1981

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ISSN 0228-4235
ISBN 0-7714-0254-6

CENTRE FOR THE STUDY OF INTERNATIONAL ECONOMIC RELATIONS

WORKING PAPER NO. 8102C

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This paper contains preliminary findings from research work still in progress and should not be quoted without prior approval of the author.

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COMPARISON OF AUSTRALIAN AND CANADIAN MANUFACTURING INDUSTRIES: SOME EMPIRICAL EVIDENCE

by

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February 1981

*I am grateful for the helpful comments of Greg McColl and Ignatius Horstmann. Any remaining errors are mine alone.

International comparisons of industries are comparatively rare in the literature. Since the pioneering work of Rostas (1943, 1948) in comparing labour productivities of the United States, the United Kingdom and a number of European nations, there have been major contributions by Bain (1966) and Denison (1967), which also compare relative industry productivities in a number of countries, and by Scherer (1973, 1975) in his studies of multiplant operations. The reason for the relative paucity of literature is not hard to find. In the preamble to his study of international differences between the industrial structures of eight countries during the 1950's, Bain summed up the problems involved.

> "It took only a few months to arrive at the firm conclusion...that...it would be impossible to assemble enough data to support a comparative analysis of the industrial organisation of more than two or three countries which would be worth printing." (1966, p. 4).

As a partial result of the problems of obtaining broad-ranging, comparable data, the most common international comparative studies are of Canada and the United States, for which comparable data are fairly readily available. Geographic proximity and close political and trade ties give added incentive to comparisons of these countries. Among the best known is that by West (1971), while more recent contributions have been made by Spence (1971), Williams (1978) and Oksanen and Williams (1978).

While there is obviously great interest in comparisons between Canadian and U.S. industries which serve domestic markets of emormously differing sizes, a comparison of industries in Australia and Canada is in many ways just as obvious and interesting an exercise because of the similarities in the two economies, particularly the presence of:

(a) similar consumption patterns;

(b) similar geographic concentrations of industrial capacity, sparsely distributed populations, and the transport cost and communication problems associated with long internal distances;

(c) similar federal systems of government with consequent problems of achieving coordinated and consistent economic strategies; and

(d) similar histories of protectionism.

One characteristic of the Canadian economy not shared by Australia is its proximity to the United States. The importance of the U.S. as a source of Canada's imports and as a market for Canadian exports is particularly important. In 1973 approximately 70 percent of Canada's foreign trade (both imports and exports) was conducted with the United States (Economic Council of Canada, 1975, p. 98). Canada's two most important manufacturing provinces, Ontario and Quebec, are within 24 hours by road of many major U.S. centres and therefore for a wide range of commodities, Canadian international transport costs may be expected to be relatively low when compared with those of Australia, and indeed, lower than some in the domestic markets.[1] Thus, we have a comparison of the geographically isolated Australian manufacturing sector, which has developed behind high natural barriers of transport costs,[2] superimposed on the artificial barriers of tariffs and other measures of trade control, and Canadian industry, which may be considered to have developed primarily behind the artificial barrier of trade protection alone. Despite the potential significance of such a comparison, apparently the only direct study of Australian and Canadian industries is that by Maizels (1958), though Caves (1974) has looked at aspects of foreign direct investment in the two countries.

This study is an attempt to fill part of what Round (1974) has called the "industrial organization vacuum in Australian manufacturing industry". It uses an approach similar to Oksanen and Williams' (1978) in their comparison of Canadian and United States manufacturing industries. First, pairwise comparisons of means and distributions are made of variables which have been chosen as to be independent of the exchange,rate and which reflect aspects of: i) industry structure; ii) labour force characteristics; iii) foreign trade characteristics; iv) the use of natural resources; and v) protection in order to explore possible differences between given attributes of the respective manufacturing sectors.[3] The paper then uses multivariate discriminant analysis in considering possible differences in the variables comprising a given sets of attributes, (i) to (iv) when they are considered jointly, and then combines variables chosen from the four sets of attributes in an effort to construct a composite discriminant function which may enable the classification of industries as either Australian or Canadian. Finally, two further composite discriminant functions are computed. To the original composite discriminant function are added variables which seek to measure two important components of the two countries' protective structures: tariff protection and the protection afforded by international transport costs. Separate functions are computed: the first adding nominal tariffs and nominal transport costs to the composite function; and the second, adding effective tariffs and effective transport costs. Here the aim is to assess the relative contributions of these elements of the respective protective structures, when taken with the other industry characteristics, to the statistical separation of Australian and Canadian industries. Thus, this paper has two aims: to ascertain if there are differences in certain attributes of Australian and Canadian manufacturing industries; and to see if it is possible to accurately determine the national origins of industries from these attributes.

The Australian and Canadian data used in this study have been provided in the main by the Australian Bureau of Statistics and Statistics Canada, respectively. The former were provided for 171 4-digit industries classified by the Australian Standard Industrial Classification, and the latter for 166 4-digit manufacturing industries comprising the Canadian Standard Industrial Classification. Thus, an essential part of this study entailed the reconciliation of the industry classifications used in each country and the construction of an Australia-Canada Industrial Classification (ACIC), such that a given ACIC industry consists of a group of operating units engaged in the same activities. The final concordance produced 85 ACIC industries.[4]

This is a cross-section study using data drawn (where possible) from the period 1973-74 for Australia, and 1974 for Canada.[5] These periods avoid the impact of the wide-scale imposition of non-tariff barriers protecting certain Australian industries which in the main have been imposed since July 1974.[6] In instances where data have been drawn, or have been estimated from data drawn from other periods (e.g., the 1971 Australian Census), there is the implicit assumption that they are representative of the chosen time periods for the respective countries.

1. PAIRWISE COMPARISONS OF AUSTRALIAN AND CANADIAN MANUFACTURING INDUSTRY CHARACTERISTICS

For the variables comprising the groups (i) to (v) above, Tables 1-1 to 1-5 contain the respective means, standard deviations, Wilcoxon matched-pairs signed-rank test for differences in central tendency,[7] the Kolmogorov-Smirnov (K-S) two-sample test of whether two independent samples have been drawn from the same population (or from populations with the same distributions) (Siegel 1956, p. 127),[8] and the F-test for the equality of variances for the 170 (i.e., 2 x 85) industries comprising Australian and Canadian manufacturing sectors. The full definitions of the variables used in this study and their sources appear in Appendix 1.

(i) Industry Structure

Table 1.1 compares the means and distributions of variables reflecting aspects of the respective industrial structures of the Australian and Canadian manufacturing sectors. Of the 13 variables contained in the table, there are significant differences in central tendency in 9 cases. The proportions of establishments employing less than ten, less than twenty, and less than fifty persons (EMP10, EMP20, EMP50) are all higher in Australian than in Canada, as is the ratio of wages and salaries to value added (LABINT). The opposite is true of the variable measuring the tendency for enterprises to diversify into other than their primary activity (DIVRAT), as well as those measuring the proportions of establishments employing more than ninety nine persons (EMPLG), the number of employees per enterprise and per establishment (EMPENT, EMPEST), and number of production workers per establishment (PRODEST). There are no significant differences in the respective central tendencies for the measure of eight-firm concentration (CONC8), the number of establishments per enterprise (ESTENT), relative minimum efficient scale (RMES50), and the proportions of small enterprises comprising the respective manufacturing sectors (SMALLE).

In nine cases the F ratio is significantly different from unity at the 5 percent level of significance. The variables are CONC8, DIVRAT, EEMPLG, EMPENT, EMPEST, ESTENT, PRODEST, RMES50 and SMALLE. In each case the variance is higher in Canada than in Australia. The Z statistic derived from the K-S two-sample test indicates that in the cases of DIVRAT, EMP10, EMP20 and LABINT, it is not possible at the 5 percent level of significance to reject the null hypothesis that the two samples have been drawn from the same population distribution.

TABLE 1.1
COMPARISON OF MEANS AND DISTRIBUTIONS: INDUSTRY STRUCTURE VARIABLES

Variable Name	Means Aust	Means Can	St. Dev. Aust	St. Dev. Can	Wilcoxon - signs test (diff. in central tendency) Z	Aust Vs. Can (K-S Test) Z	Variance Ratio F
CONC8	.6422	.6789	.239	.735	.0693	.6903	9.450
DIVRAT	.1497	.3973	.089	.181	7.3745	4.9853	4.138
EMP10	42.2245	29.4325	22.491	20.513	5.7764	2.0708	1.200
EMP20	56.5520	43.6291	24.556	26.671	5.4159	1.9941	1.179
EMP50	71.3545	62.1296	22.646	31.611	4.9273	1.6873	2.051
EMPLG	18.4582	25.2136	19.338	31.747	5.0351	1.5339	2.695
EMPENT	194.0401	271.6215	355.300	527.704	4.4409	1.4572	2.205
EMPEST	115.3536	170.1467	175.679	309.203	4.8397	1.4578	3.097
ESTENT	1.3070	1.3498	.350	.753	1.0659	1.1504	4.628
INTSPEC	.4466	.4399	.104	.118	.9165	.7670	1.287
LABINT	.5356	.4748	.106	.100	5.9461	2.1475	1.236
PRODEST	88.2223	122.4402	138.977	224.152	4.1035	1.5339	2.600
RMES50	.1031	.1238	.067	.149	.3028	.6136	4.945
SMALLE	.8941	.8814	.127	.171	.4646	.5369	1.812

Significance levels: Z 1 percent = 2.57
5 percent = 1.96
F 1 percent = 1.63
5 percent = 1.44

Sources: See Appendix 1.

The results of the bivariate comparisons suggest that there are a number of significant differences in the structures of the Australian and Canadian manufacturing sectors. On average, Australian manufacturing is characterized by firms employing comparatively small numbers of employees, using relatively labour-intensive production processes in comparison with firms in the Canadian manufacturing sector. When compared with Canadian enterprises, those in Australia tend to limit their production to their primary activity and not to diversify to other industries.

Of particular interest are the findings concerning the average sizes of enterprises and establishments in the two countries. While the development of an Australian manufacturing sector characterized by relatively labour-intensive, small firms is probably the result of a complex of many influences, it seems likely that the protected nature of the Australian market may make an important contribution to the formation of industries with such characteristics. Thus, through its effects on relative prices, tariff and/or transport cost protection may increase the size of the domestic market available to local firms, encourage entry and permit the profitable operation of larger numbers of small firms than would be possible in the absence of protection.

(ii) Labour Force Characteristics

Table 1.2 shows that there are significant differences in the central tendencies of the two sets of variables in all but the case of the percentage of production employees to total employment (PEMPPC). There are also differences in the distributions of the percentage of tertiary qualified employees (ED2)(F-test), the indicator of innovative activity (INNOV)(F-test), the percentages of production workers in industry workforce (PEMPPC) (F-test), percentages of industry workforce born overseas (MIGRPC) (K-S test) and the percentages of female migrants in industry workforce (FMIGRPC) (F-test and K-S test).

TABLE 1.2
COMPARISON OF MEANS AND DISTRIBUTIONS: LABOUR FORCE CHARACTERISTICS

Variable Name	Means		St.Dev.		Wilcoxon - signs test (diff. in central tendency) Z	Aust Vs. Can (K-S Test) Z	Variance Ratio F
	Aust	Can	Aust	Can			
ED1	16.1659	19.3301	4.985	5.423	5.7248	1.4200	1.183
ED2	3.1740	3.6281	2.035	2.562	2.9643	1.0738	1.585
FEMP	.2734	.2350	.184	.169	4.8478	1.0738	1.185
FEPROD	.2029	.1600	.177	.161	5.6569	.8437	1.208
FMIGRPC	11.072	8.386	1.201	.910	7.6834	3.7581	1.743
FPROD	.6228	.5239	.241	.287	6.3470	1.0738	1.418
INNOV	.9409	.9126	.066	.042	3.3849	1.6106	2.469
MIGRPC	39.2807	20.2104	9.705	8.122	7.7404	3.9882	1.427
PEMPPC	73.2829	72.1892	9.373	11.752	1.1108	.6136	1.572

Source: See Appendix 1

TABLE 1.3
COMPARISON OF MEANS AND DISTRIBUTIONS: FOREIGN TRADE CHARACTERISTICS

Variable Name	Means Aust	Means Can	St.Dev. Aust	St.Dev. Can	Wilcoxon Z	K-S Z	Variance Ratio F
EXIMP	3.1191	1.3015	10.772	2.896	.8518	.9204	13.830
EXIMPTO	-.1478	-.1657	.347	.468	1.1169	.9204	1.870
EXTO	.0790	.1604	.143	.217	5.0171	1.9174	2.302
IMPTO	.2269	.3261	.351	.480	3.8844	1.4572	1.870
INTRA	40.6482	47.9423	27.387	27.343	2.0441	1.2271	1.003
TRADBAL	-.3330	-.3078	.565	.503	.7909	.8437	1.261

Significance levels Z 1 percent = 2.57
5 percent = 1.96
F 1 percent = 1.63
5 percent = 1.44

Source: See Appendix 1

The differences in central tendency suggest that in comparison with Canada, manufacturing industries in Australia are characterised by higher levels of female participation, by larger proportions of their workforces born overseas, and by lower proportions of their workforces with education to matriculation level (ED1), or with University or similar tertiary qualifications (ED2). Fully consistent with the last two results, there is evidence of less innovative activity in Australia than in Canada (INNOV).[9]

The higher proportion of females in the Australian manufacturing industry workforce is, to the writer, at first glance a surprising result. While attitudes are quickly changing, there is in Australia still some tendency for the male dominance of the household, and for the male to consider that the necessity for the female to work reflects adversely on his ability to provide for his family. However, the proportion of women in persons who are "economically active" at the time of the 1971 Census conducted in both countries is indeed higher in Canada (26.7 percent in Australia and 28.4 percent in Canada) (International Labour Organisation (I.L.O), 1976, pp. 19, 45), while women participants in Canada comprised 34.6 of the total workforce compared with 31.7 percent in Australia (I.L.O. 1976, pp. 67, 156).

That the proportion of women in Australian manufacturing is relatively high stems from the different distributions of economic activity in the two countries. In 1971, manufacturing employment constituted 22.9 percent of total employment in Australia, but only 19.4 percent in Canada. The largest difference, however, is in the relative importance of community, social, and personal services in Canada. While in both countries approximately one-half of employees in this sector are women, in Canada the sector employs 30.4

percent of the total workforce, in Australia, only 18.8 percent (ILO, 1976, pp. 67, 156). Further, within the manufacturing sectors, the relative size of the sectors of manufacturing which could be characterized (perhaps chauvenistically) as most suited to the employment of unskilled women (e.g., packaging, light assembly and machining tasks, particularly in textiles, clothing and footwear) is larger in Australia. Thus it would appear from the data of Table 1.2 that there are relatively more opportunities for women in the manufacturing industry workforce in Australia, and that they are likely to be more commonly engaged in activities requiring fewer skills and less education.

The higher proportion of the Australian manufacturing industry workforce born overseas which may be observed from Table 1-2 stems in great part from the simple fact that there is a higher proportion of such persons resident in Australia (20.2 percent compared with 15.3 percent in Canada (ABS Population Census, 1971;Statistics Canada, Population Census, 1971)). The disproportionate number of immigrants in manufacturing in both countries (39.3 percent in Australia, 20.2 percent in Canada) is likely to be a product of the greater availability of unskilled occupations requiring little formal education and/or language skill in that sector of the economy than in others such as wholesale and retail trade, and community, social and personal services which together comprise 39 percent of the workforce in Australia and 45 percent in Canada (I.L.O. 1976, pp. 65, 156). Within the respective manufacturing sectors, Australian manufacturing is characterized by the greater relative size (in terms of employment) of industries characterized by simple assembly/fabrication tasks (e.g., in basic metals industries transportation (particularly in motor vehicles and associated industries, and textiles and clothing)) and from the previous section there is evidence that Australian industries on average use more labour-intensive methods than those in Canada. Taken together, these imply a greater relative availability of occupations which could be considered most suitable for the employment of newly-arrived, unskilled non-English-speaking immigrants. Indeed, Australia's immigration program since World War II may well have made a significant contribution to the apparent need for wide-scale protection of manufacturing. With the implementation of the large-scale immigration programme after World War II and the arrival of increasingly large numbers of unskilled non-English-speaking immigrants grew the need for the stimulus of those sectors of industry most suited for their employment. While for much of the 1950's import licencing (as a result of the "dollar shortage") provided perhaps the most important element of the protection of manufacturing, with the relaxation of these restrictions in the early 1960's the tariff became preeminent in providing a protective barrier encouraging the "...expansion and increased diversity of Australian industry" (Vernon, p. 368). It is suggested here that there is a distinct similarity between the circumstances following World War II and those following the Victorian gold rushes during the 1850's. Then, as a result of the gold rushes in the eight years to 1860, the Victorian population increased from 150,000 to 540,000. With their ending, the idea that employment could be maintained by means of a protective tariff gained acceptance, and 1865 brought the introduction into the Victorian assembly the first protectionist Australian tariff (see Reitsma 1960; Goodwin 1966). It may not be drawing too long a bow to suggest that in both periods large-scale immigration resulted in the perceived need for protectionism to provide employment opportunities for immigrants.[10]

(iii) Foreign Trade

Table 1.3 contains data which suggest that on average, Australian industries are less open to foreign trade than are their Canadian counterparts. The means of the ratios of exports to turnover and imports to turnover (EXTO and IMTO, respectively) for the two countries are significantly different and are each higher for Canada than for Australia. The dispersions of these variables is also greater for Canada; however the K-S two-sample test indicates that it is not possible to reject the null hypothesis that the two samples have been drawn from the same population distribution. Canadian industries are also characterised by greater intra-industry trade, (INTRA) suggesting that Canadian firms are, within a given industry, on average more specialised in production than are Australian industries (Grubel and Lloyd, 1975).

These findings may reflect greater opportunities for international trade in Canada owing to its proximity to the United States, its major trading partner. It is possible that there is further encouragement to international trade provided by the likelihood of relatively high internal transportation costs (of which no explicit account is taken here). Canada is a country in which distance from the major manufacturing provinces of Ontario and Quebec to many of the major U.S. markets on the east coast and in the mid-west are less than those from many Canadian markets, particularly those on the west coast.

Neither of the measures of industry trade balance, TRADBAL or EXIMTO, are significantly different in terms of either central tendency or in their distributions in each country. The distributions of the ratio of exports to imports (EXIMP) in the respective countries are characterised by a significantly greater dispersion for Australia, indicating widely differing ratios across industries. That the average ratio of exports to

TABLE 1.4
COMPARISONS OF MEANS AND DISTRIBUTIONS:
RESOURCES USE

Variable Name	Means		Std.Dev.		Wilcoxon - signs test (diff. in central tendency) Z	Aust Vs. Can (K-S Test) Z	Variance Ratio F
	Aust	Can	Aust	Can			
FUELINT	.0524	.0486	.099	.132	3.2623	1.3038	1.619
NATRES1	.0640	.0608	.158	.162	1.4987	.9971	1.051
NATRES2	.0413	.0328	.106	.125	.7256	.5369	1.390
NATRES3	.1054	.0936	.177	.195	1.3094	.9204	1.213

Source: See Appendix 1

TABLE 1.5
COMPARISONS OF MEANS AND DISTRIBUTIONS:
PROTECTION

Variable Name	Means		Std.Dev.		Wilcoxon - signs test (diff. in central tendency) Z	Aust Vs. Can (K-S Test) Z	Variance Ratio F
	Aust	Can	Aust	Can			
NTARIFF	22.13	12.09	11.37	11.58	6.44		1.03
NTRANS	16.85	4.40	12.90	2.81	7.69		21.07
ETARIFF	36.49	28.45	25.49	49.48	4.36		3.84
ETRANS	16.12	5.68	24.41	14.09	4.11		3.02

Source: Conlon (1980); See Appendix 1

Significance Levels Z 1 percent = 2.52
5 percent = 1.96
F 1 percent = 1.63
5 percent = 1.44

imports in Australia is approximately 3:1 stems mainly from the high levels of exports (and low imports) of the food group of industries and particularly of meat products. If the food group of industries (ACIC 1-12) is omitted, the ratios are .230 for Australia and 1.225 for Canada. The data thus reflect a more "uniform" trade pattern across Canadian industries compared with those of Australia.

To the extent that Australia's isolation is reflected, ceteris paribus, in higher international transport costs (Linneman 1966; Geraci and Prewo 1977; Conlon 1979) than Canada, this result suggests that such costs serve not only to protect Australian industries from import competition,[11] but also to limit their export potential. Transport costs for exports, however, are not explicitly considered here.

(iv) The Use of Resources

The data of Table 1.4 indicate that there are no significant differences in the use of replenishable, non-replenishable and total natural resources (NATRES1, NATRES2, and NATRES3, respectively), by Australian and Canadian manufacturing industries. That the proportion of electricity and all other fuels in total material usage (FUELINT) is higher in Australia than in Canada is surprising, in view of the extreme winters in that country. No one group of industries dominates this data set in either country and whether, for example, the result reflects a relative inefficient use of fuels in Australia, or the use of different production techniques, cannot be determined from the available information.

(v) Protection

Table 1.5 summarizes the results of other research by the present author (Conlon 1980) and indicates that the means and distributions of the two elements of the protective structures of Australia and Canada considered here--tariffs and transport costs--are significantly different, whether nominal or effective rates are considered.[12] Not only is the mean of each protection variable significantly lower in Canada than in Australia, but the relative contribution of transport costs to the total protective barrier in Canada is also substantially lower. In Australia nominal transport costs contribute over 40 percent of the total nominal trade barrier; in Canada just over one-quarter. In effective rate terms, transport costs provide over 30 percent of the total barrier in Australia; in Canada just under 17 percent. On this evidence, Australian manufacturing has developed behind significantly higher average natural and man-made barriers to trade than has the manufacturing sector of Canada.

Such results are hardly surprising. Australia is well known for its protectionist policies toward manufacturing. At the time from which the data for this study were drawn, Australian manufacturing sheltered behind higher average tariff barriers than the industries of Japan, the countries of the European Economic Community, Sweden, Canada, and the United States (Industries Assistance Commission, 1978, p. 78). The direct relationship between distance and transport costs documented by many researchers (e.g., Linneman 1966; Lipsey and Weiss 1974; Geraci and Prewo 1977; Zerby and Conlon 1978) receives support in these findings. When Australia's geographic isolation is compared with Canada's proximity to the United States and its importance to Canada's trade,[13] it would have been surprising indeed if Canada's international transport costs had not been significantly lower.

(vi) A Summary of the Bivariate Comparisons

Only the most tentative conclusions can be drawn from the bivariate comparisons which have been conducted here. Nevertheless, the results suggest that there may well be relationships between protection and the industry, labour and foreign trade characteristics of the Australian and Canadian manufacturing sectors. While it is difficult to establish directions of causation, the data are consistent with the hypothesis that the relatively high average level of protection available to Australian manufacturing over many years[14] through its effect on relative prices in encouraging resources to flow into the protected sector (or discouraging their movement from it), has encouraged the development of a manufacturing sector which, compared with Canada, is relatively large vis-à-vis other sectors of the economy.

The data are also consistent with the hypothesis that the relatively higher average levels of protection in Australia may act to encourage entry and permit the profitable operation of a relatively larger number of small firms and establishments than would be possible under lower protection. The industries which have developed on average use relatively labour intensive production techniques, and provide greater scope for the employment of women, immigrants and the unskilled than does Canadian manufacturing. While protection against imports, whether by means of tariffs (or other artificial trade barriers) or by transport costs may well increase the size of the domestic market available to local firms, the results of Section (iii) suggest that Canada's proximity to the U.S. may provide it with greater opportunities for international trade than isolated Australia. Thus for Australian industry, international transport costs must be observed from two viewpoints: as an advantage to import-competing industries; and as a disadvantage to export and potential export industries. While transport costs for exports are not explicitly considered here, the data of Section (iii) are consistent with the hypothesis that Australia's isolation may, on balance, act to reduce the total size of markets (i.e., domestic sales + exports - imports) available to Australian firms.

2. CLASSIFICATION OF AUSTRALIAN AND CANADIAN MANUFACTURING INDUSTRIES BY DISCRIMINANT ANALYSIS

The multivariate discriminant analysis here in essence looks at possible differences in the Australian and Canadian manufacturing sectors, and attempts to assess which attributes of the respective sectors make the greatest contributions to the statistical "separation" of Australian and Canadian manufacturing. As the application of multivariate discriminant analysis is relatively uncommon in the literature of economics, this section briefly describes the technique and some of the problems which may arise in its application.

(i) Multivariate Discriminant Analysis: Some Theoretical Considerations

Discriminant analysis is a statistical method which is used to assign items to the appropriate one among two or more groups on the basis of a discriminant function. Such a function is a linear combination of "discriminating" variables, whose weighting coefficients are estimated from sample data. The theory underlying discriminant analysis may be illustrated where the technique is applied (as in the present case) to two mutually exclusive groups of populations (Johnston 1960, pp. 334-340), and using the following symbols.

Two populations: P_1 and P_2

Vector of measurements: $X' = [x_1, x_2, \ldots, x_k]$

Density functions: $f_1(X)$ and $f_2(X)$

A priori probabilities: P_1 and P_2, where $P_1 + P_2 = 1$

Classification rule: X space divided into two regions R_1 and R_2. If X falls in R_1, item is allocated to P_1. If X falls in R_2, then is allocated to P_2.

Costs of misclassification: c(2/1) denotes the cost of classifying observation from P_1 in P_2 and c(1/2) the cost of classifying observation P_2 in P_1. Correct classifications are costless.

The two populations are multivariate; an individual drawing from either population consists of measurements on (k variables. The a priori probabilities refer to the probability that a new observation comes from P_1 or P_2. Assuming that $f_1(X)$ and $f_2(X)$ are each multivariate normal with different mean vectors μ_1 and μ_2, but the same covariance matrix Σ, then the ratio of the densities is

$$\frac{f_1(X)}{f_2(X)} = \frac{\exp[-\frac{1}{2}(X - \mu_1)'\Sigma^{-1}(X - \mu_1)]}{\exp[-\frac{1}{2}(X - \mu_2)'\Sigma^{-1}(X - \mu_2)]}$$

$$= \exp[X'\Sigma^{-1}(\mu_1-\mu_2) - \frac{1}{2}(\mu_1-\mu_2)'\Sigma^{-1}(\mu_1-\mu_2)] \quad . \qquad (2.1)$$

Defining

$$\delta = \Sigma^{-1}(\mu_1-\mu_2)$$

and

$$\frac{c(1/2)P_2}{c(2/1)P_1} = c^*$$

then the classification rule can be written

$$R_1: X'\delta - \frac{1}{2}(\mu_1 + \mu_2)'\delta > \log c^*$$

$$R_2: X'\delta - \frac{1}{2}(\mu_1 + \mu_2)'\delta < \log c^* \qquad (2.2)$$

and $X'\delta$ is the discriminant function.

Then, if there is a set of n_1 sample observations that are known to have come from P_1 and another set of sample observations that are known to have come from P_2, and letting $\bar{x}_1$ and $\bar{x}_2$ denote the vectors of sample means computed from each set of data, these are maximum likelihood estimates of μ_1 and μ_2. The deviates from the sample means for each set of data may be computed so that

X_1 is an $(n_1 \times k)$ matrix of deviations from $\bar{x}_1$

and

X_2 is an $(n_2 \times k)$ matrix of deviations from $\bar{x}_2$

Then

$$S = \frac{1}{n_1 + n_2 - 2}[X_1'X_1 + X_2'X_2] \tag{2.3}$$

based on the pooled sums of squares from the two samples is a maximum likelihood estimate of the common variance matrix Σ. The elements of the discriminant function D may then be estimated by

$$D = S^{-1}(\bar{x}_1 - \bar{x}_2) \qquad (2.\ )$$

If the scalar z is defined as $z = x'D$ for any vector of observations x it will have a mean value $\bar{z}_1$ taken over the sample observations from P_1 and a mean value $\bar{z}_2$ taken over the sample observations from P_2 It can be shown that (2.4) gives the vector D which maximizes the ratio

$$\frac{(\bar{z}_1 - \bar{z}_2)^2}{\sum_{i=1}^{2} \sum_{j=1}^{n_i} (z_{ij} - \bar{z}_i)^2}$$

which provides an intuitive justification for the discriminant function for the objective is to have a vector D which would differentiate the two populations as much as possible by making the squared difference between

$\bar{z}_1$ and $\bar{z}_2$ as great as possible. On the other hand increasing this difference may well increase the variance of z within each sample and so D is found to maximize the variance between samples relative to the pooled variance within samples.

Now with the estimates $\bar{x}_1$, $\bar{x}_2$, S, and D from the sample data a practical discrimination procedure is to replace μ_1 μ_2 and δ in a rule such as (2.2) with the corresponding estimated values. The larger the samples from which the estimates have been drawn, the greater is the probability that the practical procedures will approximate to the optimal properties of theoretical procedures such as (2.2).

In the discriminant analysis used here, the populations or "groups" are provided by the two countries, Australia and Canada, and the observations or "items" are the 170 (i.e., 85 x 2) industries. The objective is to obtain a linear combination of variables that will optimally classify industries into one group or another. The discriminant function applied here is of the form:

$$D_i = d_{i1}Z_1 + d_{i2}Z_2 + \dots + d_{ik}Z_k \qquad (2\text{-}5)$$

where D_i is the score of the discriminant function i, the d's are weighting coefficients, and the Z's are the standardized values of the k discriminating variables used in the analysis. When the overall averages (the grand means) for each of the individual discriminating variables are substituted into equation (2-5), the critical value of D is determined. If an individual item's D_i value is above the critical value it is assigned to one group, and if it is below it is assigned to the other.

The discriminant score for each industry is computed by multiplying the value of each discriminating variable by its corresponding coefficient and adding the resulting products. The coefficients have been so derived that the discriminant scores produced are in standard form: over all the cases in the analysis, the score from one function will have a mean of zero and a standard deviation of one. Thus for any single case, the score represents the number of standard deviations from the mean for all cases on the given discriminant function. The absolute values of the standardised discriminant function coefficients represent the relative contributions of the associated variables to that function, and their signs indicate whether the variables are making a positive or a negative contribution. The average of the scores for the items within a particular group is the group mean (also termed the group centroid) for the particular function. The group centroid is the most typical location of an item from that group in the discriminant function space, and a comparison of group means indicates by how far the groups are separated.

Discriminant analysis pricedures are based on two important assumptions: that the variables used to describe or characterise the members of the groups are multivariate normally distributed; and that the group variance-covariance matrices are equal across all groups. A discussion of the implications of a breakdown of the two assumptions follows.

(a) Multivariate normality

Most available normality tests are for univariate, rather than multivariate normality. For the present study no test of multivariate normality was available. According to Eisenbeis, "the tactic which most researchers have adopted is simply to be satisfied that the more standard discriminant procedures yield reasonable approximations and proceed as if the normality assumption held" (Eisenbeis, 1977, pp. 875-76). That "tactic" is adopted here.

Gilbert (1968) has conducted research into the effects of applying discriminant analysis if the multivariate normality assumption fails to hold. He compared the performance of the mean discriminant function with performances of two logit models, and with a model which assumed mutual independence of the variables. His work suggested that there was only a small loss in predictive accuracy using the linear function and that as the number of variables increased, the results were quite stable. Lachenbruch, Sneeringer and Revo (1973), however, found that standard linear procedures may be sensitive to nonmultivariate normality, but suggest that the problems may not be as great when distributions are bounded, and that overall classification error rates were not affected as much as individual group error rates. They suggest that the data be transformed, if possible, to approximate normality, and standard tests then applied.[15] In this respect, Eisenbeis notes that:

> "...the application of a transformation (e.g. to natural logs) may change the interrelationships among the variables and may also affect the relative positions of the observations in the group. In the case of the log transformation there is also [the acceptance of] an implicit assumption...[that]... the transformed variables give less weight to equal percentage changes in a variable when the values are larger than when they are smaller" (Eisenbeis, 1977, p. 877).

As a result of these considerations and Gilbert's (1968) findings, no transformations have been used in the present study.

(b) Equality of group variance-covariance matrices

A breakdown in the assumption of equality of variance-covariance matrices across groups affects, <u>inter alia</u>, the significance test for the differences in group means and the appropriate forms of the classification rules. In summarising the available evidence in this respect, Eisenbeis states:

> "...that rejection of the hypothesis of equal group dispersions may have a significant and undesirable impact on the test for the equality of group means. More importantly, depending on the sample sizes, number of variables, and differences in the dispersions, use of linear classification rules when quadratic rules are indicated may have drastic effects on the classification results. Logically then, the test for the equality of the dispersion matrices should precede both the list for the equality of group means and the estimation of classification errors" (Eisenbeis, 1977, p. 882).

In the present study, Box's M significance test was computed with results that indicated a significant departure from equality of the matrices in all cases. While the inequality of the covariance matrices may be expected to lead to some misclassifications, with an excessive number of observations classified to the more dispersed group, here the empirical tests of the success of the discriminant functions in correctly classifying industries was reflected in nearly all cases by the absence of any observable tendency to classify more frequently in one group than another.

(c) A summary

The present application of discriminant analysis has the advantages of prior knowledge of the correct group memberships, the equality of group sizes and the consequent a priori probabilities of group membership. These all mitigate problems inherent in some applications of the technique. Essentially in this application, given this prior knowledge, it will be obvious if the classification is successful. In applications without such knowledge it is of course difficult to gauge how successful the classification has been.

As the group membership sizes are equal, the classification rule in the present application is straightforward. The costs of misclassification are equal, and the a priori probability of an observation belonging to one group is the same as the probability that it belongs to the other.

In respect of problems mentioned earlier, Eisenbeis concludes:

> "Other problems such as nonnormality ... [and] interpreting the significance of individual variables, are not as easy to remedy. Until further research is done one must simply temper the conclusions reached by recognising that they may be significantly biassed in some cases" (Eisenbeis, 1977, p. 896).

(ii) Discriminant Analysis of Four Aspects of Australian and Canadian Manufacturing Industries

The objective of the pairwise comparisons of Section 1 was to explore possible differences between a given attribute of the two manufacturing sectors. This section considers possible differences in the sets of attributes (i) to (iv) when, for a given set, the variables are considered jointly. Here multivariate discriminant analysis is used as a means of predicting with a given set of attributes, the correct group (i.e. Australia or Canada), membership of the 170 industries (i.e. 2 x 85) considered in this study. The individual industries are assigned to the group of industries which have characteristics most like its own. Since the true memberships of the groups are known, a table (sometimes called the "confusion matrix" or the "hits and misses" table) may be prepared incorporating the correct and incorrect classifications. Essentially, the fewer the misclassifications of individual industries, the more distinct or dissimilar are the groups in respect of that set of attributes. The analysis also aims to discern which variables, representing a set of attributes contribute most in separating the groups. Thus, in this respect the aim is to shed light on the answers to two questions: Are the characteristics of the two manufacturing sectors considered here significantly different? and, if they are: which variables contribute most to the difference?

The tables of this section contain standardised discriminant functions using variables reflecting various aspects of the industry structure and industry characteristics of both countries.[16] The functions have been computed first using the data for all (170) industries and second using data for 86 (i.e., 2 x 43) randomly selected industries from the full data sets. The experiment using randomly selected industries was repeated five times. The reason for the estimation of the second set of functions stems from the upward bias arising from the use of all n observations to calculate the discriminant function, and then classifying the same n individuals with the function. A method of avoiding this bias, which was adopted here, was to fit a discriminant function to part of the data (86 items) and to use the resulting function to classify the remaining 84 (i.e.: 2 x 42) items (Frank, Massy and Morrison, 1965).

(a) Industry structure

For the six experiments conducted on the data, Table 2-1 contains the standardised discriminant function coefficients derived in the manner previously described for the variables listed in Table 1-1 together with extracts from the confusion matrices described earlier.[17] The standardised discriminant function coefficients of the table suggest that of the industry structure variables considered, DIVRAT and EMP10 provide the greatest relative contributions to the prediction of the group memberships. DIVRAT is prominent in each function, and in the case of the function derived in the fifth sample experiment, is the only variable entering the analysis.[18] EMP10 has the highest (absolute) value in four of the five functions in which it appears. For all experiments, the value of Chi-square indicates that the respective functions discriminate between real differences in the population at the 1 percent level of significance.

The signs of the standardised coefficients should be compared with the signs of the respective group centroids. For example, the group centroids for the discriminant function fitted to the data derived from all industries are +.98061 for group 1 (Australian industries), and -.98061 for group 2 (Canadian industries).[19] Thus the negative sign of DIVRAT for that function indicates that a relatively high value of that variable for a given industry will lead, _ceteris paribus_, to an industry being classified as Canadian.

The fact that pairwise comparisons may differ from the _ceteris paribus_ results of multivariate analysis has been noted in the study by Oksanen and Williams (1978, p. 99). This phenomenon is also apparent in the present study. For example the pairwise comparisons of Table 1.1 show higher means of establishments per enterprise, ESTENT, and 8-firm concentration, CONC8, for Canada than for Australia, though in neither case was the difference statistically significant. The multivariate analysis, however, shows that all things being equal, a larger number of establishments per enterprise and high industrial concentration leads an industry to be classified as Australian. In summary, the signs indicate that "high" values of CONC8, EMP10, ESTENT and LABINT lead to an industry being classified as Australian, while "high" values of DIVRAT, EMP20, EMP50, EMPLG and INTSPEC lead to an industry being classified as Canadian. The signs for SMALLE for random sample experiments 1 and 3 are ambiguous.

The extracts from the confusion matrices show a relatively high degree of accuracy of the discriminant function's ability to predict correct group memberships. Of the five functions which use the data derived from the 86 industries chosen at random (the grouped data) the functions correctly predict group membership of the remaining 84 industries (the ungrouped data) on average in approximately 80 percent of cases for both countries (a total of 176 and 165 of 210 cases for Australia and Canada, respectively). The chi-square test indicated that the percentage of correct classifications was significant at the 1 percent level. Similarly, a chi-square test was performed for the individual experiments and indicated that the percentage of correct classifications was significant at the 5 percent level in all experiments and at the 1 percent level for most. The percentage of correct classifications in discriminant analysis may be interpreted in a manner analogous to R^2 in regression analysis (Morrison 1969). Just as a high R^2 tells how much variance has been explained by an equation, the results of these tests show how well the functions classify the individuals.

The discriminant analyses of Table 2.1 show that an industry will be classified as Australian if it is characterized by industrial concentration and by small, relatively labour intensive, vertically-integrated firms which tend not to participate in activities classified to other than their principal activity. That Australian manufacturing is characterised by both industrial concentration and small establishment is a particularly interesting result. Indeed, there is no inconsistency between the juxtaposition high concentration and the small (average) size of establishments. Here the image created is one in which Australian manufacturing industries are dominated by few large firms coexisting with a fringe of many smaller ones. This result is further discussed in Section 5.

(b) Labour force characteristics

Table 2.2 contains the standardised discriminant function coefficients for the variables of Table 1.2, and extracts the associated confusion matrices. Of the labour force variables entering the discriminant analyses,

TABLE 2-1

STANDARDISED DISCRIMINANT FUNCTION COEFFICIENTS:
INDUSTRY STRUCTURE VARIABLES - AUSTRALIA AND CANADA.

Variable Name	All Industries	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
CONC8		-.18532	-.24484		-.20469	
DIVRAT	-.88985	.89136	.87265	.75179	.89557	1.0000
EEMP10	.93925	-.92229	-1.26663	-.66093	-1.44825	
EEMP20	-.64085		.93262		1.07312	
EEMP50		.91921				
EEMPLG		.50228				
EMPENT						
EMPEST						
ESTENT	.15689	-.34594		-.59040		
INTSPEC	-.16050	.19469				
LABINT	.33996	-.54364	-.18367	-.48807	-.16738	
PRODEST						
RMES50						
SMALLE		-.38489		.20146		
WILKS' LAMBDA	.5068	.4354	.5122	.4774	.4737	.4765
Chi-square	112.13[a]	66.09[a]	54.52[a]	60.24[a]	60.88[a]	61.893[a]
d.f.	6	9	5	5	5	1
GROUP CENTROIDS						
GROUP 1	.98061	-1.12536	-.96445	-1.03383	-1.04160	-1.03584
GROUP 2	-.98061	1.12536	.96445	1.03383	1.04160	1.03584

Industries Correctly Classified As:	All Industries		Sample	1	2	3	4	5
Australian	(n=85)	76[a]	(n=42)	36[a]	36[a]	36[a]	32[b]	36[a]
Canadian	(n=85)	68[a]	(n=42)	33[b]	32[b]	31[b]	34[a]	35[a]
% Correctly Class.	(n=170)	84.7	(n=84)	82.1	81.0	79.8	78.6	84.5

Notes: (a) χ^2 significant at 1 percent level.
(b) χ^2 significant at 5 percent level.

both total migrant and female migrant participation in industry workforces (MIGRPC and FMIGRPC, respectively) when all experiments are considered, make the largest relative contributions to the prediction of group memberships. The percentage of production employees in total employment (PEMPPC) and the proxy for innovative activity (INNOV), each have the highest standardised coefficient in one of the six experiments. Of the two experiments where aspects of female participation in the force enter the function (FPROD and FEPROD), their relative contribution is lowest of all variables entered.

When compared with the group centroids, the signs of coefficients indicate that ceteris paribus, "high" values of INNOV, (i.e. low innovative activity; see Oksanen and Williams 1978, p. 97), FMIGRPC and MIGRPC lead to an industry being classified as Australian; a "high" value of PEMPPC leads to an industry being classified as Canadian. The signs for FPROD and FEPROD in sample experiments 3 and 4, respectively, suggest that a relatively high proportion of females in the workforce leads to an industry being classified as Australian. Chi-square for each function is significant at the 1 percent level and indicates that within the population, significant differences exist between the two groups.

The extracts from confusion matrices for the ungrouped data show that the proportion of industries correctly predicted as being Canadian is significant at the 1 percent level in four cases, and at the 5 percent level in the remaining case. The functions are less successful in predicting correct group membership in the case of Australia. While two of the five experiments yielded a proportion of correct predictions significant at the 1 percent level, one at the 5 percent, and one at the 10 percent levels, in the case of sample experiment 3,the proportion of correct classifications is not significant at 10 percent level. The five functions predict correct group membership of the ungrouped industries on average in 76 percent of cases for Australia (159 of 210 cases) and in 82 percent (172 of 210 cases) for Canada. Both results are significant at the 1 percent level.

TABLE 2·2

STANDARDISED DISCRIMINANT FUNCTION COEFFICIENTS:
LABOUR FORCE VARIABLES - AUSTRALIA AND CANADA.

Variable Name	All Industries	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
ED2						
FEMP						
FEPROD					.39979	
FMIGRPC	-.45581	-.56868	-.60327	-.46423		-.49499
FPROD				-.33897		
INNOV	-.53556	-.62888	-.51783	-.61629	.72814	-.49671
MIGRPC	-.66418	-.57408	-.56970	-.51102	.88568	-.64819
PEMPPC	.43965	.56906	.48081	.76626	-.57363	.39477
WILK'S LAMBDA	.5472	.5277	.4897	.5015	.5419	.5630
Chi-square	100.07[a]	52.40[a]	58.54[a]	56.24[a]	50.24[a]	47.09[a]
d.f.	4	4	4	5	4	4
GROUP CENTROIDS						
GROUP 1	-.90417	-.93487	-1.00882	-.98526	.90876	-.87057
GROUP 2	.90417	.93487	1.00882	.98526	-.90876	.87057

Industries Correctly Classified As:		All Industries		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Australian	(n=85)	67[a]	(n=42)	34[a]	33[b]	26	30[c]	36[a]
Canadian	(n=85)	73[a]	(n=42)	34[a]	34[a]	38[a]	34[a]	32[b]
% Correctly Class.	(n=170)	82.3	(n=84)	81.0	79.8	76.2	76.2	81.0

Notes: (a) χ^2 significant at 1 percent level.
(b) χ^2 significant at 5 percent level.
(c) χ^2 significant at 10 percent level.

In summary, these analyses suggest that there are significant differences in labour force characteristics in the two countries. The workforces of Australian manufacturing industries are distinguished by their high proportions of migrant employees and by relatively low innovative activity. There is evidence that the proportion of females in the workforces may make a relatively small contribution to group separation and that high proportions of females ceteris paribus, classify industry as Australian. In contrast to the bivariate comparison of Table 1-2, in this analysis a relatively high proportion of production workers in total employment ceteris paribus, classify industries as Canadian. On this evidence, Canadian industries tend to be characterised by fewer "overhead" staff than Australian industries.

(c) Foreign trade

In contrast with the earlier results which suggest that it is possible to distinguish with a high degree of accuracy between Australian and Canadian industries on the basis of industry structure and employment characteristics, the discriminant functions of Table 2-3 do not predict group membership with accuracy. In the case of each experiment the distance between the group centroids is relatively small, while the predicted group memberships of the ungrouped data differ widely with each experiment. Indeed, in the case of Canadian industries, on average the functions derived from these data predict the incorrect group more often than not.

In Section 1(c) it was noted that as a result of the very high ratio of exports to imports (EXIMP) in the food group industries in Australia, there is a significantly higher dispersion for this variable for Australia than for Canada. Consequently, discriminant functions were fitted to the foreign trade data with the omission of EXIMP. However the results are,

TABLE 2.3

STANDARDISED DISCRIMINANT FUNCTION COEFFICIENTS: FOREIGN TRADE VARIABLES - AUSTRALIA AND CANADA.

Variable Name	All Industries	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
EXIMP	-.70454	-.91365	-.73338	-.66513	-.79792	-.78357
EXIMPTO						
EXTO	.97442	.86644	1.53085	.99198	1.05287	1.00707
IMPTO			-.84420			
INTRA						
TRADBAL			-.67929			
WILK's LAMBDA	.9181	.9372	.85310	.9285	.9554	.8372
Chi-square	14.268	5.3779	13.028	6.1542	3.7806	14.748
d.f.	2	2	4	2	2	2
GROUP CENTROIDS						
GROUP 1	-.29689	-.25570	-.41011	-.21741	-.21335	-.43580
GROUP 2	.29689	.25570	.41011	.21741	.21335	.43580

Industries Correctly Classified As:	All Industries		Sample	1	2	3	4	5
Australian	(n=85)	75[a]	(n=42)	7	35[a]	40[a]	22	37[a]
Canadian	(n=85)	31	(n=42)	34[a]	11	10	32[b]	13
% Correctly Class.	(n=170)	62.4	(n=84)	48.8	54.8	59.5	64.3	59.5

Notes: (a) χ^2 significant at 1 percent level.
(b) χ^2 significant at 5 percent level.

TABLE 2.4

STANDARDISED DISCRIMINANT FUNCTION COEFFICIENTS: RESOURCE USE VARIABLES - AUSTRALIA AND CANADA.

Variable Name	All Industries*	Sample 1	Sample 2*	Sample 3	Sample 4*	Sample 5*
FUELINT		.76248		1.0000		
NATRES 1		.74497				
NATRES 2						
NATRES 3						
WILK'S LAMBDA		.96579		.98134		
Chi-square		2.8888		1.5720		
d.f.		2		1		

* No variable qualified for the analysis

Industries Correctly Classified As:	All Industries		Sample	1	2	3	4	5
Australian	(n=85)	-	(n=42)	11	-	6	-	-
Canadian	(n=85)	-	(n=42)	37	-	40	-	-
% Correctly Class.	(n=170)	-	(n=84)	57.2	-	54.8	-	-

like those just described poor, and do not provide accurate predictions of group memberships.[20] Thus, on the basis of the trade data used in this study, it is not possible to accurately distinguish between Australian and Canadian industries.

(d) The use of resources

The attempt to discriminate between Australian and Canadian industries on the basis of their use of resources, using the variables of Table 1-4, was also noticeably unsuccessful. In four of the six experiments no variables qualified for the analysis. In the two experiments where variables were entered (FUELINT in both experiments, NATRES1 in one), as a result of the greater dispersion of the Canadian observations, by far the majority of industries are classified as Canadian by the functions. The conclusion here is simple: it is not possible to accurately distinguish between group memberships on the basis of the industries' use of resources.

3. DISCRIMINANT ANALYSES OF SELECTED ATTRIBUTES OF AUSTRALIAN AND CANADIAN MANUFACTURING INDUSTRIES

It has been shown that it is possible to distinguish between Australian and Canadian manufacturing industries with a high degree of accuracy on the basis of the characteristics of the respective industry structures and of their labour forces, when each group of characteristics is considered separately. Neither the variables reflecting foreign trade characteristics, nor those reflecting the use of resources enable an accurate distinction to be made. This section combines the results of Section 2 by choosing from the four sets of attributes examined there--industry structure, labour force, foreign trade and the use of resources--variables which, within each set, on average made relatively large contributions to the separation of the two groups of industries and which illustrate a variety of aspects of industries. Thus the functions of Table 3.1 include variables reflecting aspects of the respective industry structures (DIVRAT, EMP10, and LABINT), labour forces (FEMP, MIGRPC and PEMPPC), foreign trade (EXTO, INTRA and TRADBAL), and resource use (FUELINT). The functions appearing in Tables 4.1 and 4.2 add to these variables nominal tariff and transport cost protection (NTARIFF and NTRANS) and the corresponding effective rates of protection (ETARIFF and ETRANS), respectively (Conlon 1980), in order to assess (when taken with the other industry characteristics) the relative contributions of the protective structures to the statistical separation of Australian and Canadian industries.

(a) Selected industry characteristics

The discriminant functions of Table 3.1 show that, of the industry characteristics considered, MIGRPC and DIVRAT make the greatest relative contributions to the respective functions. Other variables making relatively large contributions are TRADBAL and EMP10. The remaining variables, in general, make relatively little contribution to discrimination between the groups. Taken together, the signs of the standardised coefficients (including those which did not enter all functions and/or made relatively little contribution) indicate that <u>ceteris paribus</u>, an industry will be classified as Australian if it is characterised by relative labour intensity (LABINT), a favourable balance of trade (TRADBAL), a large proportion of establishments employing less than 10 persons (EMP10), and the use of a relatively large proportion of fuels and electricity in total materials inputs (FUELINT). An industry will be classified as Canadian if, <u>ceteris paribus</u>, it is characterised by a relatively high degree of intra-industry trade (INTRA), a high proportion of exports to turnover (EXTO), enterprises with a relatively high proportion of their output classified to other than their primary activity (DIVRAT), and a relatively high proportion of production employees in total employment (PEMPPC). All of these results are consistent with the previous findings.

TABLE 3.1

STANDARDISED DISCRIMINANT FUNCTION COEFFICIENTS: SELECTED INDUSTRY CHARACTERISTICS - AUSTRALIA AND CANADA

Variable Name	All Industries	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
LABINT	.19610	.55113			.20779	
INTRA	-.25909		-.22206	-.23506	-.45459	-.27146
EXTO	-.18585	-.18611		-.21283	-.22571	-.34557
TRADBAL	.49224	.47559	.50754	.65818	.48206	.44679
FEMP					.36021	
DIVRAT	-.68041	-.68264	-.61228	-.54108	-.81237	-.73975
EEMP10	.25938	.40732	.51898	.55182	.31812	
FUELINT	.15318	.19066			.20203	
REMPPC	-.22171	-.41995	-.39893	-.31065	-.34532	
MIGRPC	.75807	.68558	.96362	.99343	.57332	.64904
WILK's LAMBDA	.35667	.33228	.31032	.34914	.33697	.34109
Chi-square	168.56[a]	88.142[a]	94.782[a]	84.707[a]	85.993[a]	87.662[a]
d.f.	9	8	6	7	10	5
GROUP CENTROIDS						
GROUP 1	1.33508	1.40099	1.47335	1.34936	1.38631	1.37362
GROUP 2	-1.33508	-1.40099	-1.47335	-1.34936	-1.38631	-1.37362

Industries Correctly Classified As:	All Industries		Sample	1	2	3	4	5
Australian	(n=85)	78[a]	(n=42)	38[a]	32[b]	33[b]	37[a]	38[a]
Canadian	(n=85)	78[a]	(n=42)	35[a]	40[a]	38[a]	35[a]	39[a]
% Correctly Class.	(n=170)	91.8	(n=84)	86.9	85.7	84.5	85.7	91.7

Notes: (a) χ^2 significant at 1 percent level.
(b) χ^2 significant at 5 percent level.

The functions all display a high degree of discriminatory power, the chi-square test indicating (at the 1 percent level) that there is a significant difference between the variates of the two groups. The extracts from confusion matrices for the ungrouped data also reflect a high degree of discriminatory power. The chi-square test indicates that for Canada, the percentage of correct classifications was significant at the 1 percent level for all experiments, and for Australia at the 1 percent level for three experiments and at the 5 percent level for the remaining two. On average, over the five experiments for the ungrouped data, the function correctly predicts Australian group membership in 85 percent of cases (178 of 210 cases) and Canadian group membership in 89 percent (187 of 210 cases). Both results are significant at the 1 percent level.

4. SELECTED ATTRIBUTES AND PROTECTION

(a) Nominal protection

Table 4-1 incorporates the variables discussed in the previous section and the two components of the nominal protective structure, NTRANS and NTARIFF. The addition of the nominal protection variables increases the discriminatory power of the function. Both variables enter all functions and after MIGRPC,[21] NTRANS makes the highest relative contribution to the function in five of the six experiments. The relative contribution of NTARIFF is generally small. The addition of the two nominal protection variables causes the omission of EXTO and FUELINT from all functions.

For the ungrouped data, in every case for both countries the percentage of correct classifications is significant at the 1 percent level. For these five experiments, the functions predicted the correct group membership of Australian industries in 91 percent of the cases (191/210) and of Canadian industries, in 94 percent (197/210) of cases. Both results are highly significant.

TABLE 4.1

STANDARDISED DISCRIMINANT FUNCTION COEFFICIENTS:
NOMINAL PROTECTION AND SELECTED INDUSTRY CHARACTERISTICS
AUSTRALIA AND CANADA

Variable Name	All Industries	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
NTRANS	.57631	.56805	-.45468	.61760	.64403	-.41995
NTARIFF	.25729	.20931	-.24043	.22806	.22957	-.26235
LABINT	.28335	.54458		.26142	.36701	
INTRA	-.25595		.15034		-.31018	.21933
EXTO						
TRADBAL	.42041	.40602	-.33280	.41971	.31679	-.30495
FEMP				.16985	.43851	
DIVRAT	-.55607	-.54535	.53376	-.46080	-.68056	.60175
EFMP10	.20799	.32022	-.45953	.29943	.25748	-.15020
FUELINT						
PEMPPC	-.24425	-.38903	.21729	-.33922	-.30632	
MIGRPC	.70566	.73297	.85849	.71220	.49578	.68296
WILK's LAMBDA	.26566	.24657	.24658	.26010	.23668	.28440
Chi-square	216.72	112.01	112.00	107.06	113.84	101.22
d.f.	9	8	8	9	10	7
<u>GROUP CENTROIDS</u>						
GROUP 1	1.65276	1.72757	-1.72750	1.66688	1.77481	-1.56766
GROUP 2	-1.65276	-1.72757	1.72750	-1.66688	-1.77481	1.56766

Industries Correctly Classified As:	All Industries		Sample	1	2	3	4	5
Australian	(n=85)	83[a]	(n=42)	41[a]	36[a]	40[a]	36[a]	38[a]
Canadian	(n=85)	81[a]	(n=42)	39[a]	41[a]	39[a]	38[a]	40[a]
% Correctly Class.	(n=170)	96.5	(n=84)	95.2	95.6	94.0	88.1	92.8

Note: (a) χ^2 significant at 1 percent level.

TABLE 4.2

STANDARDISED DISCRIMINANT FUNCTION COEFFICIENTS:
EFFECTIVE PROTECTION AND SELECTED INDUSTRY CHARACTERISTICS
AUSTRALIA AND CANADA

Variable Name	All Industries	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
ETRANS	.37772	.28732	.27071	.28234	.44854	
ETARIFF	.14545	.22088	.16408			-.18831
LABINT	.25935	.61067			.21358	
INTRA	-.23632		-.18857	-.20432	-.34655	.28182
EXTO						.30149
TRADBAL	.39377	.38509	.41214	.49553	.29927	-.46140
FEMP					.36313	
DIVRAT	-.67113	-.69791	-.60940	-.56284	-.77839	.71137
EEMP10	.23578	.39395	.51685	.54467	.30936	-.15507
FUELINT		.18015				
PEMPPC	-.25042	-.45832	-.32271	-.32644	-.32862	
MIGRPC	.77413	.73259	.96378	1.00872	.56840	-.69280
Wilk's Lambda	.32943	.30569	.28752	.33823	.30716	.32997
Chi-square	181.54	94.220	99.716	87.262	93.839	89.254
d.f.	9	9	8	7	9	7
<u>GROUP CENTROIDS</u>						
GROUP 1	1.41828	1.48943	1.55575	1.38239	1.48429	-1.40831
GROUP 2	-1.41828	-1.48943	-1.55575	-1.38239	-1.48429	1.40831

Industries Correctly Classified As:	All Industries		Sample					
				1	2	3	4	5
Australian	(n=85)	80[a]	(n=42)	38[a]	35[a]	35[a]	36[a]	37[a]
Canadian	(n=85)	78[a]	(n=42)	36[a]	38[a]	39[a]	37[a]	38[a]
% Correctly Class.	(n=170)	92.9	(n=84)	88.1	86.9	88.1	86.9	89.3

Note: (a) χ^2 significant at 1 percent level.

The overall success rate was just over 92 percent (388 of 420 cases), compared with 87 percent for the function excluding the nominal protection variables.

(b) Effective protection

Table 4.2 incorporates the industry characteristics of Table 3.1 and ETRANS and ETARIFF, the components of total effective protection. Again, when compared with the first function of this section, the inclusion of elements of the respective barriers to trade increases the ability to accurately discriminate between Australian and Canadian manufacturing industries, though the increase is small. Overall, the ungrouped data are correctly classified in 88 percent of cases (369/420). The percentages of correct classifications for the individual experiments are all significant at the 1 percent level. However, the contributions of ETRANS and ETARIFF to the functions are relatively small, and of the two variables, ETRANS makes the greater contribution in each experiment.

5. A SUMMARY OF RESULTS

It has been shown that it is possible to discriminate with a high degree of accuracy between Australian and Canadian manufacturing industries on the basis of characteristics of industry structure and labour forces. In essence, there are significant differences in these two facets of the respective manufacturing industries. On the other hand, analysis of trade characteristics and the use of natural resources did not enable accurate discrimination between the two groups.

The findings of this paper suggest that, by comparison with Canada, firms in Australia are less diversified into activities other than their principal one, and are less specialised in production within their basic activity. Industries tend to be classified as Australian if they are characterised by high levels of industrial concentration and by a high proportion of small firms. While at first glance the juxtaposition may not seem obvious, it is indeed consistent with the existence of market structures consisting of many small firms dominated by a few large ones. Part of the explanation for the development of such industry characteristics may lie in the relative heights of internal transportation costs and the relative geographic dispersions of populations. Ceteris paribus, there is a tendency for a larger number of enterprises and/or establishments the higher are the former and the larger is the latter. A geographic concentration of a large proportion of the population in few centres, with the remainder widely dispersed may permit or encourage the development of an industry such that relatively few large enterprises/establishments may develop to serve the large markets, leaving small enterprises/establishments to serve small local markets. In Australia there is perhaps the most extreme example of the co-existence of areas of high density with a high average dispersion of population (though most of the population is concentrated around the coastal fringes). For example, 39 percent of the population dwells in Sydney and Melbourne, the major centres of manufacturing, while the average population density is 1.8 persons per square kilometre (Showers 1979, p. 225). In Canada the populations of Toronto and Montreal, the major manufacturing centres, together comprise 24 percent of the population, while a further 4 percent dwell in Vancouver. The overall population density is 2.3 persons per square kilometre, with a large majority dispersed in the area along the strip within 50 miles of the Canada-U.S. border (Showers 1979, p. 226). When compared with Australia, there is not only the tendency for the population to be more evenly spread in Canada, but also the likelihood many small Canadian population centres may have supplies more readily available from U.S. rather than Canadian sources.

Labour forces in Australian manufacturing are characterised by high levels of migrant and female participation. There is evidence that Australian firms carry a relatively high proportion of non-production employees, and it is likely that a relatively large proportion of these employees represent "middle management", holding responsibility for supervising routine operations rather than the higher paid echelons of management research staff who engage in non-routine activity. Both these findings, and most importantly the relatively high proportion of non-production workers characterised by Australian industries have their counterparts in the findings by West (1971), Spence (1977), and Oksanen and Williams (1978) in their studies of Canadian and U.S. industries. Those studies suggested that industries in Canada were characterised by high proportions of non-production workers, and this may be symptomatic of their inability to exploit managerial and administrative economies of scale available to their United States counterparts. The findings of this paper suggest that with respect to Canada, the same may be true of Australian industries.

Section 4 showed that a "composite" discriminant function incorporating variables reflecting a range of industry characteristics which, within a given set of attributes, made a relatively large contribution to group separation is, on average, able to predict correct group membership in approximately 87 percent of cases. When transport cost and tariff protection are added to the composite function, the ability to distinguish between Australian and Canadian industries improves and this suggests that differences in the protective structures contribute to the statistical separation of the two manufacturing sectors. The addition of nominal rates of protection to the function enables the prediction of correct group membership (on average) in 92 percent of cases, compared with 88 percent when effective rates are added to the function. In both sets of experiments international transport costs make a relatively greater contribution than tariffs. While the last result is not surprising in view of Australia's geographic isolation, it provides an incentive for further study of what has been a largely neglected influence on international trade flows.

The composite discriminant functions suggest that of the variables considered, ceteris paribus, the greater the diversity of the activities of Canadian firms (into other than their primary activity) and the higher proportion of migrants in Australian industry workforce and Australian industry's nominal transport cost protection contribute most to group separation. The results show that structure, employment and protection characteristics of similar industries differ significantly between Australia and Canada, and that such differences are not random. Indeed, the differences are systematic and show that the national origin of an industry can, with a high degree of accuracy, be determined from these characteristics.

Footnotes

[1]These circumstances may well provide a stimulus to foreign trade rather than domestic trade.

[2]Discussions of the relationship between geographical distance and transport costs may be found in Linneman (1966) and Geraci and Prevo (1977).

[3]The classification of the variables of this study into one or another of these categories tends to be arbitrary.

[4]The concordance will be provided by the author on request.

[5]The reporting period for the Australian Bureau of Statistics is 1 July to 30 June. The period for Statistics Canada is the calendar year.

[6]Mainly in the textiles, clothing and motor vehicle industries.

[7]The t-test for equality of means was not used as it relies on the equality of variances.

[8]The K-S two-sample test is concerned with the agreements between two sets of sample values:

> "If the two samples have in fact been drawn from the same population distribution, then the cumulative distributions of both samples may be expected to be fairly close to each other, inasmuch as they both should show only random deviations from the population distribution. If the sample cumulative distributions are 'too far apart' at any point, this suggests that the samples come from different populations" (Siegel, 1956, pp. 127-8).

[9]Reflected by the lower mean of INNOV in Canada than in Australia. See Oksanen and Williams (1978, p. 97).

[10]See Reitsma (1960) and Conlon (1978) for a discussion of the development of protection in Australia.

[11]International transport costs on material imports of course, act in the opposite direction.

[12]A full discussion of the structure of protection in Australia and Canada and of the definitions of the protection variables contained in Table 1.5 may be found in Conlon (1980), copies of which may be obtained from the author.

[13]In 1974, 70 percent of Canadian trade (both exports and imports) was with the U.S. (Economic Council of Canada, 1975, p. 98).

[14]An excellent discussion may be found in Reitsma (1960). See also Conlon (1978).

[15]For a more complete discussion, see Eisenbeis, 1977, pp. 876-87.

[16]It will be noted that there is the likelihood that some variables within a set of attributes will be highly correlated. However in discriminant analysis the problem of multicollinearity is not an important concern. In this respect, in his survey of the literature, Eisenbeis comments:

> "Some authors...exclude highly correlated variables because of their belief that 'multi-collinearity' was harmful. In fact, multi-collinearity is a sample property that is largely an irrelevant concern in discriminant analysis, except where the correlations are such that it is no longer possible to invert the dispersion matrices" (Eisenbeis, 1977, p. 883).

[17]Full tables will be provided by the author on request.

[18]It will be noted in the discriminant function tables that often there may be no discriminant function coefficient against one or more variables in the list of variables included in the analysis. This stems from the method of variable selection chosen for this study. Here variables have been entered stepwise so as to minimise Wilks' lambda, which is a measure of group discrimination. The entry criterion is the overall multivariate F ratio for the test of differences between the group centroids; the variable which maximises the F ratio also minimises Wilks' lambda. The test takes into consideration the differences between the centroids and the homogeneity of the groups. In the present case, a variable is considered for selection only if its partial multivariate F ratio is greater than one. The partial F ratio measures the discrimination introduced by the variable after taking into account the discrimination achieved by the other selected variables. Variables included using this criterion are then similarly tested for removal on the basis of their partial multivariate F which in this case must also be less than one for removal to occur. Variables have also been tested for tolerance levels: a low tolerance level indicates that the computer programme would have difficulty in inverting a covariance matrix which included this variable. If a variable with very low tolerance is used there are also likely to be large rounding errors in computing the discriminant function coefficients. The minimum tolerance level here is .001.

[19]The signs of the group centroids and of the coefficients of the variables may vary from experiment to experiment depending on which variables enter the function, and the order in which they are entered.

[20]Full results will again be produced by the author on request.

[21]For the three sets of composite functions discussed in section 4, MIGRPC makes the greatest relative contribution in fourteen of the total of eighteen experiments conducted. When these experiments were repeated omitting MIGRPC from the function the discriminatory power of the functions nevertheless remains significant. For all functions, chi-square is significant at the 1 percent level, while the ungrouped cases are correctly classified in the three sets of experiments in 80, 89 and 81 percent of cases, respectively. When compared with the corresponding sets of functions discussed in this section, the omission of MIGRPC reduces the discriminatory power by approximately 5 to 6 percent. Of the variables included in the sets of experiments, DIVRAT makes the greatest relative contribution in 16 of 18 experiments. Consistent with the later results of Section 4, in these experiments nominal rates of protection add more discriminatory power than effective rates, and transport cost protection (whether nominal or effective measures) makes a greater contribution to group separation than does the corresponding measure of tariff protection. For the set of experiments which includes nominal rates of protection, NTRANS makes the greatest relative contribution in two cases and is ranked second (after DIVRAT) in the remaining four.

APPENDIX 1

AUSTRALIA

DATA USED FOR DIRECT COMPARATIVE STUDY

VARIABLE	UNITS	DESCRIPTION
CONC8	Ratio	Estimated 8 firm concentration ratio, 1973-74 = ((VA1/4 73 + VA2/4 73)/VA73) x VA74)/VA74
DIVRAT	Ratio	Estimated diversification ratio, 1973-74. The ratio: value added of establishments classified to a different industry than that of the parent enterprise. To value added of all establishments of enterprises in the industry = DIVERS69/VA
ED1	%	Percentage of employees whose highest level of education is final year (years 11-12) high school, 1973-74 = (MATRIC/AVEMPL) x 100
ED2	%	Percentage of tertiary qualified employees, 1973-74 = (DEGREE/AVEMPL) x 100
EMP10	%	Percentage of establishments employing less than 10 persons 1972-73 = (EMPL10/ESTAB73) x 100
EMP20	%	Percentage of establishments employing less than 20 persons, 1972-73 = ((EMPL10 + EMPL1019)/ESTAB73) x 100
EMP50	%	Percentage of establishments employing less than 50 persons, 1972-73 = ((EMPL10 + EMPL1019) + EMPL2049 /ESTAB73) x 100
EMPLG	%	Percentage of establishments employing 100 persons or more, 1972-73 = (((ESTAB73 - (EMPL10 + EMPL1019 + EMPL2049 + EMPL5099))/ESTAB73) x 100
EMPENT	No.	Estimated employment per enterprise, 1973-74 = AVEMPL/ENTER
EMPEST	No.	Employment per establishment, 1973-74 = AVEMPL/ESTAB
ESTENT	No.	Average number of establishments per enterprise, 1972-73 = ESTAB73/ENTER73
ETARIFF	%	Effective tariff, f.o.b. 1974. See Conlon (1980) for details of computation (Source: I,J)
ETRANS	%	Effective transport cost, f.o.b., 1974. See Conlon (1980) for details of computation (Source: J)

VARIABLE	UNITS	DESCRIPTION
EXIMP	Ratio	Ratio: exports to imports, 1973-74 = EXP/IMP
EXIMPTO	Ratio	Ratio of exports - imports to turnover (shipments), 1973-74 = (EXP-IMP)/TOVER
EXTO	Prop'n	Proportion of exports to turnover (shipments), 1973-74 = EXP/TOVER
FEMP	Prop'n	Proportion of females of total employees, 1973-74 = FEMPL/AVEMPL
FEPROD	Prop'n	Proportion of female production workers of total employees, 1973-74 = FEMPROD/AVEMPL
FMIGRPC	%	Percentage of female employees born overseas in total female employment, 1973-74 = (FMIGRAN/FEMPL) x 100
FPROD	Prop'n	Proportion of female production workers of total female employment, 1973-74 = FEMPROD/(FEMPROD + FEMPAD)
FUELINT	Prop'n	Fuel intensity, 1973-74 = ELECFUEL/MATERIAL
IMPTO	Ratio	Ratio of imports to turnover (shipments), 1973-74 = IMP/TOVER
INNOV	Ratio	Indicator of innovative activity (see Oksanen and Williams, 1978). Ratio of average wages of production employees to average wages and salaries of all employees, 1973-74 = (WSPROD/PRODEMP)/(WSAL/AVEMPL)
INTRA	Index	Intra-industry trade, 1973-74 = ((EXP + IMP) - |EXP - IMP|)/(EXP + IMP) x 100
INTSPEC	Ratio	Intra-industry specialization (see Oksanen and Williams, 1978). Ratio of value added to turnover (shipments), 1973-74 = VA/TOVER
LABINT	Prop'n	Labour intensity, 1973-74 = WSAL/VA
MIGRPC	%	Percentage of employees from overseas, 1973-74 = (MIGRAN/AVEMPL) x 100
NATRES1	Prop'n	Replenishable natural resource intensity = REPLEN69/INPUT69
NATRES2	Prop'n	Nonreplenishable natural resource intensity = NREPLEN69/INPUT69
NATRES3	Prop'n	Total resource intensity (REPLEN69 + NREPLEN69)/INPUT 69

VARIABLE	UNITS	DESCRIPTION
NTARIFF	%	Nominal tariff, f.o.b., 1974. See Conlon (1980) for details of computation (Sources: I,J)
NTRANS	%	Nominal transport cost, f.o.b., 1974. See Conlon (1980) for details of computation (Source: J)
PEMPPC	%	Percentage of production employees of total employment, June 1974 = (PRODEMP/EMPL) x 100
PRODEST	Prop'n	Measure of scale (see Oksanen and Williams, 1978). Production employment per establishment, June 1974 = (PRODEMP/ESTAB)
RMES50	Prop'n	Relative MES50 = MES50/VA
SMALLE	Prop'n	Number of small enterprises as a proportion of the total number of enterprises in the industry, 1973-74. Small enterprises are those which produce the lower 50 percent of value added of the industry, when all firms are ranked according to size (Source: D)
TRADBAL	Prop'n	Trade balance, 1973-74 = (EXP - IMP)/(EXP + IMP)
WSPROD	$'000	Wages and salaries per production worker, 1973-74 = WSPROD/PRODEMP

AUSTRALIA

BASIC DATA AND SOURCES

VARIABLE	UNITS	DESCRIPTION	SOURCE
AVEMPL	No.	Average total employment, 1973-74	L
DEGREE	No.	Estimated tertiary qualified employees, 1973-74 = (Proportion of tertiary qualified employees, 1971) x AVEMPL	C,I
DIVERS69	Prop'n	Diversification ratio, 1968-69. The ratio: value added of establishments classified to a different industry than that of the parent enterprise to value added of all establishments of enterprises in the industry.	B
ELECFUEL	$'000	Value of electricity and fuels purchased and transferred in 1973-74	G

VARIABLE	UNITS	DESCRIPTION	SOURCE
EMPL10	No.	Establishments employing less than 10 persons, 1972-73	E
EMPL1019	No.	Establishments employing 10-19 persons, 1972-73	E
EMPL2049	No.	Establishments employing 20-49 persons, 1972-73	E
EMPL5099	No.	Establishments employing 50-99 persons, 1972-73	E
EMPL71	No.	Total employees, end June, 1971	C
EMPL	No.	Total employment, end June, 1974	G
ENG71	No.	Engineers employed, end June, 1971	C
ENTER73	No.	Enterprises, 1972-73	F
ENTER	No.	Estimated number of enterprises, 1973-74 = (ENTER73/ESTAB73) x ESTAB	F,G
ESTAB73	No.	Establishments, 1972-73	F,L
ESTAB	No.	Establishments, 1973-74	G
EXP	$'000	Exports, 1973-74	L
FEMP	No.	Total females employed, end June, 1974	G
FEMPL	No.	Average female employment, 1973-74	L
FMIGRAN	No.	Estimated number of female employees born overseas, 1973-74 = (FMIGRN71/100) x FEMPL	H,L
FMIGRN71	%	Percentage of female employees born overseas, end June, 1971	H
FEMPROD	No.	Female production employees, end June, 1974	G
IMP	$'000	Imports, 1973-74	L
INPUT69	$'000	Value of total inputs, 1968-69. Concordance between input-output commodity classification and the industrial classification used in this study will be provided by the author on request.	A

VARIABLE	UNITS	DESCRIPTION	SOURCE
MATERIAL	$'000	Value of materials, components and supplies, purchases transferred in 1973-74	G
MATRIC	No.	Estimated number of employees whose highest level of education is year 11-12 high school, 1973-74 = (Proportion of employees whose highest level of education is final year high school, 1971) x AVEMPL	H,L
MES50	$'000	Minimum efficient size. See Parry (1977). Average value added of the largest firms producing 50 percent of the industry's value added, 1973-74	D
MIGRAN	No.	Estimated number of employees born overseas, 1973-74 = (MIGRAN 71/100) x AVEMP	H,L
MIGRAN71	%	Percentage of employees born overseas, 1971	H
NREPLEN69	$'000	Value of nonreplenishable resource inputs, 1968-69 = total value of Australian input-output commodities, 11.02, 12.14 used	A
PRODEMP	No.	Total production employees, end June, 1974	G
REPLEN69	$'000	Value of replenishable resource inputs, 1968-69 = total value of Australian input-output commodities 01, 03, 04 used.	A
TOVER	$'000	Turnover, 1973-74	G
VA73	$'000	Value-added, 1972-73	D,F
VA1/473	$'000	Value added - first four largest enterprises, 1972-73	D
VA2/473	$'000	Value added - second four largest enterprises, 1972-73	D
VA	$'000	Value added, 1973-74	L
WSAL	$'000	Total wages and salaries, 1973-74	L
WSPROD	$'000	Wages and salaries paid to production and all other workers, 1973-74	G

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APPENDIX 2

CANADA

DATA USED FOR DIRECT COMPARATIVE STUDY

VARIABLE	UNITS	DESCRIPTION
CONC8	Ratio	8 firm concentration ratio, 1974 = (VA1/4 + VA2/4)/VA.
DIVRAT	Ratio	Diversification ratio, 1974. The ratio: value added of establishments classified to a different industry than that of the parent enterprise <u>to</u> value added of all establishment of enterprises in the industry = DIVERS/VA.
ED1	%	Percentage of employees whose highest level of education is final year (grade 12 or 13) high school, 1971 = ((MATRICF71 + MATRICM71)/(EMPM71 + FEMP71)) x 100.
ED2	%	Percentage of tertiary qualified employees, 1971 = ((DEGREEM + DEGREEF)/(EMPM71 + FEMP71)) x 100.
EMP10	%	Percentage of establishments employing less than 10 persons, 1974 = (EMPL10/ESTAB) x 100.
EMP20	%	Percentage of establishments employing less than 20 persons, 1974 = ((EMPL10 + EMPL1019)/ESTAB) x 100.
EMP50	%	Percentage of establishments employing less than 50 persons, 1974 = ((EMPL10 + EMPL1019 + EMPL2049) /ESTAB) x 100.
EMPLG	%	Percentage of establishments employing 100 persons or more, 1974 = (((ESTAB - (EMPL10 + EMPL1019 + EMPL2049 + EMPL5099))/ESTAB) x 100.
EMPENT	No.	Employment per enterprise, 1974 = AVEMPL/ENTER
EMPEST	No.	Employment per establishment, 1974 = AVEMPL/ESTAB
ESTENT	No.	Average number of establishments per enterprise, 1974 = ESTAB/ENTER
ETARIFF	%	Effective tariff, f.o.b., 1974. See Conlon (1980) for details of computation (Source: H)
ETRANS	%	Effective transport costs, f.o.b., 1974. See Conlon (1980) for details of computation (Source: H)

VARIABLE	UNITS	DESCRIPTION
EXIMP	Ratio	Ratio: exports to imports, 1974 = EXP/IMP
EXIMPTO	Ratio	Ratio of exports - imports to shipments (turnover), 1974 = (EXP - IMP)/SHIP
EXTO	Prop'n	Proportion of exports to shipments (turnover), 1974 = EXP/SHIP
FEMP	Prop'n	Proportion of females of total employees, 1974 = (FEMPROD + FEMPAD)/AVEMPL
FEPROD	Prop'n	Proportion of female production workers of total employees, 1974 = FEMPROD/AVEMPL
FMIGRPC	%	Percentage of female employees born overseas in total female employment - 3 digit, 1971 = (FMIGRAN71/FEMP71) x 100
FPROD	Prop'n	Proportion of female production workers of total female employment, 1974 = FEMPROD/(FEMPROD + FEMPAD)
FUELINT	Prop'n	Fuel intensity, 1974 = ELECTFUEL/MATERIAL
IMPTO	Ratio	Ratio of imports to shipments (turnover), 1974 = IMP/SHIP
INNOV	Ratio	Innovative activity (see Oksanen and Williams, 1978). Ratio of average wages of production employees to average wages and salaries of all employees, 1974 = (WSALPROD/(MPROD + FEMPROD))/((WSALPROD + WSALADM) /AVEMPL)
INTRA	Index	Intra-industry trade, 1974 = ((EXP + IMP) - |EXP - IMP|) /(EXP + IMP)) x 100.
INTSPEC	Ratio	Intra-industry specialization (see Oksanen and Williams, 1978). Ratio of value added to shipments (turnover), 1974 = VA/SHIP.
LABINT	Prop'n	Labour intensity, 1974 = WSAL/VA
MES50	$'000	Minimum efficient size. Average value added of the largest firms producing 50 percent of the industry's value added, 1974.
MIGRPC	%	Percentage of employees born overseas - 3 digit, 1971 = ((MMIGRAN71 + FMIGRAN71)/EMPM71 + FEMP71)) x 100.

VARIABLE	UNITS	DESCRIPTION
NATRES1	Prop'n	Replenishable natural resource intensity = REPLEN/INPUT
NATRES2	Prop'n	Nonreplenishable natural resource intensity = NREPLEN/INPUT
NATRES3	Prop'n	Total resource intensity = (REPLEN + NREPLEN)/INPUT
NTARIFF	%	Nominal tariff, f.o.b., 1974. See Conlon (1980) for details of computation. (Source: H)
NTRANS	%	Nominal transport cost, f.o.b., 1974. See Conlon (1980) for details of computation. (Source: H)
PEMPPC	%	Percentage of production employees of total employment, 1974 = ((MPROD + FEMPROD)/AVEMPL) x 100
PRODEST	Prop'n	Measure of scale (see Oksanen and Williams, 1978). Production employment per establishment, 1974 = (MPROD + FEMPROD)/ESTAB
RMES50	Prop'n	Relative MES50 = MES50/VA
SMALLE	Prop'n	Number of small enterprises as a proportion of the total number of enterprises in the industry, 1974. Small enterprises are those which produce the lower 50 percent of value added of the industry, when all firms are ranked according to size.
TRADBAL	Prop'n	Trade balance, 1974 = (EXP - IMP)/(EXP + IMP)
WSPROD	$'000	Wages and salaries per production worker, 1974 = WSALPROD/(MPROD + FEMPROD)

CANADA

BASIC DATA AND SOURCES

VARIABLE	UNITS	DESCRIPTION	SOURCE
AVEMPL	No.	Average total employment, 1974	G
DEGREEF71	No.	Number of female employees with University degrees, 1971	A
DEGREEM71	No.	Number of male employees with University degrees, 1971	A
DIVERS	$'000	Value added of diversified firms, 1974 = (1 - SPEC) x VA	D
ELECTFUEL	$'000	Cost of fuel and electricity used, 1974	G

VARIABLE	UNITS	DESCRIPTION	SOURCE
EMPL10	No.	Establishments employing less than 10 persons, 1974	F
EMPL1019	No.	Establishments employing 10-19 persons, 1974	F
EMPL2049	No.	Establishments employing 20-49 persons, 1974	F
EMPL5099	No.	Establishments employing 50-99 persons, 1974	F
EMPM71	No.	Employment, males, 1971	B
ENTER	No.	Enterprises, 1974	D
ESTAB	No.	Establishments, 1974	G
EXP	$'000	Exports, 1974	C
FEMP71	No.	Employment, females, 1971	B
FEMPAD	$'000	Administrative employees - female, 1974	G
FEMPROD	No.	Production workers - female, 1974	G
FMIGRAN71	No.	Number of female employees born overseas, 1971	B
IMP	$'000	Imports, 1974	C
INPUT	$'000	Value of total inputs, 1974	E
MATERIAL	$'000	Cost of materials, 1974	G
MATRICF71	No.	Number of female employees whose highest level of education is Grade 12 or 13, 1971	A
MATRICM71	No.	Number of male employees whose highest level of education is Grade 12 or 13, 1971	A
MMIGRAN71	No.	Number of male employees born overseas, 1971	B
MPROD	No.	Production workers, male, 1974	G

VARIABLE	UNITS	DESCRIPTION	SOURCE
NREPLEN	$'000	Value of nonreplenishable resource inputs, 1974 = total value of Canadian input-output commodities 031000 to 05000 used	E
REPLEN	$'000	Value of replenishable resource inputs, 1974 = total value of Canadian input-output commodities 00100 to 03000 used	E
SHIP	$'000	Value of total shipments, 1974	G
SPEC	Ratio	Enterprise specialization ratio, 1974	D
VA	$'000	Total value added, 1974	G
VA1/4	$'000	Value added - first four largest enterprises, 1974	D
VA2/4	$'000	Value added - second four largest enterprises, 1974	D
WSAL	$'000	Total wages and salaries, 1974	G
WSALADM	$'000	Administrative salaries, 1974	G
WSALPROD	$'000	Wages and salaries paid to production workers, 1974	G

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