish between fixed capital replacement expenditures and fixed capital expansion expenditures (only total expenditures are provided). In order to draw the distinction, some rather arbitrary assumptions must be made, though the assumptions can usually be supported by other economic evidence (as done in the above reference). In this study, we decided to stick to conventional data in order to produce results that may be comparable with other studies based on conventional data. Nevertheless, the decomposition analysis would probably be improved by the alternative treatment of fixed capital replacement even though additional assumptions are required.

Third, the reader will recall that our decomposition analysis is capable of further refinement with respect to international trade. That is, some of the decomposition factors can be split into a domestic-origin impact and an international-origin impact (see, again, Chapter 3). So far this split has only been performed along the industry dimension and has not yet been performed along the various occupational dimensions or along the age group and education category dimensions. Neither have the important correlation analyses of Chapters 3, 4 and 5 embodied the distinction between impacts of purely domestic origin and impacts affected by Canadian international trade. Nevertheless, our basic decomposition methodology is capable of performing all the

required calculations and the economic interpretation of our decomposition results would be aided by the corresponding finer distinctions. So here again is substantive scope for further work.

A fourth suggestion concerns the notion of relative importance of the various decomposition factors in explaining employment growth differentials along the particular dimensions analyzed in the study. That is, we might wish to have a well-defined method (or measure) of ordering the decomposition factors in terms of their "explanatory" value. This notion turns up, implicitly, in the correlation matrix analyses of Chapters 3, 4 and 5 and the corresponding discussions. We provide hints as to the desirable properties of such a measure, but this is all. It should be noted that conventional regression methods do not provide such a measure because employment growth (say, as dependent variable) is always equal to the simple summation of the various decomposition sources (say, as independent variables) of that growth. That is, all the "regression coefficients" are identically equal to unity and there are no "residuals". We feel, nevertheless, that it is still possible and desirable to develop measures of relative importance of decomposition factors for purposes of explaining employment growth differentials. Any such measures, though, would depend on the disaggregation level of the particular dimension being analyzed. One place to look for a quantification of the desired notion would be Theil (1972).

The fifth and final suggestion for future research focuses on an important statistical data problem mentioned in Chapter 2. There it was pointed out that Canadian occupational data, based on a household census, is seriously inconsistent with Canadian industrial employment data, based on establishment surveys. In order to utilize both sets of data, a number of adjustments are required. These adjustments become very large at finer levels of industrial disaggregation, and so it was decided to work with the 39-industry level where the required adjustments are not large. But a successful decomposition analysis really requires more industrial disaggregation, as explained earlier in this section. Aside from the technical adjustment problem, there are other difficulties working with Canadian household census data for occupations. Household data embody an element of self-reporting that is generally known to be biased in the direction of "self-importance" with respect to occupational categories. For example, we feel that "too many" households report their occupations as being in the various managerial categories in the year 1981 as compared to 1971. If these categories are over-estimated, it is not clear which other categories are under-estimated. Besides, there is an inherent contradiction in mixing household-based data with the establishment-based data on industry employment and production. The two sets of data have different conceptual foundations which cannot be simply reconciled by purely mathematical adjustment procedures. In fact, it can be shown that adjustment procedures introduce additional elements of

ambiguity and distortion, with the result that decomposition analysis comes to reflect arbitrary elements as well as economic substance.

For all these reasons, then, we think the time has arrived for Canada to adopt an occupational-reporting system which is establishment-based and which is, therefore, directly compatible with other data required for economic analysis of Canadian labour markets and technological change. Such a reporting system might build upon the experience gained from the Statistics Canada Occupational Employment Survey of the mid-1970s. The system might also follow the lead of the U.S. Bureau of Labor Statistics which deploys occupational survey data (combined with an occupation-industry cross tabulation) based on establishment reporting. We realize, of course, that there are technical survey problems and respondent-burden problems involved in the setting up of such an endeavour. Nevertheless, the effort is worthwhile because the present situation is unsatisfactory. We feel that the professional expertise of Statistics Canada has an opportunity here of making a major contribution to our understanding of Canadian occupational employment change. There is a real challenge waiting to be met.

REFERENCES TO LITERATURE

This study has so far neglected to give specific references to the literature of decomposition analysis and related subjects. Rather than have references scattered throughout the study, we prefer to concentrate many of the references in one section. That is the purpose of this section.

There have been a number of Canadian studies which also attempt a decomposition analysis of sources of employment change. The studies include Magun (1984), Lavallée and Picot (1986) and Roy (1987). An important American study is Kutscher (1984). We found all these studies to be useful background material. But for reasons already explained in Chapter 1, we believe that our study offers significant advances in terms of methodology and provides some unique features not available elsewhere. In the Appendix to follow, we show specifically how the results of decomposition analysis could differ depending on whether the methodology is unbiased or not (see, again, Chapter 1). It should also be noted that our methodology yields an exhaustive analysis of sources of employment growth -- there are no "residuals" left over to be accounted for. Two theoretical papers that helped us clarify some of the basic methodological issues of decomposition analysis are Kattermann (1984) and Törnqvist et al (1985). We advise anyone interested in doing future research in this area to consult those

two papers. Further details follow in the Appendix to this study. An older reference to the subject matter is Fromm (1968).

As already mentioned in the previous section, we feel that the results of decomposition analysis can be improved with more industrial disaggregation. Once this is done, it would then be possible to subject the results to deeper economic analysis. For example, there have evidently been dramatic changes in the intermediate demand for basic raw materials in recent decades (see, e.g., Larson et al (1986)). Some of these changes do show up in our results, but other changes are "blurred" by industrial aggregation. Future research should be able to highlight and pinpoint these important technological events. Another example is the changing role of "contracted-out" intermediate services and their required identification (see, e.g., Ray (1986)). Once again, a finer industrial disaggregation is needed for a completely successful analysis. A good recent reference that actually combines the two above examples and other aspects of structural and technological change is the work of Carter (1982) for Data Resources, Inc.

Finally, there are references in the literature to the inconsistencies involved in trying to reconcile household-based occupational data and establishment-based industrial production data in the same analysis. A good recent summary of the problems can be found in Hunt (1985). The problems that Statistics Canada

faced in trying to implement an establishment-based Occupational Employment Survey (OES) are outlined in Moser (1980). This reference also contains suggestions as to how some of those problems can be resolved. The statistical results and survey methodology of OES are given in Statistics Canada (1976). We feel that the fundamental "household-establishment problem" must be resolved before carrying out Canadian decomposition analysis at finer levels of (industrial) disaggregation. This is because the ultimate purpose of such an analysis must feature an occupational dimension, and this dimension ultimately depends on (weighted averages of) industrial disaggregation for most of the occupational decomposition factors. So Canadian occupation data must be put on a consistent basis with Canadian industrial employment and production data in any further work on decomposition analysis of sources of Canadian employment change by occupation.

APPENDIX

DECOMPOSITION MODEL AND METHODOLOGY

This Appendix contains the model and methodology that underlie the decomposition analysis of the study. Although it is possible to present a long and elaborate Appendix, this strategy is not adopted here. The emphasis, rather, is on presenting just enough material to permit the reader to understand the calculation procedures that were actually performed. The Appendix uses mathematics, but the mathematical level is kept reasonably elementary. There is no reason to get involved in complex mathematical formalisms if both the model and methodology can be understood on the basis of simple examples. This means that in some cases we illustrate the decomposition by concentrating on "typical terms" without necessarily showing the full generality of the considered procedure. In all these cases, the full generality is quite evident without filling the Appendix with elaborate formalisms.

The decomposition model presupposes knowledge of input-output techniques and related methodology. We feel it would be inappropriate to attempt to "teach" input-output within the confines of this Appendix. References are given, however, to the literature for the uninitiated reader. We also assume the reader has some corresponding knowledge of elementary matrix algebra.

Aside from these elements, the Appendix is essentially self-contained. It should be noted, nevertheless, that we deploy a particular treatment of the Canadian input-output model at least with respect to international trade. Rather than spell out the full account of this particular model, we again provide an easily available reference to our treatment of the underlying input-output model. This aspect, however, is not crucial for understanding our decomposition procedures and their attractive economic properties. The emphasis in the Appendix is on clarifying the exact nature of our decomposition procedures and supplying (mathematical) proofs of their properties.

BASIC DECOMPOSITION MODEL

It is appropriate to begin with the simplest case. We first assume the most elementary input-output model (see Leontief (1966)). This is not the model actually used in the study, but it serves to illustrate the basics of decomposition analysis. We have therefore:

A represents the inter-industry (input-output) coefficient matrix;

y represents the (column) vector of final demand;

x represents the vector of industry gross output;

ℓ represents the vector of direct labour coefficients.

For any time period the following identity holds:

$$x = Ax + y$$

so that:

$$x = (I-A)^{-1}y.$$

Total labour employed in the economy is then equal to:

$$\ell'x = \ell'(I-A)^{-1}y$$

and labour employed in each industry of the economy is represented by the vector:

$$\hat{\ell}x = \hat{\ell}(I-A)^{-1}y$$

where the symbol (') represents transposition and (^) represents diagonalization.

Consider now the decomposition of the change in total labour employed in the economy into two summary sources called (1) technological change, and (2) final demand change. It is convenient to represent the row vector $\ell'(I-A)^{-1}$ by simply q'.

Since we are dealing with employment change, there is an initial year represented by a subscript "0" and a final year represented by the subscript "1". Putting all this together we are concerned with decomposing the expression:

$$q_1'y_1 - q_0'y_0$$

into the two (summary) sources of change mentioned above.

The usual method of decomposition is:

$$q_1'y_1 - q_0'y_0 = (q_1'-q_0')y_1 + q_0'(y_1-y_0)$$

where the first expression on the right-hand side of the above decomposition signifies that part of total employment change due to (1) technological change, and the second expression signifies that part due to (2) final demand change. The rationale of this significance is well-known and is obvious from the economic meaning of the representations. However, there is nothing unique about the above decomposition. An alternative decomposition which also has economic significance is:

$$q_1'y_1 - q_0'y_0 = (q_1'-q_0')y_0 + q_1'(y_1-y_0).$$

where the two expressions on the right-hand side have economic interpretations corresponding to those in the usual decomposition

as above. Which decomposition is "correct"? They are both "correct" and, indeed, have slightly different significances (see Kattermann (1984)). Do the results differ very much from one decomposition to the other? The answer to this question depends on the particular case. For Canada 1971-81 we find that the usual decomposition yields (in terms of the change in number of persons employed):

$$2{,}098{,}592 = -673{,}632 + 2{,}772{,}224$$

and the alternative decomposition yields:

$$2{,}098{,}592 = -431{,}085 + 2{,}529{,}677$$

So the usual decomposition procedure "exaggerates the role of technological change as a (negative) source of total employment change. The alternative decomposition "diminishes" the role of technological change and its corresponding displacement of employment over the time period 1971-81 for Canada. Indeed, the differences are large and can easily be explained by the different "weighting" (patterns) implicit in the two methodologies.

The basic strategy of this study's decomposition model is to recognize that both the "usual" and the "alternative" decomposition methods represent <u>biased</u> views of sources of

employment change. For an unbiased decomposition in the above simple case we take:

$$q_1'y_1 - q_0'y_0 = (q_1'-q_0')y_{01} + q_{01}'(y_1 - y_0)$$

where $y_{01} \equiv (1/2)(y_0+y_1)$

$$q_{01}' \equiv (1/2)(q_0'+q_1'),$$

that is, the average of the two decomposition methods. For Canada this yields:

$$2,098,592 = -552,358 + 2,650, 951$$

Now it is straightforward to indicate an unbiased decomposition of sources of employment change by individual industry (rather than total employment change over all industries). Here we represent the matrix $\hat{\ell}(I-A)^{-1}$ by the symbol Q. So analogous to the preceding development we have:

$$Q_1y_1 - Q_0y_0 = (Q_1-Q_0)y_{01} + Q_{01}(y_1-y_0)$$

where

$$Q_{01} \equiv (1/2)(Q_0+Q_1).$$

So far, we have only shown the simplest decomposition. That is, our decomposition only yields two summary sources of employment change. Our next task is to show how the source called "final demand change" can be further decomposed in an unbiased manner. We will consider the aggregate case (total employment change), since the disaggregated case (employment change by industry) follows easily as seen above. The decomposition expression accounting for "final demand change", as already shown, is:

$$q'_{01}(y_1-y_0).$$

First note that:

$$\begin{aligned}(y_1-y_0) &= (i'y_1)[(i'y_1)^{-1}y_1] - (i'y_0)[(i'y_0)^{-1}y_0] \\ &= (i'y_1)[(i'y_1)^{-1}y_1 - (i'y_0)^{-1}y_0] + \\ &\quad (i'y_0)^{-1}y_0[i'y_1-i'y_0]\end{aligned}$$

where i' represents a (summation) row vector of unities. So the change in final demand <u>per se</u> has been decomposed into two expressions. The first expression on the right-hand side signifies the change in the <u>pattern</u> of final demand (over the time period concerned); the second expression signifies the change in the <u>level</u> of final demand. But once again this particular decomposition is not unique, for we may equally write:

$$(y_1-y_0) = (i'y_0)[(i'y_1)^{-1}y_1-(i'y_0)^{-1}y_0] + (i'y_1)^{-1}y_1[i'y_1-i'y_0]$$

in which the two expressions have corresponding meaning, but the implicit weights are different. For an unbiased decomposition we need to take the average of the two (alternative) sets of expressions. So putting everything together we end up with:

$$q'_{01}(y_1-y_0) = q'_{01}(i'y_{01})[(i'y_1)^{-1}y_1-(i'y_0)^{-1}y_0] + q'_{01}p_{01}[i'y_1-i'y_0]$$

where $p_{01} \equiv (1/2)[(i'y_0)^{-1}y_0 + (i'y_1)^{-1}y_1]$

that is, p_{01} represents an average pattern of final demand <u>per se</u>. The end result is that final demand change, as a decomposition source of employment change, has been further decomposed into two distinct sources of employment change each of which has a well-defined economic meaning. The first expression on the right-hand side of the last equation accounts for the change in the final demand pattern; the second expression accounts for the change in final demand level as a (decomposition) source of total employment change over the time period concerned.

We now return to the source of employment change referred to as "technological change" in the earlier development of this section. There we derived a measure represented by:

$$(q_1'-q_0')y_{01} \cdot$$

When we recall that the general symbol q' represents $\ell'(I-A)^{-1}$, it is then clear that $(q_1'-q_0')$ embodies changes in two aspects of production technology, namely ℓ' which is the general symbol representing direct labour coefficients, and A which is the general symbol representing (intermediate) input-output coefficients. A complete decomposition should be able to distinguish these two aspects of technological change and, again, the further decomposition should be unbiased. All this can be accomplished as follows:

We know that:

$$(q_1'-q_0') = \ell_1'(I-A_1)^{-1} - \ell_0'(I-A_0)^{-1}$$

$$= (\ell_1'-\ell_0')(I-A_1)^{-1} + \ell_0'[(I-A_1)^{-1} - (I-A_0)^{-1}] \cdot$$

But we also know that:

$$(q_1'-q_0') = (\ell_1'-\ell_0')(I-A_0)^{-1} + \ell_1'[(I-A_1)^{-1} - (I-A_0)^{-1}] \cdot$$

It is clear that the first expressions on the right-hand sides of the last two equations signify changes in direct labour coefficients; the second expressions of the last two equations signify changes in the input-output coefficients (more exactly, functional changes in the input-output coefficients). The two equations differ only with respect to the implicit weights involved. Once again, for an unbiased decomposition we need to take equal account of all possible decomposition methods by averaging all such possibilities. Putting everything together we find that:

$$(q_1'-q_0')y_{01} = (\ell_1'-\ell_0')(I-A)_{01}^{-1}y_{01} + \ell_{01}'[(I-A_1)^{-1}-(I-A_0)^{-1}]y_{01}$$

where $(I-A)_{01}^{-1} \equiv (1/2)[(I-A_0)^{-1}+(I-A_1)^{-1}]$

$$\ell_{01}' \equiv (1/2)(\ell_0'+\ell_1') \ .$$

So the first expression on the right-hand side of the last equation decompositionally accounts for that part of employment change due to changes in direct labour coefficients; the second expression accounts for employment change due to changes in the input-output coefficients. The two expressions together add up to the (summary) decomposition source called "technological change".

This completes our discussion of the basic decomposition model. We have now shown explicitly the calculations necessary to produce most of the empirical results reported in Chapter 3 (decomposition analysis by industry) of the text.

EXTENTIONS OF DECOMPOSITION METHODOLOGY

The basic decomposition methods have been further extended to account for Canadian employment change by occupation and by sex. In order to focus on essentials, we again work with the most elementary input-output model. The next section will (briefly) outline the actual input-output model deployed in the study, together with related considerations. In the present section we will provide proofs for some key properties of decomposition mentioned in Chapters 4 and 5 of the text. The development in this section, however, is relatively brief -- but should be understood by any reader who has followed the more detailed development in the preceding section.

Consider first the problem of conducting an unbiased decomposition of employment change by occupation. The essence of decomposition, now, is one of disaggregation, so our results must be in vector form. But the decomposition by occupation, when aggregated over all occupations, must sum to the decomposition of total employment change over all industries. One other important identity must also hold true, as we shall see. Let us write:

Z represents an occupation by industry matrix of occupational employment per unit of industry gross output (matrix of occupational employment coefficients);

S represents an occupation by industry matrix of occupational employment per unit of industry employment (matrix of occupational staffing patterns).

Note that all the calculations developed in the preceding section can be transformed from industry employment "space" into occupational employment "space" by simply substituting the general matrix Z for the general vector ℓ (that is, we substitute a matrix of occupational employment coefficients for the vector of (direct) labour coefficients). However, in occupational employment "space" (or dimension) we have an opportunity to perform further decomposition. This can be seen from the fact that:

$$Z = S\hat{\ell}$$

also noting that the matrix S has the property $i'S = i'$. This property assures us that $i'Z = i'S\hat{\ell} = i'\hat{\ell} = \ell'$, so that a decomposition, totalled over all occupational employment, must equal a decomposition, totalled over all industry employment. Now to show changes over time we introduce the usual subscripts, so that:

$$Z_1 - Z_0 = S_1\hat{\ell}_1 - S_0\hat{\ell}_0$$

$$= S_0(\hat{\ell}_1-\hat{\ell}_0) + (S_1-S_0)\hat{\ell}_1 .$$

But this particular decomposition could also be expressed as:

$$Z_1 - Z_0 = S_1(\hat{\ell}_1-\hat{\ell}_0) + (S_1-S_0)\hat{\ell}_0$$

For an unbiased decomposition we need:

$$Z_1 - Z_0 = S_{01}(\hat{\ell}_1-\hat{\ell}_0) + (S_1-S_0)\hat{\ell}_{01}$$

where $S_{01} \equiv (1/2)(S_0+S_1)$

$$\hat{\ell}_{01} \equiv (1/2)(\hat{\ell}_0+\hat{\ell}_1).$$

The first expression on the right-hand side of the last equation represents that part of occupational employment coefficient change due to changes in (direct) labour coefficients (after transformation into occupational "space"); the second expression represents that part of occupational coefficient changes due to changes in occupational staffing patterns over time.

When the above unbiased decomposition of (Z_1-Z_0) is substituted for $(\ell_1'-\ell_0')$ in the derived decomposition equations of the

preceding section, mutatis mutandis, we find that the decomposition analysis of Canadian employment change by occupation has an additional decomposition factor. The new additional expression can be written out as:

$$(S_1-S_0)\hat{\ell}_{01}(I-A)^{-1}_{01}\, y_{01}$$

There is also an expression closely related to a previous one accounting for employment changes by occupation due to changes in direct labour coefficients (after transformation into occupational space), namely:

$$S_{01}(\hat{\ell}_1-\hat{\ell}_0)(I-A)^{-1}_{01}\, y_{01} \cdot$$

Let us examine the former expression first. We easily see that:

$$i'(S_1-S_0)\hat{\ell}_{01}(I-A)^{-1}_{01}\, y_{01} = (i'-i')\hat{\ell}_{01}(I-A)^{-1}_{01}\, y_{01} = 0 \cdot$$

So the summation over all occupations of the decomposition factor responsible for changes in occupational staffing patterns identically equals zero. This important and novel property is illustrated in Chapter 4 of the text. On the other hand, the latter expression, on summation becomes:

$$i'S_{01}(\hat{\ell}_1-\hat{\ell}_0)(I-A)^{-1}_{01}\, y_{01} = (\ell_1'-\ell_0')(I-A)^{-1}_{01}\, y_{01}$$

which is exactly equal to the same decomposition source defined in industry space of the preceding section. This property *inter alia* is also illustrated in Chapter 4. The reader has now been provided with sufficient material to understand unbiased decomposition analysis of employment change by occupation. There is no need to dwell on the interpretation of the other decomposition sources since those sources become mere transformations (under matrix S) of industry space into occupation space, with the *mutatis mutandis* proviso. Therefore we now turn to outlining the novel features of decomposition analysis by occupation and sex combined, as seen in Chapter 5 of the text.

This aspect of our methodology becomes exceedingly complex if one desires to have an unbiased decomposition and, at the same time, preserve required economic properties. Nevertheless, we have succeeded in resolving all technical problems, and the calculations reported in Chapter 5 do reflect an unbiased decomposition while maintaining appropriate economic conditions. It is not possible, however, to spell out the full detail of our methodology in this Appendix because the mathematical development becomes too long and cumbersome. Instead, we merely *sketch* out the general ideas. Let:

Z^m represent the matrix of occupational employment coefficients for male employment;

Z^f represent the matrix of occupational employment coefficients for female employment;

$Z^* \equiv \begin{bmatrix} Z^m \\ Z^f \end{bmatrix}$ with Z^m and Z^f as defined above;

X^m represent the matrix of proportions of male employment in each occupation and in each industry;

X^f represent the matrix of proportions of female employment in each occupation and in each industry;

$X \equiv \begin{bmatrix} X^m \\ X^f \end{bmatrix}$ where X^m and X^f are set up in such a way that $i'X = i'$;

$\hat{S}$ represents a diagonalization of the matrix S defined previously (using a generalization of the diagonalization concept) so that $i'S = i'$ as before;

$\hat{\ell}$ represents a diagonal matrix of (direct) industry labour coefficients as before.

Then it can be seen that:

$$Z^* = X \hat{S} \hat{\ell}$$

and in the usual way, an unbiased decomposition of male and female occupational employment coefficients yields:

$$Z_1^* - Z_0^* = (X\hat{S})_{01}(\hat{\ell}_1-\hat{\ell}_0) + X_{01}(\hat{S}_1-\hat{S}_0)\hat{\ell}_{01} + (X_1-X_0)(\hat{S}\hat{\ell})_{01}$$

where, say, $(X\hat{S})_{01} \equiv (1/4)[X_0\hat{S}_0 + X_0\hat{S}_1 + X_1\hat{S}_0 + X_1\hat{S}_1]$

and analogously for the other terminal weighted matrices in the last equation. The decomposition, then, contains one novel decomposition source, namely changes in the male/female mix, which when combined with the other term expressions is:

$$(X_1-X_0)(\hat{S}\hat{\ell})_{01}(I-A)_{01}^{-1}y_{01}$$

It should be noted that in this decomposition source of occupational employment change by sex:

$$(\hat{S}\hat{\ell})_{01}(I-A)_{01}^{-1}y_{01} \equiv (1/16)[\hat{S}_0\hat{\ell}_0(I-A)_0^{-1}y_0 + \ldots\ldots$$

$$+ \hat{S}_1\hat{\ell}_1(I-A)_1^{-1}\ y_1]$$

but we have retained a simpler representation for expository reasons. Similar comments apply to all other products of terminal year "weights". This shows precisely why our decomposition is unbiased because it gives equal "weights" to all possible

combinations of decompositions. Now in the above decomposition source we find:

$$i'(X_1-X_0)(\tilde{S}\hat{\ell}_{01})(I-A)_{01}^{-1}y_{01} = 0 \ .$$

So the summation across the male/female dimension, for each and every occupation, of the changes in male/female mix as a decomposition factor, is identically zero as illustrated in Chapter 5 of the text. But it is also noteworthy that:

$$i'X_{01}(\hat{S}_1-\hat{S}_0)\hat{\ell}_{01}(I-A)_{01}^{-1}y_{01} = 0 \ .$$

So the summation across both male and female occupational employment of the changes in occupational staffing pattern as a decomposition factor, is also identically zero. But this identity need not hold true for male occupational employment alone or female occupational employment alone. This economic property too is illustrated in Chapter 5. This concludes our discussion of the key decomposition properties required to understand the exposition in the main text of this study.

COMPLETE INPUT-OUTPUT MODEL

The input-output model originally introduced towards the beginning of this Appendix is a simplified version of the model

actually used in our decomposition calculations. The simplification permits the reader to understand all our basic procedures except for our treatment of international trade. Actually, the method of handling Canadian international trade also fits into our basic model, with some revised notation. This can be seen by reference to Postner and Wesa (1983, pp. 61-62). In order to cut down on the length of this Appendix, we must assume that the interested reader has access to the above reference. There is just one real difference between the complete input-output model used in the present study and that deployed in the 1983 publication. In the present study we do not endogenize fixed capital replacement expenditures (see, again, the second section of Chapter 8 of this study). The reader with access to Postner and Wesa (1983) can easily modify the complete model so as to keep fixed capital replacement expenditure exogenous. All other aspects of the 1983 model are retained here -- including the endogenous treatment of international trade (with an exogenous balance of trade scalar) and the incorporation of all non-competitive commodities in the model context.

However, we must still explain how our decomposition procedures can be extended so as to distinguish between purely "domestic" and purely "international" aspects of some of the decomposition factors. Indeed, such extensions are performed in Chapter 3 of the text (decomposition by industry employment), though the extensions have not yet been performed in other dimensions (see,

again, discussion of future research in Chapter 8). Here again we can merely sketch out the extended procedures. The basic idea comes from a matrix decomposition of the generalized input-output matrix of the complete model. Using the notation of Postner and Wesa (1983, p. 62) we can write (mutatis mutandis):

$$A = \begin{pmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{pmatrix} = \begin{bmatrix} D(I-\hat{\mu})B & Da \\ i'\hat{\mu}B + n' & 0 \end{bmatrix}$$

$$= \begin{bmatrix} D(I-\hat{\mu}) & Da & 0 \\ i'\hat{\mu} & 0 & 1 \end{bmatrix} \begin{bmatrix} B & 0 \\ 0 & 1 \\ n' & 0 \end{bmatrix}$$

$$= \begin{bmatrix} D & 0 & 0 \\ 0 & i' & 1 \end{bmatrix} \begin{bmatrix} (I-\hat{\mu}) & a & 0 \\ \hat{\mu} & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} B & 0 \\ 0 & 1 \\ n' & 0 \end{bmatrix}$$

$$\equiv D^*UB^*$$

and where the symbol "0" may represent a scalar or a vector or a matrix of zeros (as the case may be) to preserve the rules of matrix algebra. Then the complete input-output model becomes:

$$x = Ax + y$$

$$= D^*UB^*x + D^*Uy^*$$

$$x = [I-D^*UB^*]^{-1}D^*Uy^*$$

and using the usual subscripts for the two terminal years and showing the case concerned with total employment change over industries:

$$\ell_1'[I-D_1^*U_1B_1^*]^{-1}D_1^*U_1y_1^* - \ell_0'[I-D_0^*U_0B_0^*]^{-1}D_0^*U_0y_0^*$$

Now if we wish to isolate the decomposition impact of international trade on Canadian employment change, we would need expressions typical of, say:

$$[\ell_0'(I-D_0^*U_1B_0^*)^{-1}\ D_0U_1 - \ell_0'(I-D_0^*U_0B_0^*)^{-1}D_1U_0]y_1^*$$

and so on, taking account of all such typical expressions with different combinations of weighting patterns. So international trade in its decomposition impact, with our endogenous treatment, ultimately comes from the difference between U_1 and U_0 as defined above.

LIST OF TABLES

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