Technological Innovation Studies Program

Research Report

THE RELATIONSHIP EXISTING BETWEEN THE R & D ACTIVITY OF CANADIAN MANUFACTURING INDUSTRIES AND THEIR PERFORMANCE IN THE INTERNATIONAL MARKET

by

Petr Hanel

Department of Economics
University of Sherbrooke
August, 1976.

Rapport de recherche

Programme des études sur les innovations techniques

Industry, Trade and Commerce
Industrie et Commerce

Office of Science and Technology
Ottawa, Canada
Direction des sciences et de la technologie
Ottawa, Canada

THE RELATIONSHIP EXISTING BETWEEN THE R & D ACTIVITY OF CANADIAN MANUFACTURING INDUSTRIES AND THEIR PERFORMANCE IN THE INTERNATIONAL MARKET

by

Petr Hanel

Department of Economics
University of Sherbrooke

August, 1976.

ACKNOWLEDGEMENTS

The work on this study was made possible by the grant from the Office of Science and Technology, Department of Industry, Trade and Commerce. I am endebted to several persons for providing information and data. My particular thanks are expressed to Mr. G. Westholm of the Directorate for Science and Technology and Industry, OECD, Paris, for information on R & D data, to Mr. R. D. Belli, of the U.S. Department of Commerce for information and data on sales of U.S. Affiliates abroad and finally to Mr. J. Nols of the Office Statistique des Communautées Européennes for clarifications concerning CEE Input Output tables.

The most tedious work, the compilation of data, is the result of the collective effort of my assistants: Mr. Jules Dufort, Mr. Truong Thien and Mr. Paul Guevremont; Mr. Paul Guevremont is also given credit for the computer work for the first part of the study. The programming assistance necessary for the second part of the study was given by Mr. Jean-Marie St.Pierre.

I am grateful to Mrs. Dominique Davies, who read the whole text and corrected my English.

My thanks are extended to several anonymous critics who indicated some inconsistencies in the first draft of this study.

Despite all this help, the study doubtless has shortcomings for which I am solely responsible.

TABLE OF CONTENTS

''''''''''

LIST OF TABLES

EXECUTIVE SUMMARY

The objective of the study is to analyze the role of the R&D effort in the export performance of Canadian manufacturing industries. The approach is comparative; observations for manufacturing exports of eight other industrialized countries are analyzed at the same time. [1] Although it is recognized that a break-down of industries to a very low level of agregation would be very desirable for this type of analysis, the scarce data for R&D and industrial production did not allow the definition of more than fourteen (14) two and three digit groups of manufacturing industries. [2]

The study is divided in two independent parts. In the first, several indices of export performance are calculated for 1969 and related through multiple regression analysis to a set of explanatory variables measured with a two-year lead (1967). The exports of Canadian manufacturing industries are positively correlated with their R&D effort and labour productivity. An increase of the foreign (U.S.) control not accompanied by an increase of research intensity and/or increase of labour productivity worsens the export performance. Also, the more protected an industry, the lower its export performance.

A comparison of Canadian exports to European OECD countries with exports to the rest of the world outside the OECD indicates that for a given share of R&D, an industry's share of exports to the rest of the world is higher than its share of exports to the European OECD countries.

---

1 Included in the sample were: Canada, U.S., Japan, Belgium, Germany, France, Italy, Great Britain, Sweden.

2 The industries are: food and beverage, textiles, clothing, wood products, paper, petroleum products, chemicals, rubber, non-metallic minerals, primary metals, metal products, machinery, electrical equipment, transport equipment except aircraft.

SOMMAIRE ADMINISTRATIF

Cette étude a pour but d'analyser le rôle de l'activité R et D dans les exportations des industries manufacturières canadiennes. Il s'agit d'une méthode comparative: on analyse en même temps les exportations de produits fabriqués de huit autres pays industrialisés.[1] Nous reconnaissons que dans ce genre d'analyse, une ventilation plus détaillée des industries aurait été souhaitable, mais la rareté des données R et D et de production industrielle n'a pas permis de définir plus de quatorze (14) groupes d'industries manufacturières composés chacun de 10 ou de 100 entreprises.[2]

L'étude est divisée en deux parties distinctes. Dans la première, plusieurs indices d'exportation sont calculés pour 1969 et reliés, au moyen d'une analyse à régression multiple, à une série de variables explicatives mesurées avec une avance de deux ans (1967). Les exportations des industries manufacturières canadiennes sont mises en corrélation positive avec leur activité R et D et la productivité de leur main-d'oeuvre. Une augmentation de la mainmise étrangère (E.-U.) non accompagnée d'une intensification des recherches et (ou) d'une hausse de la productivité de la main-d'oeuvre réduit forcément les exportations. Par ailleurs, plus une industrie est protégée, moins ses exportations sont élevées.

Si l'on compare les exportations canadiennes vers les pays européens de l'OCDE et ses exportations au reste du monde, on s'aperçoit qu'en ce qui concerne la R et D, la fraction des exportations au reste du monde est plus élevée que celle vers les pays européens de l'OCDE.

---

1 L'échantillon comprenait: le Canada, les Etats-Unis, le Japon, la Belgique, l'Allemagne, la France, l'Italie, la Grande-Bretagne, la Suède.

2 Les industries sont: aliments et boissons, textiles, vêtements, produits du bois, papier, produits pétroliers, produits chimiques, caoutchouc, minéraux non métalliques, métaux primaires, produits métalliques, machines, matériel électrique, matériel de transport sauf les avions.

An analysis of exports to the U.S. market indicated that the share of the U.S. manufacturing imports is for most countries of the sample (except Japan and France) positively related to the share a given national industry has in the total R&D expenditures of the same industry across the sample of nine countries. The comparative advantage expressed as the higher labour productivity and/or lower unit wages of the exporting industry compared to the importing U.S. industry contributed to the explanation together with the negative influence of the tariff protection and distance. The U.S. foreign control had a negligible influence on Canadian exports to the U.S.

In the bilateral trade between Canada and the U.S., the higher the relative intensity of R&D in the Canadian industry compared to the American one, the better the Canadian balance of commerce in the given industry.

Thus it is possible to conclude that the pattern of Canadian manufacturing exports and imports is closely associated with the level of R&D effort in each industry. The level of R&D effort in an industry is better measured by the share of the total R&D effort in the given industry across the sample than by the various relative measures such as R&D per sales or per employee. The wage rate and labour productivity in the Canadian compared to the U.S. industry, complement in the expected way the explanation of the trade in manufactured goods between Canada and the United States.

In the second part of the study the change in Canadian manufacturing exports from 1963 to 1971 was found to be mainly a result of the increase in the world demand for exports. All so-called "high technology" industries (except the special case, the transport equipment industry) experienced a decrease of their export's competitiveness; their exports increased less than the world demand for them.

D'une analyse des exportations au marché américain, il a ressorti que le pourcentage des importations américaines de produits fabriqués est, pour la plupart des pays de l'échantillon (sauf le Japon et la France), directement reliée à la fraction que consacre au R & D une industrie nationale donnée et cela pour les neuf pays de l'échantillon. L'avantage en termes de "plus forte productivité de la main-d'oeuvre" et (ou) de "plus faible unité salariale" de l'industrie exportatrice par rapport à celles de l'industrie importatrice américaine contribue à expliquer ce fait ainsi que l'influence négative de la protection douanière et de la distance. Le contrôle américain des entreprise à l'étranger n'influe guère sur les exportations canadiennes vers les Etats-Unis.

Dans le commerce bilatéral entre le Canada et les Etats-Unis, plus l'intensité relative de l'activité R et D dans l'industrie canadienne est élevée en comparaison de l'industrie américaine, plus la balance commerciale du Canada est favorable dans l'industrie en question.

On peut donc conclure que le tableau des exportations et des importations manufacturières du Canada est étroitement relié à l'effort R et D dans chaque industrie. Son niveau dans une industrie donnée est mesuré plus exactement par le pourcentage de l'effort R et D dans l'industrie donnée pour tous les pays de l'échantillon, que par les diverses mesures relatives telles que l'effort R et D par vente ou par employé. Le taux de salaire et la productivité de la main-d'oeuvre de l'industrie canadienne au regard de ceux de l'industrie américaine complètent, comme on peut s'y attendre, l'explication de la situation des échanges de produits manufacturés entre le Canada et les Etats-Unis.

Dans la deuxième partie de l'étude, on a constaté que l'évolution des exportations manufacturières du Canada de 1963 à 1971 résultait surtout de l'augmentation de la demande mondiale d'exportations. Toutes les industries dites de grande technicité (sauf un cas spécial: le secteur du matériel de transport) ont vu fléchir la compétitivité de leurs exportations, qui ont augmenté plus lentement que la demande mondiale.

The changes in R&D expenditures were also decomposed in order to isolate the effect of the competitive change. The Canadian manufacturing sector exhibited a positive competitive increase of R&D expenditures in the order of nine percent. R&D expenditures of nine industries experienced a competitive increase. The changes in the price competitiveness of manufacturing exports were measured by an index of unit labour costs, which improved in most of the "low technology" industries.

The analysis of changes in exports, R&D and in price level of thirteen Canadian manufacturing industries identified the influence of competitive changes in prices and R&D on the competitive change of exports. Predictably, the competitive change of exports by the "high technology" industries appeared to be influenced more by changes in R&D than by changes in relative prices. On the other hand, the remaining "low technology" industries appeared to rely on price changes rather than on technological competition. Although most Canadian industries recorded an increase of their R&D competitiveness, the increase was not sufficient to reverse the unfavourable effects of price increases and of other undetermined factors and the Canadian manufacturing sector suffered an overall loss in its export competitiveness.

Analysis of the growth of total manufacturing exports of nine countries again demonstrated that the competitive changes in exports are better explained by changes in both R&D and prices than by price changes only. The estimated coefficients, however, appeared very sensitive to changes in specification of the period of observation.

The results of the analysis of export changes as function of price and R&D changes support, on the one hand, the importance of R&D factor in trade but, on the other hand, the unstable and not always statistically significant results call for caution in quantitative interpretation of the estimated coefficients.

L'évolution des dépenses consenties à l'activité R et D a été décomposée, elle aussi, pour isoler l'effet de l'évolution de la compétitivité. Le secteur manufacturier canadien a affiché une hausse positive de la compétitivité des dépenses R et D de l'ordre de 9%. Les dépenses R et D de neuf industries ont accusé une hausse compétitive. Les changements de compétitivité des exportations manufacturières sur le plan des prix ont été mesurés par un indice des coûts unitaires de la main-d'oeuvre, qui se sont améliorés dans la plupart des industries à basse technologie.

L'analyse de l'évolution des exportations, de l'effort R et D et du niveau des prix chez 13 industries manufacturières canadiennes a expliqué l'influence de l'évolution de la compétitivité en fait de prix et de R et D sur la situation compétitive des exportations. Comme on pouvait s'y attendre, l'évolution de la compétitivité des exportations chez les industries à haute technologie "semble subir davantage l'influence de l'effort R et D que celle des changements de prix. Par contre, les autres industries à "basse technologie" semblaient compter sur les changements de prix plutôt que sur la compétitivité technologique. Bien que la plupart des industries canadiennes aient noté une compétitivité accrue du côté R et D, elle ne suffisait pas à annuler les effets défavorables des hausses de prix et d'autres facteurs non déterminés, et le secteur manufacturier canadien a essuyé une perte générale de compétitivité à l'exportation.

L'analyse de la croissance des exportations manufacturières totales de neuf pays a démontré une fois de plus que la situation compétitive des exportations s'explique mieux par les changements dans l'effort R et D et dans les prix combinés que par les changements de prix considérés isolément. Cependant, les coefficients estimatifs semblaient très sensibles aux changements de spécifications durant la période d'observation.

Les résultats de l'analyse de l'évolution des exportations en fonction de l'évolution des prix et de l'activité R et D étayent d'une part l'importance du facteur R et D dans le commerce mais, d'autre part, les résultats instables et pas toujours significatifs au point de vue statistique exhortent à la prudence dans l'interprétation quantitative des coefficients estimatifs.

PART ONE

I INTRODUCTION

The first part of the study analyzes the determinants of the export performance of a selected group of manufacturing industries from Canada and from the eight other most industrialized countries of the world. Its object is to define which economic characteristics best explain trade pattern at one particular point in time, the year 1969. After a brief discussion on the concept of export performance, the study specifies several simple relationships which exist between the latter concept and the explanatory variables. By using the multiple regression technique to estimate these relationships, it is possible to establish how the different variables, including the R & D effort, are related to the export performance of a given industry. Due to the comparative aspect of the study, the analysis is not limited to Canadian manufacturing industries: the total sample of manufacturing industries of all nine countries will be analyzed first, followed by a more detailed analysis of the subsamples of the manufacturing industries of each country.

To allow for the possibility that the export performance determinants may be related, to a certain degree, to the economic character of the export markets, several broad market areas of special interest to canadian exports are examined. The total exports of one industry towards the world market are analyzed first. Next, the study looks at these exports towards the subset of less developed countries excluded from the OECD group and then towards the market of European member countries of OECD. Due to the overwhelming importance of the US market for both Canadian and foreign exports,the analysis of the export flow towards the US market is complemented by an attempt to analyse the bilateral trade between the US and Canada.

The comparison of regressions estimated for individual countries will permit the identification of those economic characteristics which are related to the export performance and to the comparative advantage of the manufacturing industries of each country. At the same time, it will be possible to assess the validity of the hypothesis claiming that one of the most important, if not the most important factor in determining the export performance is the technological effort of manufacturing industries.

The second part of the study concentrates on changes in the trade structure of the nine countries over a period of time. It is an attempt to identify the various causes underlying the observed changes in the competitiveness, as well as in the commodity and market structures of exports of each of the nine countries. The technique used for this purpose, the constant market share analysis, makes it possible to identify which part of the change is related to the change in the demand conditions facing each country's exports. The remainder of the changes in exports is then attributed to the improvement or deterioration of the exporting country's capacity to compete and must therefore be a function of the supply characteristics of the exporting country.

This analytical framework was used in several studies and lead to an attempt to correlate the residual change of the market share (the change in the competitiveness) with changes in the exporting country's price level relative to its competitors on the given market. The theoretically expected, and to a certain extent empirically confirmed, relationship is that a decrease in prices will improve the market share of a country's exports. However in the world of differentiated, technologically progressive products, low price is only one, and not necessarily the most important element of competitive strength.

Many commodities exported by manufacturing industries are characterised by a high level of product differentiation and a high content of R & D effort, it is therefore logical to expect that a measure of the change in the R & D input, together with the relative price changes, will provide a better explanation of the change in market shares than the price change only. Furthermore, those two explanatory variables will help us to identify which of the manufacturing industries seem to be more price competitive and which depend on technological advance for their competitiveness.

This analytical framework will again be used for Canada and its competitors for a period of eight years, 1963-1971. As exports respond to changes in economic variables, specially in R & D effort, with a certain lag, the study will specify an appropriate lag structure.

Export performance

The concept of export performance is a rather elusive one and lends itself to several interpretations. If we are interested in the export performance of an industry we may relate the value of its exports either to the total sales or employment of the industry or alternatively, to the value of all manufactured exports of the country. Obviously, the two measures may be highly correlated but they are not identical and both may provide different insights. From the point of view of the balance of payments, a measure relating the exports of an industry's products to its imports may be useful. All these "country specific" measures of export performance can be expected to be a function of the economic characteristics of the industries that generate the exports, "a", of trade barriers, "b", and in the case of bilateral trade also a function of the economic characteristics of the industries of the importing country, "c".

Symbolically written:

$EX = f(a,b,c)$

Where EX is one of the following "country specific" measures of export performance:

$(EX_{AW} / SA_A)_I$, $(EX_{AW} / EM_A)_I$, $(EX_{AW} / EXT_{AW})_I$, and
$(EX_{AB} / EX_{BA})_I$

$EX_{AB,I}$ ... Value of exports from country "A" to area (country), "B" in products of industry "I";

EXT_{AB} ... Value of total exports of country "A" to area "B";

A ... Country of origin: (A = CAnada, US, JApan, BELgium, GErmany, FRance, ITaly, UK, SWeden); [1]

B ... Area (country) of destination: (B = W, World; W - OECD, World except OECD; OECD-EU; EEC; EFTA; US; JApan; CAnada);

1. To facilitate the notation, the first two letters indicating the area of origin or the destination are printed with capital letters for countries and as follows for European Economic Community, EEC, European Free Trade Area, EFTA, countries of Organization for Economic Cooperation and Development, OECD and all countries of the world, W.

I ... Manufacturing industry: (I = 1, ..., 14) (Given the internationally comparable data on industrial production and R & D, the break-down to 14 industries represents the lowest possible level of aggregation. See Appendix A for definitions and details);

$SA_{A,I}$ ... Value of sales of the industry "I" in country "A";

$EM_{A,I}$ ... Total employment of the industry "I" in country "A".

For an international comparison it is possible to develop several revealing measures of export performance based on models of international trade flows. [2] One of them is the degree of specialization in exports, S_{AI}, of a country "A" in products of industry "I".

$$S_{A,I} = \frac{(EX_{AW} / EXT_{AW})I}{(EX_{T,I} / EX_{T,T})}, \quad \text{where: } EX_{T,I} = \sum_{A = CA}^{SW} EX_{A,W,I} \quad \text{and}$$

$$EX_{TT} = \sum_{I=1}^{N} EX_{T,I}$$

$$N = (1...14)$$

For example, if $S_{CAnada, paper} > 1$, then it simply means that Canada exports the products of its paper industry more intensively than the rest of the world. In other words, the share of paper exports as a percentage of total Canadian exports is higher than the share of paper exports in the world exports. However, it can be also interpreted as a situation where the share of the Canadian paper industry's exports in the world's paper exports exceeds the share that Canada's combined manufacturing exports have in the combined manufacturing exports of the world.

2. See Nappi (1974) and Leamer and Stern (1970) for detailed discussion.

The set of indices S_{AI} for all industries may be considered as a proxy for the comparative advantage of country A. [3]

It is possible to construct an analogical index of specialization in imports. [4]

Finally, the intensity of exports between two countries with respect to their commodity structure is quantified by calculating an export performance index, [5] $E_{AB,I}$.

$$E_{A,B,I} = \frac{EX_{AB,I}}{EXT_{AW}} \Big/ \frac{EX_{T,I}}{EX_{T,T}}$$

The values of the indices of export performance introduced above are calculated for all industries of the countries of our sample in Appendix B, and are briefly discussed in the next chapter.

What determines the value of S_{AI} for an industry of a particular country? Again it will be a set of economic characteristics of the industry and country of origin and of trade barriers but, in contrast with the explanatory variables influencing the "country specific" measures of export performance, the explanatory variables of S_{AI} must be related to a world standard, whenever possible. Thus S_{AI} is expected to be, in general, a function:

---

3. This was the interpretation used by Balassa (1965), and Yamazawa (1970).
4. Instead of relating the exports, we relate the import structure of country A to that of the sample of industrialized countries.
   $R_{A,I} = (IM_{WA} / IMT_{WA})_I / IM_{T,I} / IM_{T,I})$, where $IM_{BA,I}$ is the value of A's imports of products of I's industry from area B.
5. Balassa, op. cit.

$S_{AI} = g(\bar{a}, \bar{b})$, where $\bar{a}$, $\bar{b}$ stand respectively for the economic characteristics and trade barriers expressed in an index form following as closely as possible the logic of the construction of the index S_{AI}, in order to relate the variable concerning an industry of country A relative to its competitors (the standard of reference "the world" being either the rest of the industrialized countries of the sample or actually the "world" itself).

Explanatory variables

Before starting the description of the explanatory variables, one distinctive aspect of the study must be stressed. In contrast to works of similar nature,[6] the values of all industry characteristics used throughout this study are actual values of the characteristics of respective national industries; they are not imputed from US industry data. This frees the study of a very restrictive and unacceptable assumption underlying the above mentionned studies. All assume that the relative factor intensity and factor utilization are the same in different countries.[7] The selection of industry characteristics, which are supposed to be associated with the measure of export performance, was based on theoretical considerations as well as on the results of some recent studies of a similar nature. The following paragraphs concentrate on the variables explaining the "country specific" export performance measures.

7. Those familiar with the Heckscher-Ohlin (H-O) theory of trade will recognize it as one of the key assumptions of the H-O model. We shall return to the unsuitability of the H-O framework for our study later.
6. C.f. Vernon (1970), Wilkinson (1968), Keesing (1967) and others.

From the theoretical point of view, without going into unnecessary details, the following points are worth mentioning. A cross-section analysis of trade flows represents a general equilibrium approach and leads to an explanation of trade by factors affecting the demand for and the supply of a particular traded product. Thus, although demand and supply are both functions of price (among other variables), the market clearing quantity, which in this context is the observed value of exports, is then not a function of the price. [8] Therefore, in a general equilibrium situation, the explanatory variables should not include a price variable. However, to the extent that the observed variables do not reflect an equilibrium situation, it is possible that, for instance, high prices offer a proper explanation for low exports. Temporary disequilibria are likely to exists on the labour market, especially in the group of several manufacturing industries that are analyzed. A wage cost variable, the total wage bill of the exporting industry as per its total employment was tried but due to its overall poor statistical performance, it was eventually excluded from some regressions. [9]

The textbooks on foreign trade offer two general models as an explanation of the commodity composition of trade, our main concern. In

---

8. This point is well explained by Leamer and Stern, op. cit., p. 146. Consider the demand function for exports $q^D = f(p, D_1,...D_n)$ and the supply function for exports $q^S = g(p, S_1,...S)$. The first indicates that quantity demanded depends on price and demand factors and the second, that quantity supplied depends on price and supply factors. The market clearing quantity, which is the observed quantity, is then solved as $q = q^S = q^D = (D_1...D_n, S_1...S_n)$.

9. In fact, it was not excluded completely. Wages per unit of output (value added), the efficiency wage, WA/VA, is one of the explanatory variables in the function for EX/EXT. Wage cost variable was also used in the analysis of bilateral commerce with the U.S.

the Ricardian world the differences in technology, and resulting differences in relative labour productivity, determine which products are exported. In the more sophisticated, but not necessarily more realistic, model of Hecksher and Ohlin (H-O), technology is the same everywhere and the trade structure is a result of the relative abundance and shortage of the factors of production. In spite of some ingenious attempts to integrate the R & D effort and technology in general, as a special form of investment and accumulation of human capital, into the H-O model,[10] its basic assumption of a universal access to the same technology by each trading partner makes it inappropriate for an analysis of the effects of R & D effort on the trade pattern. Besides this theoretical argument the empirical tests of the H-O theory gave negative or inconclusive results.[11] The more specific theoretical framework based on the product life cycle (Vernon, 1966) cannot be applied because each industry in the sample is composed of many products of different maturity.

Considering these difficulties, it is felt that the Ricardian framework is more appropriate. A labour productivity variable shall therefore be used and defined as value added per employee, VA/EM.

Recent studies of the trade in manufacturing indicated that among the most reliable explanatory variables were various proxies for what was called the technology factor. In most of the empirical studies, the proxy was the percentage of professional personnel in the labour force.[12] In the Gruber and Vernon study, the US R & D effort and other industrial

10. Discussed by Johnson (1968).
11. There is an abundant literature of empirical tests of the H-O model. For the test of Canadian trade structure, which also failed to support the H-O theory, see: Wahl (1961) and Matuszewski, Pitts and Sawyer (1965).
12. The more important contributions in chronological order: Kravis (1956), Posner (1961), Vernon (1966), Keesing (1967), Wilkinson (1968), Hufbauer (1970), Gruber & Vernon (1970).

characteristics were imputed to other countries and the trade flows were analyzed under assumption of a uniform intensity of these characteristics from country to country. The present study is, as far as it can be determined, the first attempt to analyze trade flows in manufacturing between several countries using the measures of R & D effort expressed in terms of the actual R and D expenses or actual R & D employment in each of the manufacturing industries of the nine countries constituting our sample.

The technology intensity measures are defined, in this study,[13] as the ratio of the number of qualified engineers and scientists engaged in R & D activity to the total employment of an industry: RD/EM, or as the ratio of total intramural R & D expenditures to total sales of an industry: RD/SALE. Alternatively, the R & D intramural expenditure in the given industry is expressed as the percentage of the total intramural R & D expenditures of the whole business sector,[14] RA.[15]

With the growing importance of multinational firms, especially in the technologically progressive manufacturing industries, there is a growing possibility that the international division of labour resulting in the international specialization in exports and imports, under assumption of immobile factors of production, is gradually being replaced by a division of labour within a limited number of multinational firms. It is so far neither

---

13. In the results are also included estimates for equations with a dummy variable DUMMY = 1 for industries supposingly R & D intensive i.e. I = 6, 7, 12, 13, 14; for Canada. See next chapter for discussion.
14. The business sector contains all industries of the primary, secondary and tertiary sectors - for details see Appendix A.
15. Obviously, the three variables are intercorrelated; we will not use them in the same regression but they will be chosen according to the logical consistency with the dependent variable to explained.

theoretically nor empirically clear which are the net effects of this phenomenon on trade flows. It is likely that they vary during the life cycle of a product [16] but also from industry to industry and from country to country. The static framework of a cross-section analysis of highly aggregated industries is not suitable for an analysis of these possibilities because the problem is dynamic and microeconomic in nature. However, without hoping to uncover all the underlying general ties between R & D, export performance and control of manufacturing industries, the model specifies a variable expressing the extent of foreign control of each industry. The foreign control variable is the ratio of sales of US affiliates (local plus exports) to total sales of the given industry, CONTROL.

The use of data covering sales of US affiliates only instead of unavailable data covering all foreign controled firms represents probably only a minor problem due to the preponderant importance of the US controlled multinational firms.

The last group of factors influencing trade performance is composed of two quantifiable barriers to trade. The first is a tariff variable, i.e. the ratio of the nominal tariff [17] protecting the given national industry to the average of nominal tariffs protecting that industry in all countries in the sample, MTARIFF. A potentially more suitable measure would be based on the effective rate of tariffs, however, it is impracticable to calculate them. On the other hand, non-tariff barriers may actually prove to be more

---

16. Cf. Vernon, (1966).
17. Cf. Appendix A for the discussion of averaging procedures used and for the sources of data.

effective trade obstacles than the tariffs - there is unfortunately no way to include them in an analysis of this type.

The second variable is the distance between the exporting and importing areas. This variable serves as a proxy not only for transport costs but also for communication costs and differences in taste and demand structure in general.[18] It is calculated as an estimate of the distance in miles between the mid points of the two areas, with the distances on the ground multiplied by a factor of two. The distance variable, D_{AB}, is of course used only when a sample of industries belonging to several countries is analyzed. The distance itself cannot explain the commodity structure of one particular country, although if available, the transport costs per product, would serve this purpose.

The explanatory variables for the indices of export performance are constructed from the same theoretical premises as those explaining the country specific measures of export performance. To make them similarly distributed and logically consistent with the index form of the dependent variable, they are similarly transformed into ratios by relating a national industry's characteristic to the average of the corresponding characteristic for the same industry across all countries in the sample. This ratio is then deflated by the proportion of the country's overall importance relative to the sum of other countries of the sample. Thus the R & D intensity variable in index form, RARB, becomes:

18. The distance variable has proven to be very important in the analysis of trade flows. See Glejser (1968), or in a context closer to this study Vernon (1970).

$$RARB_{A,B} = \frac{RD_{A,I}/RD_{A,T}}{RD_{T,I}/RD_{T,T}} \quad \text{where } RD_{A,T} = \sum_{I=1}^{N} RD_{A,I}, \quad RD_{T,I} = \sum_{A=CA}^{SW} RD_{A,I}$$

$$\text{and } RD_{T,T} = \sum_{I=1}^{N} RD_{T,I}, \quad N = (1....14)$$

Similarly, the variables used above, MTARIF and CONTROL, are deflated for each country by a ratio of average tariff (control by foreign firms) for the country as a whole to the corresponding average for all countries of the sample. The variables thus transformed are designated I TARIFF and I CONTROL. There is only one conceptual difference between these and the explanatory variables of country specific measures of export performance. Instead of using two separate variables for productivity and labour cost per employer, a ratio of shares formed as above from a composite variable, the efficiency wage, is used and defined as the ratio of wages to value added created in an industry, IWA/VA.

There is one problem related to the specification of variables in the form of shares.[20] The share of each country is negatively related to the other countries'shares and therefore the regression results for one country are not independent of those for the next one. The result is that for any characteristic, one or two countries each tend to be on opposite sides, while the rest wind up with inconclusive results in the middle. However, if the export shares are associated with the shares of R & D and other variables, as presumed here, then one would expect that the extreme cases would be at the extremes of the distribution and the "average cases"

19. See page 10.
20. This critique is due to Keesing (1970) who made the comments on a similar specification used by Vernon (1970).

would be in the middle. The problem is therefore solved. As for the advantages of the formulation of variables in terms of shares it must be said that the dependent as well as the explanatory variables permit a more meaningfull international comparison.

The effect of the R & D effort on the export performance of an industry is not instantaneous. The exports react to changes in R & D and in other explanatory variables with a certain lag. Its length depends on the speed with which the exports incorporate the technological improvements generated by the R & D activity and also on the speed of the response of importers to the improved exports.[21] The lag varies greatly from case to case and there is no available empirical information which could be used for this study. For reasons related to data availability a simple lag of two years was used.[22] The export values are for the year 1969 and the industry characteristics are all for the year 1967.

Next chapter reports the estimated functions and their coefficients in tables which are followed by an interpretation and discussion of results.

---

21. A good theoretical examination of this lag structure is presented by Posner (1961).
22. Theoretically, it would be more appropriate to establish an individual lead for each explanatory variable and specify a system of equations related by a recursive lag structure. This formidable task is outside the scope of this study and was not attempted.

II. EMPIRICAL RESULTS OF CROSS-SECTION ANALYSES

This chapter focuses on the results of several cross-section analyses, covering a sample of fourteen manufacturing industries from nine countries. The regressions are first estimated for each country separately, then for the total sample constituted by a pool of the nine countries.[1]

As it is likely that the determinants of the export performance of an industry may vary, to an important degree, from one export market to another, e.g. Canadian exports to the United States may be relatively more (or less) R & D intensive than exports to Europe, regressions are estimated for the following market areas:

First, the total exports (to the world) of each of the fourteen manufacturing industries to the world. Secondly, their exports to the European members countries of the OECD and then, the exports to the world outside the OECD countries.

Eventually, due to the importance of the US market not only for Canada but also for the majority of other countries, the exports of manufacturing industries to the US are in focus. In addition to analyzing the exports going from each national industry to the US, the study also looks at the bilateral trade between Canada and the US.

In order not to overburden the reader with a maze of tables, the text presents only the results for total exports and leaves the rest of

1. In fact, due to data problems, industry 6, (petroleum products), was excluded for Belgium and Sweden. Further details concerning the data and their sources are in Appendix A.

the tables in Appendix C.

In discussing and interpreting the empirical results, attention is concentrated on Canada; the results for other countries and for the overall sample, although also available in the tables, are referred to only for comparison with Canada and in general are not exhaustively discussed at this point.

Before interpreting the results of the estimated regressions, the main hypothesis will be stated. It is expected that both the country specific measures of export performance and the degree of specialization in exports will be positively associated with the respective measures of R and D performance. It is also expected that the positive association will be stronger the more technologically developed is the market to which the exports are directed and the more technologically intensive is the exporting industry. Thus for example, the exports to European member countries of the OECD should display a higher degree of technological intensity than the exports to the world outside the OECD.

For several reasons however, these general expectations can be contradicted by the specific trade performance. For instance, the dependence of manufacturing industries constituting our sample on primary resources varies greatly. Thus the outstanding performance of Canadian paper exports is better explained by the relative abundance of the primary resources in Canada than by a lead in R & D activity.[2] On the other hand, the technological character of industries is also very variable. Owing to the low number of observations it is impracticable to use slope dummy variables for the research intensive industries. Experiments with the intercept dummies were not very successful and are reported for information only in Table 1 for Canada. As long as the contribution of R & D to export performance varies from industry to industry, the estimated common regression coefficient of the R & D variable gives only an idea of the average contribution the R & D makes to the export performance of an industry within the analyzed sample. This average is likely to be an overestimate for the technologically less intensive industries and an underestimate for the technologically more intensive ones.

The technologically less intensive standardized products (and industries) are likely to compete through labour productivity as predicted by Ricardian theory. A positive association of the productivity variable with the export performance variable is therefore expected. Furthermore, the more and industry is export oriented, the more likely it is that it will benefit from economies of scale; this aspect is also likely to con-

2. In this particular case the situation is more complicated. Canada's share of the world's paper exports is known to be very important. What is perhaps less well known is the fact that the R and D intensity of the canadian paper industry is also well above the world standard, even after the influence of the size of the industry has been taken away. While it would be absurd in this case to claim that it is only the importance of the high R & D intensity that is the cause of the high export performance of this particular industry, it is not impossible that the relatively high level of R & D activity has played a significant role in the cost and quality competitiveness and thus improved or maintained exports. The cross-section analysis can only reveal associations existing between the variables; an attempt to identify the causal relationships by the means of shift and share analysis will be put forward in the 3 rd chapter.

tribute to the positive association. The tariff variable, relating the domestic tariff to an average of the tariffs of the same industry abroad, is expected to be negatively related to the export performance because the countries are protecting their relatively less competitive industries. The net influence of foreign control of an industry over its export performance is hard to predict. It depends on the role the foreign affiliates play with respect on the one hand to their parent companies and on the other hand with respect to the local market where they are located. The relationship is difficult to predict because it involves not only the export behaviour directly but also the R & D activity. At this point, it is impossible to go into the details of this complex problem.

The specification of the dependent and R & D variables (deflated by the employment and later by the sales or total exports) in order to eliminate the influence of the size calls for a log-linear relationship.

Total exports to the world.

The results are presented in Tables 1 to 4 and they are discussed in the same order.

1) Exports per employee

The explanatory variables explain 45% of the variance of Canadian exports per employee (65% when the dummy variable is included) but they do not pass the F test at the 95% level in either case.[3] Due to

3. The F ratios are significant at the 90% level however. The low statistical significance is due to the low number of observations.

Table 1

Regressions relating total exports per employer of the manufacturing industries to explanatory variables.

$$\log (EX/EM)_{A,W,I} = a_0 + a_1 \log (RD/EM) + a_2 \log (VA/EM) + a_3 \log MTARIFF + a_4 \log CONTROL + a_6 DUMMY \quad R^2 \quad \text{No. of observations}$$

Net regressions coefficients of independent variables and (t statistics).

Exporting country	a_0	a_1	a_2	a_3	a_4	a_6	R^2	No. of observations
Canada	1.813 (0.3)	0.155 (0.6)	1.631 (1.0)	-2.454 (-1.7)	-0.783 (-1.0)	——	0.453	14
Canada (with dummy)	——	0.045 (0.2)	1.773 (4.9)*	-2.468 (-2.3)*	-2.028 (-2.5)*	2.061 (2.3)*	0.653	14
US*	-1.821 (-0.9)	0.172 (1.6)	0.993 (1.8)	-0.951 (-1.713)	——	——	0.772 *	14
Japan	-6.540 (-1.5)	0.604 (2.3)*	-0.343 (-0.4)	0.540 (0.4)	-0.161 (-1.8)	——	0.52	14
Belgium	-6.531 (-1.8)	0.125 (0.8)	-0.488 (-0.7)	1.413 (1.0)	0.066 (0.4)	——	0.298	13
Germany Fed.	-3.474 (-2.9)*	-0.03 (-0.4)	0.167 (0.7)	0.577 (0.5)	0.517 (2.9)*	——	0.582	14
France	-1.558 (-0.9)	0.06 (0.6)	0.810 (2.0)	0.481 (0.3)	-0.082 (-0.2)	——	0.471	14
Italy	-6.066 (-2.2)*	-0.099 (-1.3)	-0.426 (-0.7)	0.691 (0.6)	0.842 (2.7)*	——	0.634 *	14
UK	0.455 (0.1)	0.096 (0.6)	0.898 (1.3)	0.509 (0.8)	0.574 (2.9)*	——	0.754 *	14
Sweden	-8.521 (-1.4)	0.426 (1.6)	-1.174 (-0.8)	-1.075 (-1.6)	0.201 (1.1)	——	0.665 *	13
Total sample	-4.946 (-6.6)*	0.109 (2.3)*	0.088 (0.5)	-1.215 (-4.3)*	0.035 (0.7)	——	0.195 *	124

Notes

* The estimated equation for US does not include the foreign control variable.

**Total sample is constituted by a pool of all manufacturing industries of the nine countries.

* Significant at 0.05 level

the statistical weakness of the estimated regression coefficients, their interpretation must be considered tentative. All three regression coefficients have the expected signs although they are statistically insignificant. Comparison of the estimated equations with and without the dummy variable shows that there is a marked difference in the influence of the R & D variable between the more and the less technology intensive industries. At this point, it is risky to advance any hypothesis as to what is the "true" value of the regression coefficient a_1 because the reported estimates are statistically too weak.[4] Comparison of the regression coefficients a_1 for Canada and the overall sample indicates that the Canadian R & D elasticity of total exports per employee is close to the average of the countries in the sample. Comparison with individual countries shows that, while its value is only slightly below that of the US, which is surprising, there are several countries in the sample for which the R & D effort seems to have a significantly higher impact on the trade performance. The outstanding examples are Japan and Sweden.

The next variable, labour productivity, is positively associated with export performance, as expected. The regression coefficient is rather stable because when the dummy variable is included its value hardly changes although its statistical significance increases substantially at the expense of the statistical significance of the regression coefficient for the R & D variable. For the whole sample, the labour productivity shows an

4. The available data will be useful to estimate, in the future, the regression coefficients for several periods and thus check for their stability over time. On the other hand, an estimation of a regression from a pool of cross-section observations for several periods will enable us to attain estimates of a_1 with a higher degree of statistical significance.

insignificant positive association with the export performance as predicted. However, there are several exceptions when the regressions are estimated for individual countries, notably Japan, Sweden and Belgium, whose regression coefficients are negative and insignificant.[5] The tariffs are inversely related to the export performance for Canada and the majority of countries in the sample. The low statistical significance of the regression coefficient for practically all countries is probably due to important variances in the influence of tariffs on the export performance among industries. For the whole sample, on the other hand, the coefficient is rather stable with respect to inclusion of the dummy variable and is highly significant. It may be useful a stress here that the tariff variable is based on the average of the nominal post "Kennedy Round" tariffs. It is likely that the high intracountry variance of the tariff variable and the negative sign of its coefficient, for the UK and Belgium, reflect the possibility that the post "Kennedy Round" tariffs were not yet fully and uniformly implemented in all industries and/or that some industries did not yet adjust fully to the new tariff structure in their 1969 exports.

The negative coefficient of the foreign (U.S.) control variable indicates that an increase of the foreign control not accompanied by an increase of research intensity and/or labour productivity is likely to

5. The regressions for individual countries, including dummies which are not reported in the tables, show a net increase in the statistical significance of the reg. coefficient of the productivity variable and its sign becomes, in all cases, positive as expected.

Table 2

Regressions relating total exports as percentage of total sales of 14 manufacturing industries to explanatory variables.

$$\log (EX/SA)_{A,W,I} = a_0 + a_1 \log RD/SA + a_2 \log EM/SA + a_3 \log MTARIFF + a_4 \log CONTROL$$

Exporting country	a_0	a_1 log RD/SA	a_2 log EM/SA	a_3 log MTARIFF	a_4 log CONTROL	R^2	No. of observations
	Net regressions coefficients of independent variables and (t statistics).						
Canada	-3.351 (-1.2)	0.284 (1.2)	0.598 (0.7)	-2.733 (-1.9)	-0.625 (-0.8)	0.329	14
US	-3.473 (-3.7)*	0.261 (3.2)*	0.393 (1.3)	-0.749 (-1.3)	——	0.619 *	14
Japan	-3.194 (-1.5)	0.451 (3.0)*	0.564 (1.1)	-0.102 (-0.1)	-0.134 (-1.6)	0.667 *	14
Belgium	-2.373 (-0.9)	0.141 (1.0)	0.642 (1.1)	0.472 (0.3)	0.051 (0.3)	0.394	13
Germany	-2.24 (-2.7) *	0.266 (2.7)*	0.616 (3.6) *	-0.143 (-0.2)	0.180 (1.0)	0.873 *	14
France	-2.222 (-2.6) *	0.471 (3.4)*	0.169 (0.8)	-0.967 (-1.0)	-0.711 (-2.1) *	0.685 *	14
Italy	-4.627 (-2.4)*	-0.076 (-0.8)	1.119 (2.1) *	0.387 (0.3)	0.688 (2.3)*	0.446	14
UK	-1.444 (-0.8)	0.119 (0.7)	0.286 (0.8)	0.952 (1.1)	0.578 (2.4)*	0.630 *	14
Sweden	-3.427 (-1.4)	0.231 (1.3)	0.851 (1.5)	-1.359 (-2.2)*	0.283 (1.8)	0.654 *	13
Total sample	-4.016 (-7.2) *	0.197 (4.0)*	0.744 (6.1)*	-1.196 (-4.4) *	-0.002 (-0.1)	0.405 *	124

Note: * Significant at 0.05 level

worsen the export performance of Canadian manufacturing industries.[6] For most countries of the sample the foreign (U.S.) control is related directly positively with the export performance; the notable exception being Japan.

2. Exports as a percentage of total sales.

This specification is very similar to the previous one and therefore only the differences shall be stressed. The regression for Canada gives a slightly lower fit ($R^2 = 0.33$) and is statistically rather weak. Again, the R & D elasticity of exports is positive and, except for Canada, statistically significant for most countries of the sample. Compared with the R & D employment used in the previous specification, the present variable, the R & D expenses as a percentage of total sales, performed somewhat better in explaining the exports, as can be seen from a generally higher level of significance of the estimated regression coefficients for all countries. The value of the estimated R & D elasticity for Canada is again slightly above the average but not substantially different from that of the US regression.

The behaviour of the tariff and foreign control variables is similar to the previous specification and does not require further comments.

---

6. The correlation matrix (Table 5) shows that when the interactions of foreign control with R & D and labour efficiency are ignored the more foreign controled industries exhibit somewhat higher exports per employee. This simple positive correlation is also supported by other data. The survey of Foreign Owned Subsidiaries in Canada reports that the exports of all foreign owned companies in Canada increased more rapidly during the sixties than total Canadian exports as well as the positive trade balance of the reporting companies. See Industry, Trade and Commerce (1974, p. 21).

The employment per sales variable, EM/SA, is in fact the inverse of the labour productivity variable with the variable expressed, for the sake of uniformity, as a ratio of employment to sales rather than in terms of value added as in the previous specification. Therefore, its regression coefficient is expected to be negative. However, the coefficient comes with positive, although rather insignificant, values which are explained by interindustry differences in the composition of value added.[7]

In conclusion, it can be said that the specification in terms of exports and other variables deflated by sales is slightly superior, except for Canada, both in terms of total variance explained and statistical significance of estimated coefficients, to the previous specification. However, both confirm the expected role of the R & D variable in explaining export performance.

3) Exports of an industry as a percentage of total exports of the country.

The first two measures of export performance related the value of exports to the input of the productive factor (labour) or to the total output of the industry. In both cases the standard of reference was a characteristic of the exporting industry itself. The present dependent variable expresses the export performance of an industry relative to an outside standard

---

7. The ratio of sales to value added is negatively correlated with exports per sales (r = -0.24) and when the former variable is included in the multiple regression the labour efficiency performs as expected: (variables in log.)

$$\underset{}{EX/SA} = \underset{(0.5)}{4.13} + \underset{(0.6)}{0.16}\ RD/SA + \underset{(0.6)}{0.99}\ VA/EM - \underset{(-1.3)}{1.79}\ SA/VA - \underset{(-1.7)}{2.49}\ TARIFF$$

$$- \underset{(-1.1)}{0.79}\ CONTROL \quad R^2 = 0.41.$$

Table 3

Regressions relating the exports of 14 manufacturing industries expressed as percentage of the total exports of the respective country to the explanatory variables.

$$\text{Log}\ (EX/EXT)_{A,W,I} = a_0 + a_1 \log RA + a_2 \log WA/VA + a_3 \log MTARIFF + a_4 \log CONTROL$$

Exporting country	a_0	a_1 log RA	a_2 log WA/VA	a_3 log MTARIFF	a_4 log CONTROL	R^2	No. of observations
	Net regressions coefficients of independent variables and (t statistics).						
Canada	-3.179 (-1.1)	0.464 (1.8)	0.460 (0.1)	-3.360 (-2.0)	-1.366 (-1.6)	0.449	14
US*	-1.340 (-1.1)	0.368 (3.0)*	0.915 (0.8)	-0.613 (-0.6)	———	0.576	14
Japan	-0.297 (-0.1)	0.614 (5.6)*	1.261 (1.4)	-0.518 (-0.6)	-0.128 (-1.4)	0.835 *	14
Belgium	-2.084 (-3.0) *	0.346 (2.1)*	0.758 (0.7)	0.518 (0.3)	-0.278 (-1.2)	0.444	13
Germany	-1.491 (-1.8)	0.494 (3.6)*	0.241 (0.6)	-0.176 (-0.1)	-0.117 (-0.4)	0.735 *	14
France	-4.052 (-4.4) *	0.646 (5.2)*	-0.364 (-1.0)	-1.208 (-1.1)	-1.117 (-3.2) *	0.754 *	14
Italy	0.193 (0.1)	-0.05 (-0.3)	2.179 (1.2)	0.418 (0.3)	0.473 (1.2)	0.173	14
UK	-0.369 (-0.5)	0.489 (2.7)*	0.988 (0.9)	0.511 (0.5)	0.298 (0.9)	0.672 *	14
Sweden	-0.799 (-0.6)	0.426 (2.5)*	1.875 (1.2)	-1.234 (-1.6)	0.114 (0.6)	0.689 *	13
Total sample	-1.973 (-7.4) *	0.369 (8.0)*	0.393 (1.8)	-0.642 (-2.3) *	-0.097 (-2.4)*	0.389 *	124

Note: *Significant at 0.05 level

- the value of total exports of the country. If R & D is an important determinant of trade performance, it can be expected that an industry's share in a country's total exports will be positively correlated with the industry's share in the country's R & D activity. Although, this specification does not have much theoretical appeal, it has the advantage of permitting a meaningful comparison of results for exports directed to different markets, because they can always be related to the total exports of the given country toward the analyzed market.[8]

As it can be seen from Table 3, the results show that there is a strong positive correlation between the export shares and the R & D shares. The estimates of the regression coefficient are statistically more significant not only for Canada but for most countries of the sample as well. When all observations are pooled, the variance of the estimated coefficient a_1, is substantially smaller than in the case of the previous two specifications. If it were not for the consistently untypical behaviour of Italy, which does not show any significant relationship with any of the explanatory variables, the values of the estimated regression coefficient for the R & D share would be very uniform for all countries of the sample.

---

8. Thus it will be possible to compare the estimated regression coefficients for exports toward the European member countries of the OECD with those for exports to the rest of the world outside the OECD. This kind of comparison is not valid for the previous two specifications where the exports are related to the characteristics of the exporting industry itself. For example, it is meaningfull to inquire why the share of Canadian exports of electrical machines to the world outside the OECD is 5% of the total Canadian exports when the share of the same industry's exports to European OECD countries is only 2%. It does not make much sense however to know that the value of exports per employee to the rest of the world outside OECD is \$469. and that to OECD Europe the same is \$390.

Looking at the results for Canada, it can be seen that the value of the regression coefficient a_1 is higher than that of the US and it is one of the highest in the sample. This is due to the strong share of the paper industry in Canadian exports as well as in Canadian R & D. On the other hand, the poor showing of the US can be explained by the military and space orientation of US research, which results in the relatively lower share of each of the fourteen manufacturing industries' R & D expenses in the total US R & D expenses.[9] Incidently, lagging of the US non-military manufacturing industries behind their major foreign competitors has become increasingly apparent not only in R & D activity but also in general industrial and trading performance.[10]

The tariff and foreign control variable performs just as it did in the previous specifications. There is no need for comment. The efficiency wage variable is however conceptually different from the productivity measures used in previous specifications because it combines the productivity in terms of value added per employee and the wage bill per employee in the form of a ratio. The exporting industries are expected to be more productive as shown in the regressions of EX/EM. If the rate is the same in all industries, one would expect a negative sign for the a_2 coefficient. The

---

9. Thus in 1967, the total intramural expenditures of the 14 industries included in our sample (which does not include the aircraft industry) represent 90% of the total intramural expenditures of all industries in Japan, 80% in Canada but only 62% in the U.S.A.
10. The lag of US civilian R & D as one of the causes contributing to the deterioration of US trade performance is discussed by Boretsky (1973). The same problem from a more general perspective is also analysed by Melman (1975).

results show that the sign is positive for most countries although not significant. Therefore, it seems that in general, the exporting industries are offering higher wages that the import competing ones. This can be interpreted as a consequence of the tendency toward factor price equalization between trading partners. Besides, there is a positive correlation between the R and D intensity of an industry and its wage bill which contributes to the positive sign.

4) Degree of specialization in exports.

The degree of specialization in exports S_{AI}, which is the dependent variable of the last set of regressions presented in Table 4, deserves some comments before turning to the interpretation of the results of the estimations. The values of S_{AI} were calculated for all the industries of all the countries of the sample and are presented in Appendix B. Here, comments focus on the values of S_{AI} considering the total exports of each national industry to the world. Those Canadian manufacturing industries which have a higher share of total exports of all countries in the given industry than in all industries, i.e. those industries which have a higher degree of specialization in exports than the world average, have $S_{AI} > 1$. They are, in order of importance: the paper industry, transport equipment, wood and furniture, food and beverages and metallurgy. At the opposite extreme, the lowest values for $S_{AI} < 1$, belong to the textile, the non-metallic minerals, the rubber products and the clothing industries.

The degree of specialization of Canadian manufacturing industries in R & D activity will now be examined. The values of the RARB variable are reported in Appendix B.

Table 4

Regressions relating degree of specialization in exports, S_{AI}, of 14 manufacturing industries to the explanatory variables.

S_{AI} =	a_0 +	a_1 (RARB) +	a_2 I(WA/VA) +	a_3 (I TARIFF) +	a_4 (I CONTROL)	R^2	Number of observations
Exporting country	Net regressions coefficients of independent variables and (t statistics).						
Canada	1.469 (1.0)	0.340 (6.0)*	-0.911 (-0.9)	-0.855 (-1.3)	0.206 (0.3)	0.87 *	13
US	0.698 (0.8)	0.556 (2.36)*	-0.189 (-0.3)	-0.258 (-0.9)	——	0.54	13
Japan	2.383 (1.4)	0.132 (0.9)	-0.629 (-0.6)	-0.769 (-0.9)	-0.178 (-0.5)	0.54	13
Belgium	1.675 (1.8)	0.370 (5.6)*	-1.584 (-2.3)*	0.037 (0.1)	0.195 (1.5)	0.87 *	12
Germany Fed.	0.708 (0.8)	0.036 (0.3)	-0.027 (-0.1)	0.399 (0.4)	-0.089 (-0.5)	0.04	13
France	3.255 (4.0)*	-0.017 (-0.2)	-0.168 (-1.0)	-1.689 (-2.4)*	-0.285 (-2.0)	0.63 *	13
Italy	-4.895 (-1.1)	-0.024 (-0.1)	9.064 (2.2)	-2.79 (-2.1)*	-0.223 (-0.2)	0.51	13
UK	2.311 (1.4)	-0.164 (-1.1)	-0.651 (-0.6)	-0.850 (-1.1)	0.502 (1.1)	0.29	13
Sweden	-2.070 (-0.3)	1.16 (2.3)*	-3.379 (-0.6)	5.031 (1.2)	-0.581 (-0.8)	0.65 *	12
Total sample	1.597 (4.09)*	0.237 (5.6)*	-0.155 (-0.7)	-0.853 (-2.8)*	0.092 (1.05)	0.31 *	115

Note: *Significant at 0.05 level

Again, in order of importance of the values, the paper industry leads, followed by the wood and furniture industry, the metallurgy and the food and beverages industries. The least specialized in research are transport equipment , clothing, non-electric machinery, non-metallic minerals and rubber industries. If we consider the special situation of the Canadian auto-industry, due to the Auto-pact with the US, and if we do not take the transport equipment industry into consideration, we see that the ranking of industries, according the values of the degree of specialization in exports, is almost perfectly matched to the degree of specialization in R & D activity. It is therefore not surprising to find that the multiple regression reported in Table 4 confirmes this close relationship with a relatively high and significant $R^2 = 0.87$. The regression coefficient for the R and D variable is also highly significant. This very close relationship is however not generally true for other the countries of the sample. For the US, Japan, Sweden and Belgium the regressions support the hypothesis of a positive correlation between the degree of specialization in exports and in R & D , however for the other countries the correlation is very weak and, in some cases, negative.

The ratio of the efficiency wage IWA/VA displays a statistically weak negative regression coefficient for Canada and all other countries again with the exception of Italy. What does it mean? It shows that the national industries specialized in exports have generally lower efficiency wages, i.e. wage/value added, than their foreign competitors. It is important to stress here that this is not at all in contrast with the finding of the previous section that, within a country, the exporting industries have usually higher efficiency wages that the import competing ones. In the former case, the efficiency wages between the industries of the same country were compared and, in the present case, the comparison is made between the efficiency wages of the same industry across the sample. The results are therefore not inconsistent and conform to what is expected.

The tariff variable performs also as expected in the case of Canada and most other countries. The foreign control of Canadian industries is again positively correlated with the export variable. In general, looking at the results of the regression for the whole sample, it is possible to conclude that R & D plays an important role in explaining the degree of specialization in exports whereas the remaining explanatory variables behave as expected. However, the low proportion of variance explained by the regression for the overall sample and by the regressions for some countries and the relatively low statistical significance of most of the regressions and estimated coefficients does not permit us to interpret these results as more than another indication of the important role of the R & D activity as one of the most likely sources of good export performance.[11]

---

11. Several econometric problems which could have had negative influence on the results interpreted in this section were not explicitly discussed. Among those, multicollinearity could be, to a certain extent, the cause of low statistical significance of some estimated regression coefficients. To give an idea of the degree of correlation existing between the independent variables, Table 5 presents the correlation matrices for Canada and the whole sample. It can be seen that the multicollinearity exists to a certain degree between the independent variables but not in high enough level to invalidate the estimates.

Table 5

Correlation matrice for CANADA (14 observations)

	LGEX/SA	LGEX/EM	LGRD/SA	LGRD/EM	LGVA/EM	LGEM/SA	LGSA/VA	LGMTARIF	LGCONTR
COL / ROW	1	2	3	4	5	6	7	8	9
1	1.0000	0.9302	0.2100	0.1622	0.2046	0.0041	-0.2465	-0.4319	0.0682
2	0.9302	1.0000	0.3542	0.3541	0.5093	-0.3633	0.0695	-0.5376	0.2576
3	0.2100	0.3542	1.0000	0.9658	0.6023	-0.4319	0.0864	-0.1321	0.4926
4	0.1622	0.3541	0.9658	1.0000	0.6836	-0.5530	0.2130	-0.1847	0.5655
5	0.2046	0.5093	0.6023	0.6836	1.0000	-0.8684	0.4204	-0.4185	0.6336
6	0.0041	-0.3633	-0.4319	-0.5530	-0.8684	1.0000	-0.8150	0.3684	-0.5288
7	-0.2465	0.0695	0.0864	0.2130	0.4204	-0.8150	1.0000	-0.1851	0.2271
8	-0.4319	-0.5376	-0.1321	-0.1847	-0.4185	0.3684	-0.1851	1.0000	-0.5013
9	0.0682	0.2576	0.4926	0.5655	0.6336	-0.5288	0.2271	-0.5013	1.0000

Comparison of exports to Europe and to the world outside OECD.

The results of the preceding section show that no matter what standard of reference is chosen, there is an indication of a relatively high correlation between the export performance and the R and D intensity of an industry. So far, the possibility to distinguish exports according to their destination has not been included in the analysis.

Here, some interesting results of the first step taken in this direction are presented. What differences, if any, exists in the pattern of exports and their economic determinants when exports are compared to two widely different groups of countries? In order to compare substantially different markets, the reference points are on the one hand, the European member countries of the OECD (Europe) which are, except for few unimportant exceptions, industrialized and advanced economies and,on the other hand, the residual group of countries not belonging to the OECD (rest of the world). The latter group is predominantly composed of less developed countries with exception of the socialist countries of eastern Europe and the USSR.

Although, the economic indicators of the two importing areas are not used at this stage, it is nevertheless safe to assert that the first group is technologically and economically more advanced than the latter. The question arises here and to which an answer is sought is: do the characteristics of exporting industries play the same role in explaining export shares of two such widely different markets? if not, then how do they differ?

Table 6

Regression relating EXPorts to OECD Europe as a Percentage of Total Exports of 14 manufacturing industries to explanatory variables.

$\text{Log}\,(EX/EXT)_{A,E,I} = a_0 + a_1 \log RA + a_2 \log WA/VA + a_3 \log MTARIFF + a_4 \log CONTROL + a_5 \log DIST$

Net regression coefficents of independent variables and (t statistics).

EXPorting country	a_0	a_1 log RA	a_2 log WA/VA	a_3 log MTARIFF	a_4 log CONTROL	a_5 log DIST	R^2	No. of observations
Canada	-5.247 (-1.6)	0.579 (1.9)	1.629 (0.4)	-2.440 (-1.2)	-2.575 (-2.6)*	—	0.525	14
US	-2.870 (-1.8)	0.359 (2.2) *	0.624 (0.4)	0.249 (0.2)	—	—	0.373	14
Japan	-0.617 (-0.3)	0.901 (5.4) *	2.576 (1.9)	-1.651 (-1.3)	-0.235 (-1.7)	—	0.872 *	14
Belgium	-2.468 (-3.4) *	0.304 (1.8)	0.583 (0.6)	0.459 (0.2)	-0.248 (-1.1)	—	0.361	13
Germany	-2.161 (-2.8) *	0.461 (3.6) *	0.205 (0.5)	0.040 (0.0)	-0.178 (-0.7)	—	0.727 *	14
France	-4.969 (-5.6) *	0.631 (5.2) *	-0.653 (-1.8)	-1.022 (-0.9)	-1.214 (-3.6) *	—	0.77 *	14
Italy	-0.725 (-0.3)	-0.041 (-0.3)	1.938 (1.1)	0.420 (0.3)	0.409 (1.0)	—	0.129	14
UK	-1.367 (-1.8)	0.418 (2.3) *	0.897 (0.8)	0.187 (0.2)	0.335 (1.1)	—	0.633 *	14
Sweden	-1.894 (-1.5)	0.329 (1.9)	1.309 (0.8)	-1.359 (-1.8)	0.103 (0.6)	—	0.635 *	13
Total sample	-2.732 (-6.8)*	0.342 (4.9)*	1.149 (3.6) *	-1.573 (-3.7) *	-0.142 (-2.4)*	-0.411 (-0.3)	0.322 *	124

Note: * Significant at 0.05 level

Table 7

Regression relating EXPorts to the World outside OECD as a percentage of total exports of 14 manufacturing industries to the explanatory variables.

$$\text{Log (EX/EXT)} = a_0 + a_1 \log RA + a_2 \log WA/VA + a_3 \log MTARIFF + a_4 \log CONTROL \quad R^2 \quad \text{No. of observations}$$

EXPorting country — Net regression coefficients of independent variables and (t statistics).

EXPorting country	a_0	a_1 log RA	a_2 log WA/VA	a_3 log MTARIFF	a_4 log CONTROL	R^2	No. of observations
Canada	-4.752	0.587	0.766	-3.413	-1.246	0.610	14
	(-2.0)	(2.8)*	(0.3)	(-2.5) *	(-1.8)	*	
US	-2.547	0.342	0.781	-0.495	——	0.495	14
	(-1.9)	(2.6)*	(0.6)	(-0.5)			
Japan	-0.756	0.741	0.826	-0.495	-0.084	0.820	14
	(-0.4)	(5.9)*	(0.8)	(-0.5)	(-0.8)	*	
Belgium	-3.109	0.646	1.318	-0.461	-0.196	0.778	13
	(-5.0) *	(4.4)*	(1.4)	(-0.3)	(-1.0)	*	
Germany	-2.709	0.696	-0.025	-1.210	-0.111	0.801	14
	(-2.9)	(4.6)*	(-0.1)	(-0.8)	(-0.4)	*	
France	-4.248	0.683	0.385	-1.172	-0.912	0.734	14
	(-4.0)*	(4.7)*	(0.9)	(-0.9)	(-2.3) *	*	
Italy	0.549	-0.050	2.978	1.336	0.763	0.332	14
	(0.2)	(-0.3)	(1.7)	(0.8)	(1.9)		
UK	-1.178	0.593	0.863	1.332	0.276	0.786	14
	(-1.7)	(3.6)*	(0.9)	(1.4)	(1.0)	*	
Sweden	-0.749	0.806	2.593	-0.676	0.124	0.682	13
	(-0.4)	(3.1)*	(1.1)	(-0.6)	(0.5)	*	
Total sample	-3.193	0.478	0.234	0.204	-0.113	0.349	124
	(-9.0)*	(7.8)*	(0.8)	(0.6)	(-2.1) *	*	

Note: * Significant at 0.05 level

Two specifications are used. The dependent variable in the first is the ratio of exports of a national industry to the respective market area, i.e. to the European members of the OECD or to the rest of the world outside OECD, to the total exports of the given country to the respective market, $EX/EXT_{A,E,I}$ for Europe and $EX/EXT_{A,W-OECD,\ I}$ for the rest of the world. The explanatory variables remain the same as in the corresponding equation presented in the previous section, Table 3. The results are presented in the Table 6 for exports to Europe, in the Table 7 for exports to the rest of the world outside OECD.

The dependent variables of the second specification are the degrees of specification in exports to the respective market areas, $S_{A,E,I}$ or $S_{A,W-OECD,\ I}$. The explanatory variables are the same as for the corresponding specification in the previous section, Table 4. The results are presented in Appendix C.

As in the case of total exports, the estimated functions of an industry's share of the total exports of each country show better fit and higher statistical significance than the results for the degree of specialization in exports. The only exception in this respect is again Canada with an extraordinarily high and statistically significant coefficient of determination of the function explaining the degree of specialization in exports. Both sets of results suggest however the same interpretation. The emphasis will be placed on the results presented in Tables 6 and 7.

Comparison of the estimated regressions for each exporting country suggest that there is a different pattern for exports for European countries on the one hand and for Japan on the other. Canada and the US stand somewhere between the two extremes, with the former being closer to Europe.

For the European countries of the sample, and to a lesser degree for Canada, the results suggest that for a given share of R and D, an industry's share of exports to the rest of the world is higher tha its share of exports to Europe. When the R and D elasticity of export shares to the two markets are compared, it appears that for Canada and all European exporters this elasticity is in both cases positive, but higher for the exports to the rest of the world. For the US and for Japan, the R and D elasticity of export shares is respectively slightly and substantially higher for exports going to Europe. How can these findings be interpreted? It can first be argued that the European market for exports of manufactured products is more competitive in terms of technological intensity than the market constituted by the rest of the world outside the OECD. This affirmation can be supported by two simple observations.

In the case of Europe, due to the geographical proximity, the traditional interdependence and the division of labour between countries integrated in the Common Market and in the Free Trade Association, a substantial part of exports of each European country in the sample is directed to its neighbours.[12] There is a high degree of specialization in production which enables even relatively small countries to achieve economies of scale. According to Drèze,[13] who first analyzed and called the attention of economists to this pattern of specialization, it is the differentiation between the national suppliers that is more important than the differentiation within a group of goods. Thus for example, plywood is typically a Belgian export,

12. European countries of the sample exported, in 1969, 65% of their total manufacturing exports to the European member countries of the OECD. This compares to 15% for Canada, 30% for the US and only 13% for Japan.
13. Drèze (1961).

while furniture is not. The plywood industry, per se, might exhibit greater economies of scale than the furniture industry. The "hypothesis of standardization", as Drèze calls it, may explain the concentration of exports of smaller European nations among standardized, semifinished products. To the extent that this standardization exists, it must be logically complemented by a specialization of other, presumably bigger, European countries in technologically sophisticated products. The specialization is in particular products or in limited groups of products rather than in whole, broadly defined industries. Therefore, an analysis of a group of highly aggregated manufacturing industries, like the ones belonging to the sample, cannot reveal the pattern of such a narrow specialization. To the extent that this is true, the exports of a given European manufacturing industry to its neighbours will appear to respond less to the industry's R & D effort, than the exports of the particular product (group of products) in which the industry is actually specialized. The regressions, based on aggregated data, may therefore underestimate the true dependence of export shares on R & D shares. The narrow specialization of European countries in exports and R & D makes it naturally more difficult for foreign exports to penetrate the markets, unless they exhibit a substantial advantage over products available from European sources. The regressions for Canada, the US and Japan show that only the Japanese and to a lesser degree the US exports to Europe depend more strongly R & D than the exports of leading European countries such as Germany or Sweden. Both the US and Japan can offer in some industries, products of high technological sophistication which penetrate easily these European markets.

On the other hand, both American and Japanese manufacturing industries are likely to be less narrowly specialized than their European counterparts. Therefore, the aggregation bias likely to affect the results for the exports of European countries is less likely to affect the regression for the US and Japan.

As far as Canadian exports are concerned, the industries exhibiting a better than average export performance according to the values of S_{AEI}, (see the values in Appendix B) are mainly paper, metallurgy and food and beverage, i.e. industries closely related to natural resources. As for the relationship between R & D and exports, the level of the export share to Europe corresponding to a given R & D share is lower than the share of exports to the rest of the world. An increase of the R & D share appears to result in a smaller increase of the export share to Europe than to the rest of the world.

In comparison with the European members of the OECD, the non-members of the OECD, which are predominantly developing countries, represent in general an export market much less competitive than Europe. There are numerous reasons for this lack of competitiveness: the traditional dependence of many of the developing countries on their former colonial rulers, their geographical position and the consequences of bilateral aid, to name only few. Besides, the demand for imports of this group of countries is more concentrated in products which, while they are produced by technology intensive industries such as chemicals or electrical machinery, do not represent the most sophisticated products those industries are able to produce and export. For example, the less developed countries import standard electrical machinery such as power plants, electrical motors etc.... more than sophisticated electronic equipment.Owing to the impossibility of breaking the industries down into sufficient detail, the results of the regressions presented in Table 7 which shows that there is an important degree of association between the exports to the countries outside the OECD and the R&D activity performed by the exporting industries, are not to be interpreted as a causal relationship between the R & D performed and exports to those countries.

The important part of R & D activity directed to invention, innovation and development of the new, technologically most up to date products and processes are not likely to be exported to the developing countries. On the other hand, the standard products of the technologically intensive industries of most of the exporting countries in the sample are exported to the developing countries where, for reasons discussed above, they are likely to meet less competition than if they were exported to Europe, for example. This interpretation is of course tentative and cannot be corroborated by empirical data available for this study. It is also likely to become gradually less realistic as the technical expertise of countries outside the OECD improves.

Exports to the U.S. market

There are at least two reasons which justify a separate analysis of the exports to the U.S. market. The first is the real or alleged technological lead of the U.S. which has been widely accepted to be one of the factors determining the flows of international commerce and investment[14]. The other, more pragmatic, is the overall importance of the U.S. market for Canadian exports. The latter argument does not need any empirical support; the former may be clarified by a look at the R & D statistics.

There can be no doubt that in absolute terms, the U.S. manufacturing industries still spend substantially more for their R & D than their competitors. There is of course the difference of size to be taken into account. When the R & D expenses are related to the sales of the industry, the lead of U.S. manufacturing industries becomes much less evident. Only in petroleum products, non-electrical machinery and to a lesser degree[15] in rubber products, electrical products and in transport equipment industries is the U.S. R & D expenditure per sales higher than abroad. The U.S., however, is lagging behind their foreign competitors in all other technologically less intensive industries.

---

14. Vernon (1966).

15. In the last three industries, the U.S. lead is very marginal.

The ratio of R & D expenditures to the value of sales may, to a certain extent, be biased by the high wage rates paid in the U.S. for R & D. An alternative measure, the ratio of qualified scientists and engineers to the total employment of the industry[16] confirms, however, exactly the relative position of the U.S. manufacturing industries established according to the R & D expenditures per sale.

Further, the analysis of changes that occurred in the R & D expenditures between 1963-1969, which will be discussed in detail in the next part of this paper shows that, the U.S. are losing their relative advantage even in the technology oriented industries due to their slower growth. As was already pointed out above[17], one of the reasons is the deep involvement of the U.S. R & D in military oriented industries. The total R & D of the fourteen U.S. manufacturing industries included in our sample represents only 62% of the total R & D performed in the whole U.S. manufacturing sector which is substantially less than in other countries; e.g. as compared to 79% for Canada and 90% for Japan. The industries not included in our sample are the military oriented industries, aircraft and missiles, and the "other" manufacturing industries. The percentages above show the extent of specialisation in non-military oriented research.

---

16. See Table B-2, column (3), QSE/EM in Appendix B

17. See page 27

In spite of these qualifications, which cast some doubts on the technological hegemony of the U.S. manufacturing sector, the U.S. still represent the most technologically competitive market. The analysis of the exports to this market will, therefore, be a final test of the hypotheses suggesting the existence of a close association between the R & D performance and the export performance.

The dependent variable will be the share of the total U.S. imports in the given industry from all eight countries of the sample. The explanatory variables are specified so as to relate, in the form of ratios, the performance indicator of the exporting industry to the same indicator of the import competing U.S. industry. For example, the ratio of the R & D expenditures by the chemical industry as a percentage of the total R & D expenditures in the Canadian manufacturing industries to the corresponding share of the U.S. chemical industry. The list of explanatory variables includes the R & D ratio, the labour productivity ratio, the tariff ratio and the wage ratio. Also included is the variable which measures foreign, i.e. U.S., control of the industry.

The specification of the multiple regression model and the results are presented in Table 8.

Table 8

Regressions relating shares of the U.S. manufacturing imports to explanatory variables.

$$\text{Log}\left(EX_{A,US} / \sum_{A=CA}^{SW} EX_{A,US}\right)_I = a_0 + a_1(RA_A/RA_{US})_I + a_2(VAEM_A/VAEM_{US})_I^{**} + a_3(WA_A/WA_{US})_I + a_4(TARIF_A/TARIF_{US})_I + a_5\ CONTROL_I + a_6\ DIST.$$

Exporting country	Net regression coefficients of explanatory variables and (t statistics)							R^2	n	
	a_0	a_1	a_2	a_3	a_4	a_5	a_6			
Canada*	10.416 (4.5)*	0.271 (6.6)*	0.852 (0.8)	-18.948 (-6.3)*	1.317 (3.8)*	0.823 (1.9)	———	0.924 *	13	
Japan *	-1.553 (-0.4)	-0.039 (-0.2)	1.744 (0.1)	4.404 (0.1)	-1.096 (-2.0)*	-4.065 (-1.4)	———	0.617 *	13	
Belgium*	0.182 (0.1)	0.610 (2.1)*	1.673 (0.3)	-19.962 (-1.8)	-0.175 (-1.5)	3.689 (1.1)	———	0.700 *	13	
Germany	-2.875 (-0.6)	-0.009 (-0.6)	-5.310 (-2.5)*	6.841 (0.6)	-1.407 (-1.5)	14.807 (2.0)	———	0.501	14	
France	-3.075 (-0.8)	0.005 (0.2)	-0.016 (-0.01)	1.291 (0.1)	-0.989 (-1.5)	3.366 (0.4)	———	0.324	14	
Italy	-2.515 (-0.5)	0.092 (1.2)	-1.175 (-0.1)	2.160 (0.1)	-1.271 (-1.3)	3.134 (1.0)	———	0.477	14	
UK	-1.257 (-0.67)	-0.009 (-0.48)	-4.79 (-0.65)	4.58 (0.75)	-1.32 (-2.08)*	-0.41 (-0.28)		0.41	14	1969
Sweden*	-3.04 (-0.58)	-0.008 (-0.14)	-6.89 (-0.49	4.29 (0.21)	-0.25 (-0.22)	0.62 (0.14)		0.25	13	1969
Total * sample	-0.322 (-0.4)	0.193 (3.0)*	0.687 (0.6)	-3.924 (-2.7) *	-0.329 (-1.3)	1.856 (2.6)*	-0.044 (-2.8)*	0.238 *	104	
Total * sample with dummy variable	0.357 (1.09)	0.203 (3.18)*	0.779 (0.67)	-4.203 (-3.44)*	-0.420 (-1.61)	1.489 (2.00) *	-0.051 (-5.48)*	0.247 *	104	

Notes: *Significant at 0.05 level

*Indicates that the 3rd industry (clothing & footware) was not included in the regression.

** Symbol VAEM stands for VA/EM, i.e. value added per employee.

able 9

Regressions relating shares of the U.S. manufacturing imports to explanatory variables.

$$\log\left(EX_{A,US}\Big/\sum_{A=CA}^{SW} EX_{A,US}\right)_I = a_0 + a_1 \log(RD_A\Big/\sum_{A=CA}^{SW} RD_A)_I + a_2 \log(VAEM_A/VAEM_{US})_I^{*} + a_3 \log(TARIF_A/TARIF_{US})_I + a_4 \log CONTROL + a_5 \log(WA_A/WA_{US})_I + a_6 DIST. \quad R^2 \quad n$$

xporting country	Regression coefficients of explanatory variables and (t statistics).							R^2	n
	a_0	a_1	a_2	a_3	a_4	a_5	a_6		
anada	-0.483 (-0.18)	0.640 (1.20)	1.978 (0.83)	1.876 (2.31) *	0.378 (0.49)	-10.662 (-1.91)		0.602	13
apan	-4.718 (-0.90)	-1.285 (-2.29) *	1.21 (0.46)	-2.347 (-3.7) *	-0.323 (-2.83) *	0.163 (0.03)		0.748 *	13
elgium	-12.717 (-1.34)	0.518 (0.54)	-0.378 (-0.14)	-2.255 (-1.02)	0.278 (0.33)	-11.25 (-1.03)		0.443	12
ermany	7.647 (1.30)	1.548 (2.56) *	-0.704 (-0.62)	0.095 (-0.09)	0.036 (-0.09)	7.089 (1.17)		0.641 *	13
rance	-2.007 (-0.63)	-0.042 (-0.07)	0.503 (0.58)	-1.660 (-1.74)	0.314 (0.53)	0.078 (0.02)		0.486	13
taly	1.904 (0.40)	0.262 (0.89)	-2.822 (-0.43)	-2.35 (-1.89	0.539 (1.00)	4.463 (0.64)		0.486	13
y	2.227 (0.90)	1.789 (2.32) *	0.207 (0.14)	0.351 (0.46)	0.997 (2.78)	-1.700 (-0.95)		0.678 *	13
weden	-1.342 (-0.33)	0.613 (1.09)	-12.192 (-1.21)	-0.089 (-0.12)	0.047 (0.13)	16.559 (1.00)		0.393	12
otal sample	0.019 (0.03)	0.437 (3.81) *	1.270 (2.93) *	-0.439 (-1.41)	0.064 (0.68	-2.938 (-4.14) *	-0.078 (-3.48) *	0.275 *	110

otes: * Significant at 0.05 level

The 3rd industry (clothing & footware) was not included in the regressions.

* Symbol VAEM stands for VA/EM i.e. value added per employee.

The first regression shows that the Canadian share of the U.S. manufacturing imports is significantly positively related to the relative intensity of the R & D in both countries. The higher the relative intensity (i.e. the percentage of the total Canadian R & D expenditures in all manufacturing industries) of R & D in the Canadian industry compared to the relative intensity in the corresponding U.S. industry, the higher its share of the U.S. manufacturing imports. As for the labour productivity, the closer the productivity of the Canadian industry to the productivity in the corresponding American industry, that is, the higher their ratio, the higher the Canadian share of the U.S. import market. It is interesting that this positive relationship exists although none of the Canadian manufacturing industries display a higher labour productivity than their U.S. counterpart. The wage rate variable appears with the expected negative regression coefficient. The lower the wage rate in the Canadian manufacturing industry compared to the wage rate in the American one, the better the Canadian export performance. In contrast to the labour productivity variable which was statistically insignificant, the wage rate is highly significant; both variables behave as predicted by the Ricardian theory of comparative costs.

The tariff variable indicates that Canadian exports to the U.S. are more important in industries wherethe U.S.

tariff is lower than the Canadian one. This phenomena may be due in part, to the fact that an important proportion of Canadian exports to the U.S. is concentrated in resource oriented transformation industries and in production of intermediary products; it is obviously in the U.S. interest to accept these exports duty free or with very low tariff. It is more difficult however to justify the higher level of Canadian tariffs in the same industries; Canada is supposed to enjoy an absolute advantage in the resource oriented industries; their higher protection seems therefore unnecessary. This discussion is, however, rather futile because the level of aggregation is too high for a meaningful analysis of the tariff protection.

To conclude this brief summary of regression results, the extent of U.S. control over Canadian manufacturing industries appears positively related to the export performance, although, its regression coefficient is not as significant as the other ones.

The explanatory variables explain 92% of the total variance of the Canadian share of the U.S. manufacturing imports.

The same explanatory variables did not do as well when the regression was run for all observations of the total sample, although all regression coefficients appeared with the expected signs and, except for the productivity and tariff variables, they were significant. When this regression is compared with the regressions for the individual countries, it appears that the latter, in most cases do not show the expected relationship between the share of U.S. imports, the relative R & D intensity and the other explanatory variables. In view of this finding, it is necessary to interpret the relatively acceptable results of the regression for the total sample as being strongly influenced by the observations for Canadian industries, which dominate the U.S. import market.

In order to explain the U.S. import shares of other countries better, the R & D effort was measured in terms of the share a given national industry has in the total of R & D expenditures of the same industry across the sample of nine countries, $(RD_A / \sum_{A=CA}^{SW} RD_A)_I$. This specification improved regression results somewhat for all other countries, except for Canada (see Table 9).

Comparison of the two sets of regressions, which except for the R & D have identical explanatory variables, shows that on the average, the R & D expenditures by an industry expressed as a share of the total expenditures for R & D in the given industry across the sample is a better measure of the comparative advantage in technology than the ratio of relative intensities, which was used in the first set of regressions. Thus it appears that it is the absolute level of an industry's R & D effort which, when compared with the total R & D effort in the same industry accross the sample, measures its international technological competitiveness, rather than the various relative measures, which related the R & D to some other national characteristic such as employment, sales or total R & D. This finding is supported by poor results of regressions (not reported here) using the ratio of R & D/EMployment or R & D/sales as alternative measures of technology.

The fact that for Canada, however, the ratio of relative intensities of R & D performed better than the present measure, may be explained by the close specialization and similarity existing between American and Canadian manufacturing industries[18].

---

18. At this point, it is not necessary to go into the causes underlying the specialization and similarity; to a great extent, they may be considered the result of American control of Canadian manufacturing sector as a whole.

Canadian manufacturing industries which rely heavily on Canadian natural resources exhibit a high absolute level of R & D expenditures when compared with the same industries across the sample. At the same time, the relative importance of those industries within Canadian manufacturing sector is greater than in other countries, including the U.S., which are less endowed with natural ressources. The high ratio of relative intensities of R & D, therefore, is a better expression of the specialization in R & D of Canadian resource oriented industries and consequently their share of the U.S. import market. The same is true when the R & D is related to the industry performance, say to its employment in Canada and in the U.S. The division of labour between the two countries is reflected not only in the strong dependance of the U.S. on imports from Canada, but also in the high specialization of Canadian resource oriented industries in research and development, where the R & D per sale or per employee is mostly higher in Canada than in the corresponding U.S. industry. Briefly, the Canadian manufacturing industries exporting a large proportion of their output to the U.S. behave as far as their R & D per sales or per employee is concerned, as if they were American exporting industries. Their relative research intensity is higher than that of their competitors abroad.

To the extent that a portion of Canadian resource oriented industries are under the direct control of their U.S. parent companies, it is easily understood as one of the aspects of the Americanization of the Canadian economy.

In order to offer a better insight into the bilateral trade between Canada and the U.S., the determinants of their relative export-import performance are analyzed in the next section.

Bilateral trade between Canada and the U.S.

Analysis of exports to the U.S. suggests that the Canadian share of the U.S. import market is, to a great extent, explained by the ratio of performance of the Canadian exporting industry relative to the performance of the import competing industry in the U.S. The exports of the U.S. manufacturing industries are a function of their technological and overall economic performance, as it has been found in the first part of this chapter. When the two results are combined it is possible to formulate the following hypothesis:

The pattern of bilateral trade between Canada and the U.S., measured by the ratio of U.S. imports from Canada to U.S. exports to Canada in the given manufacturing industry, is a function of the relative technological and economic performances of the given industry in the two countries. The relative technological and economic performance is measured again as the ratio of the given performance indicator in Canada to the corresponding indicator in the U.S.

The specification of the regression equation and the results for thirteen manufacturing industries are presented in Tables 10 and 11. The only difference between the two specifications is in the definition of the R & D variable.

First, in Table 10, it is the ratio of the R & D expenditures per sales in the Canadian industry to the R & D expenditures per sales in the same U.S. industry. The other variables are analogically constructed ratios of labour productivity, wage rates and tariff, i.e. they are the same as in the previous two regressions. The estimated regression coefficients have the expected signs. The higher the relative intensity of R & D and of the labour productivity in the Canadian, compared to the American industry, the higher the ratio of the U.S. imports from Canada to the U.S. exports to Canada. The ratio of wages is related inversely, the lower wages in the

Table 10

Regressions relating the bilateral trade between Canadian and American manufacturing industries to explanatory variables.

$Log(EX_{CA,US}/EX_{US,CA})_I$ =	a_0 +	$a_1(RDSA_{CA}/RDSA_{US})_I^{**}$ +	$a_2(TARIF_{CA}/TARIF_{US})_I$ +	$a_3(WA_{CA}/WA_{US})_I$ +	$a_4(VAEM_{CA}/VAEM_{US})_I$ +	a_5CONTROL	R^2	n
	Regression coefficients of explanatory variables and (t statistics)							
"	-0.908 (-1.80)	1.252 (2.10)	—				0.286	13
"	-2.699 (-2.44)*	1.221 (2.24)*	1.680 (1.78)	—			0.458 *	13
"	5.65 (1.08)	1.865 (2.91)*	1.84 (2.18)	-11.314 (-1.63)	—		0.582 *	13
"	7.181 (1.21)	2.070 (2.61)*	1.872 (2.03)	-16.045 (-1.99)	3.259 (1.06)	-0.338 (-0.26)	0.658 *	13

Notes: * Significant at 0.05 level

**Symbol $RDSA_{CA}$ stands for (RD/SA); analogically, VAEM stands for VA/EM

The 3rd industry, clothing and footware was not included in the regression.

Table 11

Regressions relating the bilateral trade between Canadian and American manufacturing industries to explanatory variables.

$$\left(EX_{CA,US}/EX_{US,CA}\right)_I = a_0 + a_1\left(\frac{RD_{CA}\Big/\sum_{A=CA}^{SW} RD_A}{RD_{US}\Big/\sum_{A=CA}^{SW} RD_A}\right)_I + a_2\left(VAEM_{CA}/VAEM_{US}\right)_I^{**} + a_3\left(WA_{CA}/WA_{US}\right)_I \quad R^2 \quad n$$

		a_0	a_1	a_2	a_3	R^2	n
		regression coefficients of explanatory variables and (t statistics)					
I	"	-0.771 (-1.27)	47.683 (7.45)*	———	———	0.835 *	13
II	"	20.309 (2.57)*	62.036 (8.72)*	5.259 (1.39)	-32.254 (-2.89)*	0.915 *	13
III	"	13.910 (2.58)	32.758 (3.50)*	3.331 (1.15)	-21.010 (-2.62)	0.655 *	11

Notes: * Significant at 0.05 level

**Symbol VAEM stands for VA/EM

The 3rd industry, clothing & footware was not included in the regression. Sample for Equation III excludes also paper and transport equipment industries.

Canadian compared to the American industry, the higher the ratio of U.S. imports to exports. The Canadian tariff protection is positively correlated with the Canadian export performance. The U.S. control over Canadian industries appears to have a negligible influence.

When the R & D variable is expressed as the ratio of the Canadian industry's share of the total R & D expenditure by the same industry across the sample to the share held by the U.S. industry, the results confirm the previous ones but are statistically more significant (see Table 11). The total variance of the bilateral trade pattern between Canada and the U.S. is explained almost exclusively by the ratio of R & D shares. When the ratio of labour productivity and the ratio of wages are added, the R^2 = .915 and all regression coefficients have the correct sign, although the labour productivity is not significant.

When the tariff and U.S. control variables were added to the explanatory variables, their contribution was negligible and therefore, the results are not reported in Table 11.

The bilateral commerce between Canada and the U.S. is, to an important degree, influenced by a few, extreme cases. One of them is the exports of the Canadian paper industry which reflect above all the abundance of natural resources in Canada.

The other is the export of Canadian transport equipment which is mainly the result of the Autopact.In order to check the degree of dependence of our results on the two cases, the regression was repeated with a restricted sample of observations,excluding paper and transport equipment industries.The results still point in the same way as before, although understandably they are a bit less significant.

PART TWO

III. THE CHANGE OF EXPORTS FROM 1963-71

III THE CHANGE OF EXPORTS FROM 1963 TO 1971

This chapter is concerned with changes in the volume of exports over a period of eight years, from 1963 to 1971. A change of exports may be the result of the changes in the demand of importing countries and/or of the changes in supply conditions of the exporters. The first set of changes affecting the demand for exports of a particular national industry, may be identified by means of the constant-market-shares (CMS) analysis of export growth.[1] This relatively simple method is used to identify the part of a country's total export growth attributable to: (1) growth in over-all world demand, (2) changes in the growth of import demand in individual markets, (3) changes in commodity composition of demand in each market, and (4) changes in competitive capacity of the exporter.

When an exporting country maintains its supply conditions unchanged relative to its competitors, it maintains its share in world markets. However, when a country increases its share in world markets, it is a consequence of the increased competitiveness of its exports. For example, if Canadian exporters specialized in rapidly growing commodities and exported them to markets exhibiting a higher rate of growth than the world export market as a whole, the demand for Canadian exports would increase more rapidly than the world demand on the average. Both the commodity composition effect and the market distribution effect are positive in this case. If the actual growth of the volume of Canadian exports in the observed period

---

1. See an excellent article on the theory and methodology of application of this analysis by Richardson (1971).

   The detailed formulas for calculation of CMS are in Appendix D.

exceeded the growth which could have been expected on the basis of the growth in demand, then there must have been an improvement in the competitive capacity of Canadian exports, i.e. a positive competitive effect.

The changes in competitiveness are a function of the changes in export supply conditions. They may be attributable to a set of factors such as:

1. changes of productivity growth
2. changes in exchange rates
3. changes in export subsidies and taxation
4. changes in national price levels
5. changes in quality, introduction of new products
6. changes in marketing of exports
7. changes in swiftness of meeting export orders.

Factors 1) to 4) determine changes in price competitiveness. Fleming & Tsiang, Junz & Rhomberg, and Kreinin,[2] to name only few, measured changes in the price competitiveness and correlated them with the changes in export shares. Although the estimated price elasticity of exports with respect to changes in price competitiveness appeared with the expected negative sign, the price competitiveness explained only about one half of the total variance in observed gains or losses of actual exports, compared with constant market shares.[3]

When the importance of non price competition in highly differentiated technologically intensive industries is taken into account, the

---

2. Fleming & Tsiang (1958), Junz & Rhomberg (1965) and Kreinin (1967).
3. Junz & Rhomberg, ibid, p. 254.

relatively poor performance of the price competitiveness in explaining the changes in export shares is not surprising. The changes in quality, in technological novelty and in parameters incorporated in new or differentiated products are not likely to be reflected in lower prices. On the contrary, to the extent that these changes are successful, the new products may be exported in increased quantities in spite of constant or even higher prices. Improvements in marketing and in swiftness of meeting export orders may have a similar impact on the increase of export volumes as the quality changes. Exogeneous variables explaining changes in export shares, therefore, should include measures of quality and novelty of exported products as well as measures of the marketing and delivering capacity of exporters.

The change of quality and novelty of products cannot be directly measured when aggregated industry data are used. There is, however, a strong presumption that these changes will be more important and more numerous in industries exhibiting an intensive R & D activity. The preceding chapters of this study illustrated the importance of R & D inputs in determining the commodity composition of trade flows in manufacturing. Research and development is aimed at one or the combination of the two following objectives: (1) to introduce improved or new production processes, (2) to create improved or new products. The fulfillment of the first objective is likely to be eventually reflected in lower prices of existing products and measured by the change of the index of price competitiveness. When the R & D is aimed at creating an improved or a new product, successful attainment of this objective is likely to be reflected directly in the increased shares of exports. It is, therefore, to be expected that the change of the market share of exports is not only a function of the change in the price competitiveness but also a function of the change in the portion of R & D creating the improved, differentiated or new products. Theoretically, the change in the marketing and delivering capacity of exporters should also be included among the explanatory variables; the unavailability of data, however, makes it impossible to consider these changes in this study.

Measurement of price and R & D competitiveness

Price competitiveness

The methodology for measurement of the competitive price effects on exports was thoroughly discussed and tested by Junz & Rhomberg.[4] Their approach, as far as the price competitiveness is concerned, was adjusted to the framework of the present study. Among the three alternative price variables used by Junz & Rhomberg, only the wage costs per unit of output could be used in this study because it was the only variable for which data was broken down to the industry level[5] were available. The necessity to use the wage costs variable in this study is unfortunate because, according to Junz & Rhomberg, the unit value of manufacturing exports is proven to have superior statistical properties in explaining the change of export shares. At this point, however, it is felt

4. See: Junz & Rhomberg, op. cit. pp. 221-239
5. In contrast to Junz & Rhomberg's study, this one focuses on the whole manufacturing sector, broken down into 13 industries. The unit of observation beeing the individual industry. Their study used as the unit of observation an aggregate of several manufacturing industries (SITC sections 5(chemicals), 7(machinery and transport equipment), and 6 plus 8(basic manufactures and miscellaneous goods). Neither the unit values of exports nor the wholesale price index for the individual manufacturing industries were available for all countries of the sample.

that the disadvantage of using the better price variable, i.e. the necessity to abandon the industry level of aggregation is potentially greater than the slight improvement in statistical significance of the estimated relationship which could be expected when the unit values are used instead of wage costs.

Index of price competitiveness

To measure changes in the degree of price competitiveness between two periods, changes in a country's prices must be brought into relation to the changes in prices of other exporting countries. A composite index for each industry-I and exporting country-A is constructed as follows:

(1) First, for each industry-I of all exporting countries-A of the sample and for each of the seven markets-B in period t, the ratio of the efficiency wage cost of industry-I in country-A to the average efficiency wage cost of all countries (including country-A) is weighted by their deflated exports to market-B, for each industry-I,

$$INWA_{I,A,B,T} = \frac{(WA/SALE)_{I,A,T}}{\sum_{A=CA}^{SW}\left[(WA/SALE)_{I,A,T} \cdot EX_{I,A,B,T}\right] \Big/ \sum_{A=CA}^{SW} EX_{I,A,B,T}}$$

(I=1 ... 13) and each market B, (B=CAnada, US, JApan, EEC, EFTAD rest of of OECD Europe world outside OECD) and period T. There will be (I X B) values of INWA.

(2) To aggregate the index over all export markets-j of the given exporting industry-i of country A, it is necessary to find a sum

weighted by the exports of the i-th industry to the j markets. This aggregate, defined for each I-th industry of country A for all markets, $INC_{I,A,T}$ corresponds to the "price relative" used by Junz & Rhomberg.[6]

$$INC_{I,A,T} = \sum_{B=CA}^{W-OECD} (INWA_{I,A,B,T} \cdot EX_{I,A,B,T}) / E_{I,A,W,T}$$

where subscripts of variables, I,A,B,T are defined as above; $E_{I,A,W,T}$ stands for the <u>total exports</u> of the I-th industry in country A and period T.

(3) The index of the change in price competitiveness between period T = 1 and T = 2 is then expressed as:

$$INCO_{I,A} = \frac{INC_{I,A,T=2} - INC_{I,A,T=1}}{INC_{I,A,T=1}}$$

The index INCO will be used as one of the two explanatory variables in the regression equation explaining the change in the export share.

R & D competitiveness

To measure the change in the technological competitiveness, a country's innovative effort has to be related to the innovative effort of its competitors. Research and development producing a flow of innovations has become one of the regular elements of industrial activi-

6. Junz & Rhomberg, <u>op. cit.</u>, p. 234.

ty. In order to avoid the thorny problem of the relationship between the R & D input and its output in various forms of technological change, it is assumed that the efficiency of R & D is the same between industries and between countries.[7]

In order to keep its share of the market, every national industry has to maintain a certain non zero routine level of R & D activity. In terms of growth, this routine level may be thought of as being determined by the global average rate of growth of R & D activity in the given industry. Under these circumstances, a national industry which increases its R & D activity annually at the same rate as its foreign competitors, is not likely to improve its competitive position. In order to overtake its competitors in the technological race, the industry has to exhibit a faster growth of R & D than the average growth rate for the given industry.

In terms of the constant market share (CMS) analysis used for decomposing the elements of the change in exports between two periods, the situation described above is similar to the positive "competitive effect", which is also determined by the difference in the growth rates. If interest is focused on the national economy, it is possible to add the competitive effects of all industries to find out whether the economy experienced an overall gain or loss in R & D growth, relative to its foreign competitors. A change in a nation's

---

7. It is realized that this is far from realistic. Considering, however, the impractical alternatives available, this assumption, which also underlies the first part of this study and all studies of similar nature by other authors, is again necessary.

R & D effort between two periods, can be decomposed into two identifiable elements. The first, discussed above, determined by forces within national industries, is the "competitive effect". The other, the "composition effect", is the result of forces that determine the industrial composition of the economy. An economy specialized in rapidly growing, technologically intensive industries, will necessarily exhibit a more important increase of its total R & D than an economy specialized in traditional industries where R & D grows at a slower rate. The sum of the two effects is equal to the difference between the actual national change in R & D and the change that would have occured had the nation's R & D grown at the average world rate.

Index of R & D competitiveness

To measure the changes in R & D competitiveness between two periods, the "competitive effect" is used. Ideally, only the portion of R & D devoted to conceiving and developing new products should be used for construction of an index of R & D competitiveness which is supposed to measure non-price effects. The use of data on development activity comes closest to this ideal because on the average, development activity is concerned with new products. For the present study, however, the development data are not used because they are unavailable for some countries of the sample[8]. Instead the total intramural R & D expenses are used.

The index of R & D competitiveness is calculated for the I-th industry, in exporting country-A, according to the following formula:

$$RDCC_{I,A} = RD_{I,A,T=2} - RD_{I,A,T=1} \cdot \frac{RD_{I,T=2}}{RD_{I,T=1}}$$

where RD is the total intramural R & D expenditure. $RD_{I,T}$ is the total intramural R & D expenditure for industry I, accross all countries of the sample A, in period T.

$$RD_{I,T} = \sum_{CA}^{SW} RD_{I,A,T} \qquad (A = CA, \ldots SW)$$

8. The German data is not broken down to three usual types of R & D but only to basic research on the one hand and to the sum of applied research and development on the other hand.

The constant market share analysis of the change of Canadian manufacturing exports from 1963 to 1971

The data used are the volumes of exports of thirteen Canadian manufacturing industries[9] to seven geographical areas[10]. In order to eliminate the possible bias due to an arbitrary choice of the base period and of the end period, the average of export volumes for 1963 and 1967 (i.e.(x63 + x67)/2) was taken as the base observation and the average for 1969 and 1971 as the end period observation. The changes calculated from those data, therefore, extend over the period and are less biased than if only the 1963 and 1971 observations were used.

A crucial element for a correct application of the CMS analysis is the choice of the "standard of reference", i.e. the group of countries with which the performance of Canada's manufacturing exports are to be compared. The group of the nine industrialized countries forming the sample which was used in the first part of this study was choosen as the "world" standard because it represents a major part (90%) of the competition against Canadian manufacturing exports.

---

9. The volumes were calculated by deflating the respective annual values of exports by the unit values of exports.

10. The market areas are: Canada, U.S., Japan, EEC, EFTA, rest of OECD Europe, World outside OECD.

Brief summary of the results

First, the sum of effects for all Canadian manufacturing industries of the sample are shown in the line "Total" in Table 1. The observed difference between the value of exports at the beginning and the end of the period was (in million US $) 3 667,400. The changes in exports were identified as follows:

1.	Change due to increase of the "world" trade	3 081,640.
2.	Change due to commodity composition of Canadian exports	- 207,880.
3.	Change due to market distribution of Canadian exports	828,410.
4.	Change due to the decrease of competitiveness of Canadian exports	- 34,770.
	Total change	3 667,400.

In general, Canada's exports have mainly benefited from the overall increase of the "world"[11] trade. The market distribution, strongly influenced by the important and

11. To the extent that the exports of the group of nine industrialized countries grew more rapidly thant the world's exports, the calculated effect due to the increase of the "world" exports presented above is overestimated. However, if Canada's performance is to be compared with that of the other industrialized countries, the calculated "world" effect is the relevant one.

rapidly growing US market is the second positive effect in the change of Canadian exports. The industrial composition affected the change of exports negatively, i.e. the Canadian exports were, relatively speaking, more concentrated in the slow growth sectors. The increase in the demand for Canadian exports (sum of changes (1), (2), (3)) amounted to 3 702.17 million US $.

There was, however, a slight loss due to the decrease in the competitive capacity of Canadian manufacturing exports.

The export changes in Table 1 are given in million US $ by industry; in Table 2, the same changes are expressed as the percentage of the base period exports[12]. Although both tables are informative, the interpretation of the percentage changes is easier for inter-industrial comparison. The competitiveness increased in seven out of thirteen industries. The most impressive increase was recorded by the stone clay and glass industry (67%), followed by the transport industry (58%), clothing (51%), textile (34%) etc. On the other hand, the petroleum products industry exhibited a marked decline (-54%), followed by the ferrous and non-ferrous metals (-32%), chemical industry (-26%) and products of wood (-22%).

---

12. The base period exports are calculated as the average of the deflated exports for 1963 and 1967, i.e. (Exp. 63 + Exp. 67)/2.

Table 1

Changes of manufacturing exports from 1963 to 1971. (million US $)

Country: CANADA	no.	Industry:	(1) Δ world trade	(2) Δ commodity comp.	(3) Δ market distrib.	(4) Δ competitiveness
	1	Food & beverage	277.219	-48.965	-68.564	-36.493
	2	Textiles	25.381	-6.948	-0.567	13.539
	3	Clothing & footware	23.672	4.940	-5.217	18.844
	4	Wood & furniture	62.970	15.974	-23.023	-21.698
	5	Paper products	803.851	-322.488	-224.701	54.260
	6	Petroleum products	7.540	-4.311	29.112	-6.341
	7	Chemicals	219.460	-23.215	21.064	-91.157
	8	Non-metalic minerals	11.72	1.421	-1.007	12.362
	9	Primary metals	661.654	-74.709	-37.846	-327.349
	10	Fabricated metal pr.	36.549	-4.851	7.773	19.195
	11	Machinery non-elec.	340.518	-28.656	193.827	-48.003
	12	Electrical mach.	124.242	20.191	90.579	-64.848
	13	Transport equipment	486.849	263.745	846.975	442.917
CANADA		Total	3 081.640	-207.880	828.410	-34.770
U.S.		"	9 796.370	-6.970	-1 319.190	-3 093.550
JAPAN		"	4 259.690	156.730	-654.830	4 768.110
BELGIUM		"	2 988.370	-123.870	455.220	573.250
GERMANY		"	9 455.310	326.780	815.000	-575.800
FRANCE		"	4 606.130	-105.040	116.310	32.910
ITALY		"	3 558.130	-47.960	201.080	802.460
G.B.		"	6 317.700	89.500	-1 517.220	-984.610
SWEDEN		"	1 893.240	-81.270	-26.690	-386.07

Table 2

Changes of manufacturing exports from 1963 to 1971 (in percentages)

CANADA	no.	Industry	(1) World Trade	(2) Industrial composition	(3) Market distribution	(4) Competitiveness	(5) Observed change
	1	Food & Beverage	63.9	-11.2	-15.8	-8.4	
	2	Textiles	63.9	-17.5	-1.4	34.1	
	3	Clothing & footware	63.9	13.3	-14.0	50.8	
	4	Wood & Furniture	63.9	16.2	-23.3	-22.0	
	5	Paper products	63.9	-25.6	-17.8	4.3	
	6	Petroleum products	63.9	-35.5	246.8	-53.7	
	7	Chemicals	63.9	-6.7	6.1	-26.5	
	8	Non metalic minerals	63.9	7.7	-5.4	67.4	
	9	Primary metals	63.9	-7.2	-3.6	-31.6	
	10	Fabricated metals	63.9	-3.4	13.5	33.5	
	11	Machinery non-elec.	63.9	-5.3	36.3	-9.0	
	12	Electrical mach.	63.9	10.3	46.6	-33.3	
	13	Transport equipment	63.9	34.6	111.2	58.1	
CANADA		Total secteur manufacturier	63.9	-4.3	17.1 %	-.7 %	76.0
US		Total " "	63.9	-.04	-8.6	-20.2	35.1
JAPAN		Total " "	63.9	2.3	-9.8	71.6	128.0
BELGIUM		Total " "	63.9	-2.6	9.7	12.3	83.3
GERMANY		Total " "	63.9	2.2	5.5	-3.9	67.7
FRANCE		Total " "	63.9	-1.4	1.6	0.5	64.6
ITALY		Total " "	63.9	-0.9	3.6	14.4	81.0
G.B.		Total " "	63.9	.9	-15.4	-9.9	39.5
SWEDEN		Total " "	63.9	-2.7	-0.9	-13.0	47.3

For the sake of comparison, the calculated changes for all countries of the sample are also given in Table 1 and Table 2. Without going into the industry details, the results show that the manufacturing sector of the following countries experienced an increase of their share of world exports due to increased competitiveness: Japan, Belgium, France and Italy. On the other hand, the US, Germany and Great Britain along with Canada experienced a decrease in the competitiveness of their exports[13].

According to the theory stated in the first part of this chapter, it is expected that the change in competitiveness can be explained by the change of one or both of its explanatory variables, i.e. by the change of the price competitiveness and/or by the change of the R & D. The R & D changes are analyzed in the next section, followed by the analysis of the observed changes in the price competitiveness.

---

13. The unfavorable situation of the countries which experienced a decrease in their competitiveness is not the result of the particular choice of reference periods. Even when the changes were calculated directly from 1963 to 1971, the signs of their competitive effect remained negative although their magnitude of course changed (increased).

Change in R & D activity of Canadian manufacturing industries from 1963 to 1969.

The level of R & D activity is measured by the expenditures for intramural R & D in each of the thirteen manufacturing industries. The observation for the base period is the amount of R & D expenditure for 1963.

The observation for the final period is the average of expenditures for 1967 and 1969, all expressed in constant 1963 dollars.

The period covered by the R & D data preceeds the one for which the export changes were calculated by two years for the following reasons. First, a time lag is necessary before the changes in products and processes resulting from the R & D activity find their way to the foreign market. The length of the lag between the R & D and the exports should probably be longer than two years[14]. Unfortunately, the first available internationally comparable data for R & D are for 1963, followed by the data for 1967 and 1969. On the other hand, the export data for periods after 1971 were judged unsuitable because of the upheaval caused in international trade by the devaluation of the US $ and the resulting crisis. Therefore it was impossible to specify a lag longer than two years.

14. For an exhaustive theoretical discussion of the lags in the context of the relationship between R & D and exports, see Posner (1961).

The "standard of reference" is again the performance of the set of nine industrialized countries as it was in the case of the CMS analysis of the export growth. The growth of the R & D expenses in each Canadian manufacturing industry is compared with the average growth of the R & D expenditures in all manufacturing industries of the sample of nine countries and with the growth of the R & D expenditures in the given industry across the sample.

Brief summary of results presented in Table 3.[15].

The R & D expenditures of all thirteen Canadian manufacturing industries increased by 31.50 million US dollars over the observed period. Two thirds of this increase (22.88 million US $) reflects the global increase in R & D in the nine industrialized countries, i.e. the effect of the "world" growth of R & D. A negligible fraction (-0.32 million US $) was lost due to unfavorable industrial composition and more than a half of the total increase (9.38 million US $) represents the increase of Canadian R & D over and above what could have been expected, had the increase in Canadian R & D expenditures been proportional to the average rate of growth experienced by the sample of the nine countries. The latter

15. Table 3 presents the CMS results in absolute values (in million US $), in parenthesis the same results as percentage changes with respect to the base period observations. Both tables give the results for 13 manufacturing industries of all nine countries of the sample, however, only Canadian results are analyzed and interpreted in the text.

Table 3

Changes in R & D expenditures from 1963 to 1969 in million US $. (%).

Changes in price competitiveness from 1963 to 1969 in %

CANADA	no.	Industry	(1) Δ Observed	(2) Δ "world" growth	(3) Δ Industrial composition	(4) Δ Competitiveness	(5) Δ Prices (unit labour costs)
	1	Food & Beverage	0.86 (14.9)	0.81 (14.1)	-0.15 (-2.6)	0.22 (3.8)	-3.78
	2	Textiles	0.73 (30.0)	0.34 "	-0.24 (10.0)	0.64 (26.3)	-4.50
	3	Clothing & footware	0.02 (29.0)	0.00 "	-0.02 (-35.8)	0.04 (53.7)	-2.92
	4	Wood & Furniture	0.17 (24.0)	0.10 "	0.08 (11.9)	-0.01 (-2.0)	-0.21
	5	Paper products	1.08 (7.0)	2.22 "	-0.04 (-0.2)	-0.90 (-5.7)	0.28
	6	Petroleum products	3.44 (27.0)	1.85 "	-0.09 (-0.6)	1.71 (13.0)	-5.74
	7	Chemicals	1.72 (6.0)	4.46 "	-1.47 (-4.6)	-1.23 (-3.9)	4.85
	8	Non metalic minerals	0.24 (11.0)	0.30 "	-0.12 (-5.7)	0.06 (2.6)	-4.91
	9	Primary metals	3.41 (22.0)	2.20 "	-1.18 (-7.5)	2.44 (15.6)	6.70
	10	Fabricated metals	-0.36 (10.0)	0.54 "	-0.60 (-15.6)	-0.29 (-7.6)	4.36
	11	Machinery non-elec.	3.98 (28.0)	2.02 "	0.11 (0.7)	1.86 (13.0)	-1.95
	12	Electrical mach.	14.12 (26.0)	7.69 "	3.51 (6.4)	2.99 (5.5)	6.06
	13	Transport equipment	2.08 (100.0)	0.29 "	-0.08 (-4.2)	1.88 (89.9)	3.67
CANADA		Total manufact. sector	31.50 (20.0)	22.88	-0.32 (-0.2)	9.38 (5.8)	1.16

change, therefore, reflects the increase of the technological competitiveness of the Canadian manufacturing industries.

The R & D expenses of the thirteen manufacturing industries in all nine countries increased over the observed period by 14%. The fastest growing R & D expenses in relative terms was exhibited by the wood products industry (25%), followed by the electrical products industry (20%). The latter dominated the growth in absolute terms, accounting for half of the total increase of R & D expenditures in all manufacturing industries included in the sample. The third highest rate of increase was recorded by the non electrical machinery industry, (15%). At the other end of the scale was the clothing and footware industry with a sharp decline in R & D expenses (-31%). A slight decline (-16%) was also experienced by the fabricated metals industry. The R & D expenses in the remaining industries increased by a rate slower than 14%.

When compared with their competitors, the individual Canadian manufacturing industries exhibited a higher increase of R & D expenditures in nine out of thirteen industries, as can be seen from column (4), table 3.

The greatest increase was exhibited by the transport equipment industry (89.9%), a spectacular growth most likely attributable to the effects of the autopact. As the average rate of growth of the transport equipment industry across the sample of the nine countries was slower by 4.2% (see column (4) "composition effect") than the global average of 14%, the total competitive increase of the R & D expenditures in percentage was equal to 89.9% (= 85.7% - (-4.2%)), i.e. the "competitive effect", found in column (4). The second highest competitive effect was achieved by the clothing and footware industry (54%),[16] followed by the textile industry (26%) . The primary metals, non-electrical machinery and petroleum products also came out with important competitive increases in their R & D expenditures: 16%, 13% and 13% respectively. Finally, it is necessary to mention the electrical products industry which increased its R & D expenditure by 5.5% over the average increase of this industry across the sample. Equally important is that in absolute terms, the competitive increase of 5.5% achieved by the electrical products industry represents a full third (2.99 million US $) of the total competitive effect recorded by all Canadian manufacturing industries.

16. These impressive increases may in fact reflect a data problem rather than the reality. The R & D data for the U.S. clothing and footware industry were aggregated with those for the textile industry and were extremely low. Their estimated break down may be biased and therefore the calculated effects may suffer from this bias. In order to eliminate this problem, the observation for the 3rd and 14th industries will be temporarily left out from regression.

Before it is possible to conclude that the generally faster growth of the R & D expenditures in Canadian manufacturing industries really reflects an improvement in their competitive situation, it is necessary to exclude the possibility that the observed faster growth is merely due to low levels and slow growth in the preceding periods. The following observations indicate that this is not the case.

First, the available data on R & D before 1963, show that the rate of growth of R & D expenditures was at least as fast as the one recorded in the late sixties[17]. Secondly, as far as the level of R & D activity is concerned, a brief comparison of the ratio of qualified scientists and engineers (QSE) to the total manpower by industry, see Table 5, indicates that in the so called high technology industries, Canadian manufacturing industries did not employ substantially less QSE per 1 000 employees than their foreign competitors on the average[18]. There was however, a marked gap between the level

---

17. For example, the R & D expenditures of the electrical equipment industry between 1959 and the end period calculated as the average of observations for 1961 and 1963, increased by 90%. Increase in the textile and clothing industry was 23%, in primary metals 41%. It was not possible to compare those increases with the increases abroad because the internationally comparable data are not available for the period before 1963.

18. A notable exception is the transport equipment industry (which in this study excludes aircraft construction). The Canadian R & D level is substantially lower even in 1967 after a phenomenal rate of growth of 26%/year in the preceeding period.

TABLE 4

The number of Qualified Scientists and Engineers per 1 000 employees in several manufacturing industries in 1967.

Industry	CANADA	US	JAPAN	BELGIUM	GERMANY	FRANCE	ITALY	G.B.	SWEDEN
Electrical products	16	54	19	18	17	13	11	9	16
Machinery non-electrical	6	20	10	3	5	6	2	4	5
Transport equipment	1/2	21	7	1/2	5	3	2	2	11
Chemistry	19	36	39	18	15	11	14	14	10
Paper products	4	4	4	1	1/2	2/3	1/2	1	3 2/3
Primary metals	4 1/2	4 1/2	8	3	4	3	1/2	2	7

of the R & D manpower intensity in the Canadian and in the US industries. The higher relative rates of growth of R & D in Canadian industries, (see Table 3 column (2) and (4)) suggest that the US lead was being reduced in the sixties.

In the resource oriented industries such as paper products or primary metals, the level of the Canadian R & D was above average. Thus it is possible to conclude that the faster growth of the Canadian R & D in the observed period cannot be attributed to a spurious effect of exceptionally low levels of R & D expenditures in the base period.

Change in the price competitiveness of Canadian manufacturing industries

The change of the index of the price competitiveness measures the change in the weighted labour costs over the period 1963-1969. The base period observation is again the observation for 1963 and the end period observation is the average of observations for 1967 and 1969. The change of the index for all Canadian manufacturing industries was calculated as a weighted average of changes recorded by the price index of each industry, the weight being the industry's share of total Canadian manufacturing exports. The index of price competitiveness, that is the level of unit labour costs in Canadian manufacturing industries, recorded a decrease of 1.16% compared to the change in unit labour costs of their foreign competitors.

Table 3, column 5, gives the changes of the index of price competitiveness $INCO_{I,A}$, for each industry[19]. The greatest relative decrease, i.e. the greatest improvement, was exhibited by the petroleum products industry (-5.7%), followed by the non metalic minerals (-4.9%). At the other extreme, an important deterioration of price competitiveness was observed

19. It is acknowledged that the unit labour costs are a rather poor measure of price competitiveness when industries with different labour intensity are compared. Unfortunately, there were no better data for price competitiveness available at the industry level.

for the primary metals industry (+ 6.7%), electrical products (+ 6.1%) and chemical industry (+ 4.8%).

<u>Relationship existing between the changes in exports, in price competitiveness and in R & D competitiveness</u>

Before the results in Table 5 are examined, it may be useful to remind the reader that an increase in the price competitiveness of an industry is measured by the <u>decrease</u> of its price index. It is, therefore, expected that an increase in its competitive change can be explained by a decrease of its price index and/or by an increase of its R & D competitiveness.

Two evaluations of the observed situation are presented. In the first crude approximation, only the signs of changes are analyzed and the magnitude of changes is not taken into account. After this "qualitative" evaluation, the magnitude of changes is analyzed by a regression of the export change on the change of price and R & D competitiveness.

1) The observations of the explanatory variables displaying the expected sign with respect to the sign of the dependent variable are indicated by an asterisk in Table 5.

Table 5

Competitive changes in exports, prices and R & D in thirteen Canadian manufacturing industries.

No.	Industry	(1) Δ Exports LXCC (%)	(2) Δ R & D RDCC (%)	(3) Δ Prices INCO (%)
01	Food & Beverage	-8.416664	3.8	-3.778999
02	Textiles	34.103271**	26.3*	-4.502999*
03	Clothing & footware	50.896637**	53.7*	-2.917999*
04	Wood & Furniture	-22.031433*	-2.0*	-0.214000
05	Paper products	4.315733	-5.7	0.279000
06	Petroleum products	-53.764618	13.0	-5.737000
07	Chemicals	-26.557083**	-3.9*	4.846999*
08	Non metalic minerals	67.400940**	2.6*	-4.907999*
09	Primary metals	-31.631790*	15.6	6.698996*
10	Fabricated metals	33.578812	-7.6	4.360000
11	Machinery non-elec.	- 9.013206	13.0	-1.950000
12	Electrical mach.	-33.371231*	5.5	6.061999*
13	Transport equipment	58.166336*	89.9*	3.686999

Note: The observations of the explanatory variables (column (2) and (3)) displaying the expected sign with respect to the sign of the dependent variable (column (1)) are indicated by an asterisk. When signs of both explanatory variables correspond to the sign of the dependent variable, the latter is indicated by two asterisks.

When signs of both explanatory variables correspond to the sign of the dependent variable, the dependent variable is indicated by two asterisks. When only one of the explanatory variables appears with the expected sign, the dependent variable has only one asterisk. Eight out of thirteen industries displayed at least one sign in order with the theoretical expectation. Six among them had the expected relationship between the change of the price index and the change of exports; they were the textile, clothing, chemical, non-metalic mineral products, primary metals and electrical product industries. The change of the R & D competitiveness was positive for the majority of industries and its sign is therefore less important than the sign of the price index which was oscillating in both positive and negative directions around zero. Nevertheless, the expected sign for the change of R & D competitiveness appeared in the following five industries: textile, clothing and footware, wood and furniture, non-metalic mineral, chemical, and transport equipment.

Some industries experienced an important increase of their price index and at the same time an increase of their R & D competitiveness and a loss of their export share, (for example the electrical product industry and primary metals industry). The positive effect of the change of the R & D competitiveness on export share, i.e. the R & D elasticity

---

of exports, is likely to be lower than the price elasticity of exports in the case of these industries. Another interpretation of cases appearing with only one of the expected signs can be that the lag between the R & D and export share changes was in reality different, likely longer, than the two years used in the present study. In this case, the results of the R & D would not yet have achieved the expected effects on the foreign export markets.

Multiple regression analysis

In order to evaluate quantitatively the relationship existing between the change of the market share of exports and changes of price and R & D competitiveness, the three variables are related by the following multiple regression model.

$$EXCC_{I,A} = a_0 + a_1 \ INCO_{I,A} + a_2 \ RDCC_{I,A} + dX + u_{I,A}$$

First, the subscript I, (I = 1,....13) stands for manufacturing industry and the country of origin A is Canada. Next, the equation is estimated with observations for the whole manufacturing sector of each of the nine countries (A = CA,....SW).

As all three variables are in percentage form, the regression coefficients a_1 and a_2 estimate the partial elasticity of exports to price change and to R & D change respectively. In order to account for the interindustry differences with respect to R & D, a dummy variable X assumes value X = I for observations on technologically advanced industries, (i.e. the following: the petroleum products, chemical, non-electrical machinery, electrical products and transport equipment industries).

Table 4 - The competitive change in exports (1965-1970) as a function of changes in price and R & D competitiveness (1963-1968).

	ECC_{ai} =	b_o	b_1 $INCO_{ai}$	b_2 $RDCC_{ai}$	d_X	R^2	n
I	Canadian manufacturing industries	6.230 (0.51)	-0.880 (-0.41)	0.852 (2.42)**	-37.961 (-1.92)*	0.489 (2.87)*	13
II	Subsample of "high technology" Candn.manf.ind.	-39.207 (-3.35)*	2.133 (1.01)	0.993 (3.54)*	-	0.879 (7.26)*	5
III	Subsample of "low technology" Cndn.manuf.ind.	10.134 (0.72)	-4.107 (-1.28)	0.307 (0.46)	-	0.323 (1.2)	8
IV	Subsample of "high technology" without transport eq. industry	-37.862 (-1.19)	1.928 (0.38)	0.817 (0.23)	-	0.136 (0.8)	4

Pooled cross-section observations for two periods of three years.

Changes in exports (1965-68), (1968-71), changes in price and R & D competitiveness (1963-66), (1966-69).

ECC_{ai} =	b_{ot65}	b_{ot68}	b_1 $INCO_{ai}$	b_2 $RDCC_{ai}$	R^2	n
Subsample of "high technology"	-26.557 (-0.83)	1.906 (0.08)	3.574 (0.47)	0.595 (0.87)	0.141	10
Subsample of "low technology"	3.403 (0.30)	13.38 (1.46)	-0.968 (-0.67)	-0.038 (0.16)	0.132	16

Note: Coefficients significant at the 10% level indicated by one asterisk; significant at 5% level indicated by two asterisks.

Export changes in thirteen Canadian manufacturing industries.

The results are presented in Table 6. About fifty percent of the variance of the export change is explained by the changes in R & D and prices. The value of the regression coefficients indicates that the share of Canadian manufacturing exports increased by 0.85 percent when their R & D competitiveness increased by one percent, when prices are assumed constant; a one point (1%) decrease in the price index leads to an increase of the export share by 0.9 percent. Although both coefficients appeared with the expected signs, the price coefficient was not statistically significant.

The relatively weak statistical significance of the price variable may be due to several causes. First, as it was already mentioned earlier, previous studies which used alternative measures of export prices showed that the change in the unit labour cost was a poor proxy for the changes of price competitiveness. In comparison with the results obtained by Junz & Rhomberg[21], the unit labour cost performed better in the present study than it could have been expected. The second reason for a relatively low statistical significance of the price variable and the modest R^2 is probably the short adjustment lag between the changes in the R & D, in price competitiveness, and the resulting change in the share of exports. The two year adjustment lag used in the present study corresponds to the adjustment period for "short run" price effects used by Junz & Rhomberg. A longer, four year adjustment period used alternatively by Junz & Rhomberg improved the estimates of price elasticities in their study and it can be expected that, had a longer adjustment lag been practicable in the present study, the results would have been improved. Finally, the price and R & D elasticities of different industries are in reality very variable.

Imposing the same regression coefficient to a small number of widely different industries must necessarily result in a high variance.

---

21 Cf. Junz & Rhomberg, op. cit. p. 251. The reader is reminded that the unit labour costs were the only price measure available for each manufacturing industry individually. As for the comparison with results obtained by Junz & Rhomberg, in their study, the R^2 never exceeded 0.18 when unit labour costs were used. It is therefore possible to expect that the overall statistical performance of our regression would improve if more suitable price data were used. Aside from this problem, our price variable cannot reflect changes in tariff protection resulting from Kennedy Round negotiations, which certainly influenced commercial flows. Similarly, the influence of non-tariff barriers cannot be accounted for.

Significance of the dummy variable shows that there is a substantial difference in the value of intercept for the "high" and "low" technology industries. When the regressions for the two groups of industries are estimated separatly, (eq. II and III respectively), the regression coefficient of the R & D variable for the "high" technology industries[22] is substantially higher and more significant (although only at the 10% level) than the coefficient for the "low" technology industries. The value of the intercept remains, however, much lower for the former group. Given the low number of observations we can conclude only very tentatively that owing to the low value of the intercept (-39.2) and to the price increases, the increment of R & D competitiveness which would have improved the share of Canadian "high" technology exports in the observed period was on average about fifty percent. Among the five "high" technology industries, only the transport equipment recorded an increase of its R & D competitiveness in excess of fifty percent (90%) and it was the only industry which increased its export share.

An attempt to increase the number of observations

---

22 The results of the subsample of "high technology" industries were however dominated by the spectacular changes which occured in the transport equipment industry, namely in auto-industry owing to implementation of the auto-pact. When the observation for the transport industry (13th)was deleted, the R^2 and statistical significance of estimated coefficients decreased sharply, although their estimated values changed only slightly (cf. ev. (IV), Table 5).

for the two subsamples of industries by pooling two sets of cross-section observations of changes over shorter period of three years led to estimates V-VI reported in Table 6. Comparison of these very short term elasticities with the ones presented above (I-III), shows that although the signs and values of the coefficients were similar as before, standard errors of these very short term elasticities increased. There was also recorded an important upward shift of the intercept from one period to another. The three years period is probably too short to reveal consistantly the relationship existing between the change of prices and R & D expenditures on the one hand and the subsequent changes in the volume of exports on the other. Owing to the lack of data for more recent years it has been impossible so far to pool cross-section observations of changes over a longer period, which could lead to statistically more significant estimates.

Thus it is possible to conclude that the competitive change of Canadian manufacturing exports is not only a function of changes in price competitiveness, (unit labour costs) but also a function of technological competitiveness. High technology industries appear to compete in the international market through technological improvements, but the increase of their R & D effort in the analyzed period seemed to be insufficient to improve their share of the export market. Therefore, although one of the causes of their poor export performance was deterioration of their price competitiveness, there were likely other factors, not included in our analysis, which were responsible for the unexplained loss of export shares.[23] On the other hand, changes in exports of the remaining Canadian manufacturing industries did not appear to be significantly related to their technological effort but they benefited from increased price competitiveness. The estimates of the price and R & D elasticities have to be regarded with extreme caution because owing to the low number of observations they were not significant at the conventional 5% level and the poor results of the regressions of pooled cross-section samples indicate that the length of the observed period as well as the lag between the changes may not yet be sufficient to reveal the price and R & D elasticity with an acceptable confidence. Moreover, both explanatory variables are only crude proxies for changes they purport to measure. Aside from the measurement error, an aggregation bias specific to CSM analysis may also be present.

---

[23] To the extent that the foreign controlled subsidiaries, which form the majority of the "high technology" industries in Canada, have their export marketing strategy determined by their parent companies outside of Canada, it is likely that changes in their R & D and prices will not influence directly their exports.

Owing to all these limitations the results have to be interpreted merely as an indication that the export-share changes of Canadian manufacturing industries were not only function of changes in price competitiveness but alsoa function of changes in technological competitiveness. The latter change appeared to be decisive for the "high technology" industries, the former for the remaining ones.

In what follows, the same analytical framework is applied to total manufacturing sectors of nine industrialized countries.

Changes of manufacturing exports of the nine industrialized countries.

The specification of variables and of the regression equation was the same as above, except that the price variable was calculated from the unit values of manufacturing exports. The data for the whole manufacturing sector, i.e. the sum of respective changes in all thirteen industries in each of the nine countries, were the units of observation.

The competitive changes were calculated for two alternative periods. The first was the same as the one used for Canada, i.e. exports ($19\overline{65}$-$19\overline{70}$); prices and R & D (1963-$19\overline{68}$).[24] The values of competitive changes as well as the estimated regression coefficients are given in Table 7. Six out of nine countries exhibited the correct combination of signs for export and R & D changes. Similarly, the price changes appeared with the correct sign also six times. The competitive changes of the US, Japanese and Italian manufacturing exports were associated with the theoretically expected changes both in prices and in R & D.

Regression of the export values on the changes in

---

24. $19\overline{65}$ indicates calculated average, i.e. (1963 + 1967)/2; the same applies for other periods indicated with the bar.

R & D and prices explained *around* fifty percent of the total variance and both regression coefficients appeared with the expected signs, but only the one of the price variable was significant at the 5% level.

In order to check whether the changes and their relationship were not unduly influenced by the choice of the base period (1963), alternative periods for exports (1967-1971) and for prices and R & D (1965-1969) were used. The calculated changes and estimated regression coefficients are reported in Table 7. As far as the signs of the respective changes are concerned, in six out of nine countries both exploratory variables appeared with the expected sign.

Both regression coefficients had the expected sign, but this time only the coefficient of the R & D variable was significant. Comparison of the present estimates with the previous ones shows that not only did their significance changed drastically but their values changed noticeably as well. These changes were partly at least, caused by the fact that the end period observations were not calculated averages. To the extent that the end period observations deviated from their longer run trend, they introduced some bias in the calculated changes. The shortening of the period (4 years compared to 5 years) also probably induced some changes in the estimated coefficients.

It appears therefore that owing to the great sensitivity of estimated coefficients to the specification of the observed period it is not possible, with the presently existing data for R & D, to estimate the partial elasticities of exports to R & D and prices with a desired level of confidence.

Table 7

a) Competitive changes calculated for the whole manufacturing sector of nine countries (%).

Country:	1st period ECC (1965-70)	1st period INCO (1963-68)	1st period RDCC (1963-68)	2nd period ECC (1967-71)	2nd period INCO (1965-69)	2nd period RDCE (1965-69)
Canada	0.699	3.575	5.799	-12.971	3.575	6.900
US	-17.799	2.970	- 0.898	-13.244	2.537	- 1.385
Japan	54.447	-5.000	5.918	61.506	-2.280	20.047
Belgium	10.323	-1.280	-28.371	14.481	-1.820	- 4.567
Germany	- 3.287	-2.140	- 1.390	5.096	-1.919	7.568
France	0.402	1.310	14.176	24.755	-1.223	8.006
Italy	11.233	-6.010	6.072	8.360	-3.232	17.187
GB	- 9.475	-1.941	- 7.816	-40.056	-8.415	-19.199
Sweden	-11.397	2.590	5.780	- 8.987	1.288	- 5.333

b) Competitive changes in exports as a function of competitive changes in prices and R & D.

ECC =	a_o	a_1 INCO (UVE) +	a_2 RDCC	R^2	n
I. Manufacturing exports of each country A.	-	-4.424 (-2.61)**	0.317 (0.75)	0.478 (6.38)**	9
II. Manufacturing exports of each	-	0.882 (-0.48)	1.819) (3.38)**	0.610 (10.95)**	9

Notes: a) Equation I relates observations on exports (1965-1970) to R & D and prices (1963-1968)
Equation II relates observations on exports (1967-1971) to R & D and prices (1965-1969)

b) The statistical significance of the intercept a_o was in both cases so low that equations were reestimated without intercept.

c) Coefficients significant at the 5% level indicated by two asterisks.

PART FOUR

CONCLUSIONS

CONCLUSIONS

It was established in the first part of this study that, no matter what measure of export performance is used, the exports of Canadian manufacturing industries are positively associated with their R & D effort and labour productivity. These two explanatory variables also explain the export performance of most other countries in the sample. Given the dissimilarity among countries in the patterns of their export specialization, it appears that the association of export performance with R & D effort of a given industry indicates that R & D effort is not only an important factor for exports of high technology industries but plays a non-negligible role in the exports of traditional industries as well. The specialization of Canadian manufacturing industries in exports of resource oriented industries such as paper products, wood products, metallurgy and food products is reflected in an analogical specialization in research and development. The Canadian resource oriented manufacturing industries exhibit, in terms of R & D expenditures at least, above average relative intensity of R & D (R & D expenditures per sales) and they also account for a large share of the total expenditures for R & D in the resource oriented industries.

As far as the Canadian manufacturing industries are concerned, an increase of their foreign (US) control not accompanied by an increase of research intensity and / or labour productivity worsens their export performance.

An attempt to analyze the determinants of exports to three substantially different markets: 1) European member countries of OECD 2) World outside OECD and 3) United States, was executed in two steps. First, the exports of all nine countries to OECD-Europe and to the world outside OECD were compared. The results for Canada and the European countries in the sample suggest that for a given share of R & D, an industry's share of exports to the rest of the world is higher than its share of exports to Europe. On the other hand for the United States and for Japan, the R & D elasticity of export shares is respectively slightly and substantially higher for exports going to Europe.

An analysis of exports to the U.S. market indicated that the share of U.S. manufacturing imports is for most countries of the sample (except Japan and France) positively related to the share a given national industry has in the total R & D expenditures of the same industry across the sample of nine countries. The comparative advantage expressed as the higher labour productivity and / or lower unit wages of the exporting industry compared to the importing US industry contributed to the explanation together with the negative influence of the tariff protection and distance. The U.S. control although significant for some countries (G.B., Japan) had a negligible influence on Canadian observations as well as on the total sample.

The bilateral trade between Canada and the U.S. reflects a specialization pattern of which the R & D effort is in integral part. The higher the relative intensity of R & D in the Canadian industry compared to the American industry, the higher the ratio of U.S. imports from Canada compared with the U.S. exports to Canada, i.e. the better the Canadian balance of commerce in the given industry. This finding shows that it is not realistic to assume, as economists so far did, that the pattern of R & D specialization existing in one country (U.S.) can serve as a proxy for R & D specialization in other countries (Canada).

Thus it is possible to conclude that the pattern of Canadian manufacturing exports and imports is closely associated with the level of R & D effort in each industry. The level of R & D effort in an industry is best measured by the share of the total R & D effort in the given industry across the sample than by the various relative measures such as R & D per sales or R & D employee.

As for the other determinants, the wage rate and labour productivity in the Canadian compared to the U.S. industry, complement in the expected way the explanation of the trade in manufactured goods between Canada and the United States.

The change in Canadian manufacturing exports from 1963 to 1971 were found to be mainly a result of the increase in the world demand for exports. All so called "high technology" industries (except the special case, the transport equipment industry) experienced a decrease of their export's competitiveness; their exports increased less than the world demand for them.

The changes in R & D expenditures were also decomposed in order to isolate the effect of the competitive change. The Canadian manufacturing sector exhibited a positive competitive increase of R & D expenditures of the order of nine percent. R & D expenditures of nine industries experienced a competitive increase.

Eventually, the changes in the price competitiveness of manufacturing exports were measured by an index of unit labour costs. The price competitiveness was improved in most of the "low technology" industries.

The analysis of changes in exports; R & D and in price level of thirteen Canadian manufacturing industries identified the influence of competitive changes in prices and R & D on the competitive change of exports. Predicably, the competitive change of exports by the "high technology" industries appeared to be influenced more by changes in R & D than by changes in relative prices. On the other hand, the remaining "low technology" industries appeared to rely on price changes rather than on technological competition. Although most Canadian industries recorded an increase of their R & D competitiveness, the increase was not sufficient to reverse the unfavorable effects of price increases and of other undetermined factors and the Canadian manufacturing sector suffered an overall loss in its export competitiveness.

Analysis of the growth of total manufacturing exports of nine countries again demonstrated that the competitive changes in exports are better explained by changes in both R & D and prices than by price changes only. The estimated coefficients, however, appeared very sensitive to changes in specification of the period of observation. Owing to limited data on R & D it was not possible to use calculated averages for base and end period observations which probably would have resulted in more stable and less biased estimates of partial price and R & D elasticities.

It is acknowledged that the results for less aggregated industries would have been more meaningful; unfortunately the scarcity of data made a finer break-down impossible.

REFERENCES

REFERENCES

Balassa, B. "Trade Liberalisation and "Revealed" Comparative Advantage". The Manchester School of Economies and Social Studies, vol. 33, no. 2, (May 1965), pp. 91-123.

Boretsky, M. Concerns about the Present American Position in International Trade. U.S. Dept. of Commerce, mimeo. 1973.

Drèze, J. "Les Exportations intra-CEE en 1958 et la position Belge". Recherches Economiques de LOUVAIN, vol. 27(1961), pp. 717-738.

Fleming, J.M. and S.C. Tsiang. "Changes in Competitive Strength and Export Shares of Major Industrial Countries". IMF, Staff Papers, (August 1958).

Glejser, H. "An Explanation of Differences in Trade-Product Ratios Among Countries". Cahiers Economiques de Bruxelles, 5, No. 37 (1968).

Gruber, W.H. and Vernon, R. "The Technology Factor in a World Trade Matrix". In Vernon, R. (e.d.), The Technology Factor in International Trade. New York, Columbia University Press for the Nat. Bur. of Econ. Res., 1970.

Hufbauer, G.C. "The impact of National Characteristics and Technology on the Commodity Composition of Trade in Manufacturing Goods"., In Vernon R. (e.d.), The Technology Factor in International Trade. New York, Columbia University Press., for the Nat. Bur. of Econ. Res., 1970.

Industry, Trade and Commerce. Foreign owned Subsidiaries in Canada 1964-1971. Information Canada, 1974.

Johnson, H.G. "Comparative Cost and Commercial Policy Theory for a Developing World Economy". The Wicksell Lectures for 1968. Mimeo.

Junz, H.B. and Rhomberg R.R. "Prices and Export Performance of Industrial Countries, 1953-63". IMF, Staff Papers, (July 1965), pp. 224-69.

Keesing, D.B. "The Impact of Research and Development on United States Trade". Journal of Polit. Economy, LXXV (February 1967), pp. 38-45.

Kravis, I.B. "Availability and Other Influences on the Commodity Composition of Trade". Journal of Polit. Economy vol. 64, (1956), pp. 143-155.

Kreinin, M.E. "Price Elasticities in International Trade". Review of Economics and Statistics, (November 1967), pp. 510-16.

Leamer, E.E. and Stern, R.M. Quantitative International Economics. Allyn and Bacon Inc., Boston, 1970.

Matuszewski, T.I., Pitts, P.R. and Sawyer, J.A. "Capital and Labour Requirements for Canada's Foreign Trade". Canadian Journal of Economics and Political Science, Vol. 31, (May, 1965), pp. 206-21.

Melman, S. "Twelve Propositions on Productivity and the War Economy". Challenge, (March/April 1975), pp. 7-11.

Nappi, C. "Des Méthodes Quantitatives Appliquées à la Structure Commerciale du Québec". Unpublished paper, Université du Québec à Montréal, (April 1974).

Posner, M.V. "International Trade and Technical Change". Oxford Economic Papers, vol. 31, (1961) pp. 323-341.

Richardson, J.D. "Constant Market Shares Analysis of Export Growth. Journal of International Economics, (May 1971).

Scherer, F.M. Firm size, market structure, opportunity and the output of patented inventions. American Econ. Review, (December 1965).

Vernon, R. "International Investment and International Trade in the Product Cycle". Quarterly Journal of Economics, vol. 80, (1966) pp. 190-207.

Wahl, D. "Capital and Labour Requirements for Canada's Foreign Trade". Canadian Journal of Economics and Political Science, vol. 27, (August, 1961), pp. 349-58.

Wilkinson, B.W. Canada'a International Trade: An Analysis of Recent Trends and Patterns. The Private Planning Assoc. of Canada, Montreal, 1968.

Yamazawa, I. "Intensity Analysis of World Trade Flows". Hitotsubashi Journal of Econimics, no. 1., vol.11, (June 1970), pp. 61-91.

APPENDIX A

DATA, THEIR DEFINITIONS AND SOURCES

APPENDIX A

DATA, THEIR DEFINITIONS AND SOURCES

Observations

There are fourteen industries classified according to the major group level of the present ISIC classification (2nd revision of the International Standard Industrial Classification). Because the statistics for industrial production and R & D underwent some classification changes from 1963 to 1969, some minor adjustments were necessary to assure comparability. For the same reason, the 8th industry, rubber products, had to be excluded from the sample used for analysis of changes.

<u>The list of major industry groups used in the study</u>

No.	Name	ISIC classification	Corresponding Section	Division	S.I.T.C. Group
01	Food & Beverages	311,2,3	01,11;	Except 00,04,07; 025,051,052,054	
02	Textiles	321		65	
03	Clothing, footware, leather	322,3,4		61,84,85	
04	Wood products & furniture	331,332		63,82	

05	Paper & paper products	341	25,64
06	Petroleum products	353,4	332
07	Chemicals	351,2	05 Including 23 except 52
08	Rubber products	355,	62
09	Non metalic minerals	361,2,369	66
10	Primary metals	371,2	67,68
11	Metal products	381	69
12	Machinery except electrical	382	71
13	Electrical machinery	383	72
14	Transport equipment except aircraft	part of 384	73 except 734

The list of industries gives the conversion of this ISIC classification used for industrial production data and R & D data into the Standard International Trade Classification, S.I.T.C. used for export data.

The sources of data.

There were three major sources of data.

1. Industrial production data were compiled from the United Nations, <u>The Growth of World Industry, 1970 Edition</u>, Volume 1. General Ind. Statistics, 1960-1969., U.N., New York, 1972.

When further information was necessary, especially for missing observations or variables, national statistical year books and national statistical sources were used to estimate the missing data. For the European countries, members of CEE, their Input output tables were used: CEE, "<u>Tableaux Entrées-sorties 1965</u>" Office Statistique des Communautés Européennes, Série Spéciale 7 - 1970. Luxembourg.

For additional British data:

C.S.O., <u>Input-Output Tables for the U.K. 1968</u>, Her Majesty's Stationary Office 1973.

2. R & D data.

The international survey of the resources devoted to R & D by OECD Member countries was used as the main data source.

The data for 1963 are from:

OECD, International Statistical Year For R & D, Vol. 2. Statistical Tables & Notes, OECD, Paris, 1968.

The data for 1967

OECD Directorate for Scientific Affairs, International Survey of the resources devoted to R & D in 1967 by OECD Member Countries, Statistical Tables and Notes, vol. 1 Business Enterprise Sector, Paris, OECD, 1970.

The data for 1969

OECD Directorate for Scientific Affairs, International Survey of the resources devoted to R & D in 1969 by OECD Member Countries, Statistical Tables and Notes, vol. 1 Business Enterprise Sector, Paris, OECD, 1972.

3. Export data.

The export data were taken from:

OECD International Trade Statistics, Serie B, volumes January - December, for 1963, 1965, 1967, 1969, 1971.

Tariffs

Two tariff variables were calculated: the Pre-Kennedy Round and Post-Kennedy Round tariffs. The weighted average of nominal tariffs was used. The weights were the industry's share of total imports. General sources were used:

B. Wilkinson, Canada's International Trade: An Analysis of Recent Trends and Patterns, Private Planning Association of Canada, 1968.

B. Balassa, "Tariff Protection in Industrial Countries: An Evaluation", Journal of Political Economy, (December 1965).

H.F. Henner et all, La Protection Effective dans les pays industrialisés, Paris, Economica, 1972.

4. Data on Foreign Control.

The total sales by Majority-Owned Foreign Affiliates of U.S. Companies as percentage of the total sales of the given industry, was taken as the basic measure of U.S. control over the domestic industry. The data for 1963 were provided by the U.S. Department of Commerce. Due to some minor differences in break-down, the date for several industries were estimated by decomposing the aggregated data. The data have to be, therefore considered only as an approximation of foreign control.

The data for 1967 and 1969 suffer from the same problems.

Their source:

R.D. Belli & L.C. Maley, Jr., "Sales by Majority-Owned Foreign Affiliates of U.S. Companies, 1966-1972", Survey of Current Business, volume 54, no. 8., 1974. p.27.

APPENDIX B

APPENDIX B-1

	Observation	$SAI_{w\text{-}oecd}$	$SAI_{oecd\text{-}eu}$	SAI_{w}	RARB
			Index		
	169.000000	1.297230	1.256954	1.720349	2.070683
	269.000000	0.112953	0.276285	0.213388	1.859752
	369.000000	0.210806	0.257744	0.205489	0.553678
	469.000000	1.169817	1.712493	0.774405	3.383659
CANADA	569.000000	4.229017	3.735057	5.128350	11.709348
	669.000000	0.138074	0.004802	0.149809	2.477719
	769.000000	0.418842	0.485369	0.512257	1.130662
	869.000000	0.189872	0.106979	0.309996	0.996529
	969.000000	0.116773	0.077256	0.171238	0.928947
	1069.000000	1.061563	1.526383	1.222408	3.002869
	1169.000000	0.349884	0.182169	0.492885	1.392735
	1269.000000	0.487450	0.221249	0.449815	0.591499
	1369.000000	0.438032	0.357818	0.586763	1.236433
	1469.000000	1.073700	0.104690	1.015561	0.120610
	10169.000000	0.847810	1.080662	0.944101	0.844274
	10269.000000	0.335830	0.306420	0.326924	0.421611
	10369.000000	0.283439	0.264679	0.664483	0.054041
	10469.000000	0.527508	0.284759	0.832609	0.688196
UNITED STATES	10569.000000	0.742398	1.052673	1.070503	0.828370
	10669.000000	0.780850	0.539944	0.948910	1.106229
	10769.000000	1.042624	1.162405	0.908911	0.792573
	10869.000000	0.644225	0.372224	0.590840	1.024054
	10969.000000	0.468374	0.378645	0.556543	0.791328
	11069.000000	0.502936	0.583774	0.487419	0.566661
	11169.000000	0.703358	0.435252	0.693234	1.023504
	11269.000000	1.197621	1.254367	1.020234	0.977767
	11369.000000	1.008752	1.219326	0.856378	1.014040
	11469.000000	0.822668	0.270262	0.721223	0.962872
	20169.000000	0.817436	1.324159	1.017872	2.692122
	20269.000000	2.248429	1.096812	2.499069	3.939266
	20369.000000	1.285639	0.700180	1.108720	3.358825
	20469.000000	1.128473	0.823967	0.612516	1.092200
JAPAN	20569.000000	0.288599	0.147253	0.593381	1.032988
	20669.000000	0.195885	0.002477	0.367396	0.340185
	20769.000000	0.745510	0.735210	0.825050	1.958214
	20869.000000	1.242947	0.731909	1.707000	1.061857
	20969.000000	0.952802	1.140843	0.780124	2.258837
	21069.000000	1.509723	1.117040	1.753654	3.159321
	21169.000000	1.370247	0.813128	0.962496	1.545943
	21269.000000	0.600563	0.641704	0.586882	0.866821
	21369.000000	1.759593	1.361567	1.192825	0.999235
	21469.000000	1.210085	2.137339	1.421958	1.313418
	30169.000000	1.090170	1.072610	0.617735	1.641920
	30269.000000	1.845058	1.732299	1.076352	3.444983
BELGIUM	30369.000000	1.033106	0.975871	0.402867	1.685344
	30469.000000	1.743715	1.583240	0.709861	2.767241
	30569.000000	0.600085	0.712927	0.408209	1.259498
	30669.000000	2.041551	1.396241	4.904529	0.591364
	30769.000000	0.905959	0.858472	0.945964	3.089790
	30869.000000	0.702405	0.801371	0.616076	0.278828
	30969.000000	2.009381	1.590053	6.599426	5.356250
	31069.000000	2.557428	2.325184	1.957572	4.468281
	31169.000000	0.907094	0.878681	0.990022	3.013475
	31269.000000	0.398838	0.339399	0.648615	0.768287
	21369.000000	0.495288	0.522040	0.691686	0.900772
	21469.000000	0.743176	1.042216	0.309522	0.099884
	40169.000000	0.500106	0.529436	0.299147	0.360234
	40269.000000	0.546709	0.930291	0.762296	0.488643
	40369.000000	0.639289	0.512057	0.549812	4.433575
GERMANY	40469.000000	1.257432	1.234090	0.856741	0.470502
	40569.000000	0.335838	0.424674	0.321605	0.335804
	40669.000000	0.620761	0.434017	0.908499	0.245833
	40769.000000	1.406502	1.242207	1.923607	2.135661
	40869.000000	0.948750	1.02[illegible]	0.599043	0.730894
	40969.000000	0.810242	0.845585	0.581174	0.659124
	41069.000000	0.983688	0.862797	1.194445	2.807036
	41169.000000	1.335092	1.539778	1.011823	0.638303
	41269.000000	1.353406	1.347447	1.412244	1.325603
	41369.000000	1.167249	1.332565	1.067135	1.077929
	41469.000000	1.180475	1.331205	1.092584	1.357833

	Observation	Index: SAI_{w-oecd}	Index: $SAI_{oecd-eu}$	Index: SAI_{w}	RARB
FRANCE	50169.000000	2.392846	2.314048	2.047409	0.545094
	50269.000000	1.210688	1.106606	1.008695	2.832608
	50369.000000	1.346630	1.149120	1.573864	3.353523
	50469.000000	0.735859	0.563859	1.740293	0.847733
	50569.000000	0.430357	0.463635	0.632879	0.311852
	50669.000000	1.219281	1.189545	0.599407	1.470250
	50769.000000	1.255496	1.110726	1.149215	0.997631
	50869.000000	1.909561	1.525364	1.870347	0.678599
	50969.000000	0.800843	0.729811	0.936116	1.725535
	51069.000000	1.003931	0.919284	0.878647	0.629965
	51169.000000	0.858680	0.642041	1.354866	0.371309
	51269.000000	0.794224	0.682949	0.987680	1.121313
	51369.000000	0.788705	0.675804	1.042078	0.649499
	51469.000000	0.814277	1.087449	0.960439	0.842459
ITALY	60169.000000	0.853424	0.842515	0.614851	0.414637
	60269.000000	1.634529	1.525697	1.286635	2.072421
	60369.000000	4.243822	3.798334	1.912574	1.226906
	60469.000000	1.739289	1.537200	2.455265	0.0
	60569.000000	0.281800	0.256163	0.664036	0.502853
	60669.000000	3.393171	2.548278	3.793502	0.275978
	60769.000000	0.803987	0.682557	0.923697	2.217380
	60869.000000	1.196630	0.965046	0.790999	4.383931
	60969.000000	1.061070	1.076709	0.854012	0.260433
	61069.000000	0.478778	0.372862	0.819108	1.128512
	61169.000000	1.251965	1.045497	1.556087	0.169239
	61269.000000	1.071565	0.952589	1.311314	0.410066
	61369.000000	1.007710	1.090162	1.029369	0.831529
	61469.000000	0.724181	0.992473	0.828761	3.212796
G.B.	70169.000000	1.210828	0.742191	1.343857	1.998089
	70269.000000	1.077509	1.082880	0.837591	3.003655
	70369.000000	0.901126	0.920482	0.787775	3.378145
	70469.000000	0.443920	0.337497	0.874436	3.575525
	70569.000000	0.358253	0.429327	0.572026	0.725901
	70669.000000	1.381279	1.932688	0.573955	0.678100
	70769.000000	1.118031	1.095636	1.060325	0.980009
	70869.000000	1.272283	1.484135	1.160790	0.801199
	70969.000000	2.527449	2.477772	2.019058	1.521276
	71069.000000	0.871064	0.894129	0.814328	1.281368
	71169.000000	1.142519	1.023908	1.240279	1.095516
	71269.000000	1.256395	1.252945	1.119942	1.051390
	71369.000000	0.933083	0.908680	0.996167	1.076606
	71469.000000	0.952717	1.195313	1.107074	0.892519
SWEDEN	80169.000000	0.418173	0.387263	0.514386	2.055684
	80269.000000	0.344575	0.378453	0.111525	1.026792
	80369.000000	0.636284	0.590154	0.422888	1.794890
	80469.000000	1.474036	1.372499	0.555187	3.522273
	80569.000000	5.466076	6.244052	6.783781	5.658649
	80669.000000	0.566864	0.570714	0.022168	0.246956
	80769.000000	0.469723	0.465993	0.333305	0.703887
	80869.000000	1.027046	1.130042	0.349492	0.539797
	80969.000000	0.320245	0.335864	0.143807	2.109031
	81069.000000	1.208462	1.109032	0.884904	4.726740
	81169.000000	1.228217	1.252077	1.049800	1.301083
	81269.000000	1.057815	1.007903	1.114730	1.455500
	81369.000000	0.936418	0.657440	1.773528	1.128749
	81469.000000	1.001061	0.994276	1.875363	0.657217

APPENDIX B-2

Variables

	Observation	RD/EM	QSE/EM	VA/EM	WA	RD / SA
CANADA	169.000000	0.001079	0.00107	0.010680	0.004608	0.001052
	269.000000	0.001030	0.00103	0.006985	0.004112	0.002168
	369.000000	0.000077	0.00007	0.005373	0.003426	0.000069
	469.000000	0.000164	0.00016	0.007530	0.004503	0.000618
	569.000000	0.004171	0.00417	0.011278	0.006081	0.007758
	669.000000	0.016833	0.01683	0.016683	0.007238	0.012478
	769.000000	0.018947	0.01894	0.015708	0.006037	0.017399
	869.000000	0.004333	0.00433	0.011020	0.005339	0.005727
	969.000000	0.001451	0.00145	0.011595	0.005472	0.002738
	1069.000000	0.004442	0.00444	0.011521	0.006174	0.007585
	1169.000000	0.000864	0.00086	0.009890	0.005463	0.001720
	1269.000000	0.006516	0.00651	0.010869	0.005802	0.010823
	1369.000000	0.015789	0.01578	0.008792	0.005190	0.034109
	1469.000000	0.000522	0.00052	0.013876	0.005986	0.000734
UNITED STATES	10169.000000	0.003760	0.00376	0.015706	0.006125	0.002088
	10269.000000	0.001354	0.00135	0.008755	0.004693	0.001782
	10369.000000	0.000012	0.00001	0.007398	0.004095	0.000022
	10469.000000	0.000711	0.00071	0.009005	0.005213	0.000873
	10569.000000	0.004225	0.00422	0.015336	0.006886	0.004053
	10669.000000	0.074648	0.07464	0.038028	0.009155	0.019967
	10769.000000	0.035983	0.03598	0.024188	0.008034	0.030245
	10869.000000	0.022264	0.02226	0.014340	0.006792	0.024945
	10969.000000	0.007627	0.00762	0.014068	0.006441	0.009123
	11069.000000	0.004632	0.00463	0.015467	0.007775	0.005233
	11169.000000	0.004641	0.00464	0.013361	0.006892	0.004496
	11269.000000	0.024875	0.02487	0.014815	0.007558	0.032934
	11369.000000	0.053711	0.05371	0.013194	0.006982	0.081284
	11469.000000	0.021264	0.02126	0.015884	0.007942	0.028409
JAPAN	20169.000000	0.004106	0.00410	0.003868	0.001108	0.002584
	20269.000000	0.002606	0.00260	0.002669	0.001015	0.002844
	20369.000000	0.000979	0.00097	0.002153	0.000915	0.001068
	20469.000000	0.000302	0.00030	0.002677	0.001089	0.000278
	20569.000000	0.004456	0.00445	0.004425	0.001442	0.002833
	20669.000000	0.016667	0.01666	0.014734	0.002006	0.003028
	20769.000000	0.039168	0.03916	0.009631	0.001836	0.025989
	20869.000000	0.008987	0.00898	0.004044	0.001342	0.009775
	20969.000000	0.004516	0.00451	0.004251	0.001320	0.006173
	21069.000000	0.008080	0.00808	0.006555	0.002069	0.006084
	21169.000000	0.003130	0.00313	0.003638	0.001431	0.002809
	21269.000000	0.010011	0.01001	0.004151	0.001627	0.010934
	21369.000000	0.019167	0.01916	0.004084	0.001368	0.021032
	21469.000000	0.006832	0.00683	0.005178	0.001702	0.010420
BELGIUM	30169.000000	0.001206	0.00120	0.008308	0.002254	0.000853
	30269.000000	0.000672	0.00067	0.003148	0.001800	0.002570
	30369.000000	0.000103	0.00010	0.002516	0.001532	0.000161
	30469.000000	0.000604	0.00060	0.005287	0.002083	0.001182
	30569.000000	0.001500	0.00150	0.004754	0.002438	0.003440
	30669.000000	0.007300	0.00730	0.007020	0.004420	0.007609
	30769.000000	0.018238	0.01823	0.005321	0.003394	0.061729
	30869.000000	0.002250	0.00225	0.003950	0.002650	0.005160
	30969.000000	0.002696	0.00269	0.004270	0.002351	0.009903
	31069.000000	0.003229	0.00322	0.004107	0.002844	0.009549
	31169.000000	0.001754	0.00175	0.003068	0.002351	0.011486
	31269.000000	0.002981	0.00298	0.003482	0.002585	0.010010
	31369.000000	0.015832	0.01583	0.003495	0.002594	0.050611
	31469.000000	0.000478	0.00047	0.003496	0.002588	0.001140
GERMANY	40169.000000	0.000327	0.00032	0.007177	0.002678	0.000378
	40269.000000	0.000459	0.00045	0.003165	0.002149	0.000964
	40369.000000	0.000136	0.00013	0.002899	0.001854	0.000827
	40469.000000	0.000160	0.00016	0.005707	0.002475	0.000216
	40569.000000	0.000515	0.00051	0.003763	0.002576	0.001328
	40669.000000	0.007625	0.00762	0.043250	0.003930	0.000832
	40769.000000	0.015041	0.01504	0.007972	0.003357	0.031645
	40869.000000	0.002963	0.00296	0.003204	0.002667	0.011917
	40969.000000	0.001394	0.00139	0.005674	0.002750	0.002462
	41069.000000	0.003761	0.00376	0.002757	0.002846	0.013284
	41169.000000	0.000730	0.00073	0.005204	0.002672	0.001256
	41269.000000	0.005036	0.00503	0.004976	0.002811	0.017025
	41369.000000	0.017045	0.01704	0.003179	0.002577	0.058252
	41469.000000	0.005084	0.00508	0.004407	0.002961	0.025536

Variables

	Observation	RD/EM	USE/EM	VA/EM	WA	RD/SA
FRANCE	50169.000000	0.000538	0.00053	0.004328	0.002380	0.000856
	50269.000000	0.000913	0.00091	0.001997	0.001982	0.009606
	50369.000000	1.118577	1.11857	0.003232	0.001658	0.000781
	50469.000000	0.000224	0.00022	0.003195	0.002068	0.000857
	50569.000000	0.000757	0.00075	0.003390	0.002596	0.002585
	50669.000000	0.014551	0.01455	0.021051	0.004797	0.006294
	50769.000000	0.010875	0.01087	0.006330	0.003263	0.032430
	50869.000000	0.005302	0.00530	0.005710	0.003263	0.011734
	50969.000000	0.001459	0.00145	0.002925	0.002609	0.016963
	51069.000000	0.002647	0.00264	0.007832	0.002862	0.005389
	51169.000000	0.000153	0.00015	0.001769	0.002810	0.002497
	51269.000000	0.005708	0.00570	0.004348	0.002679	0.024249
	51369.000000	0.013335	0.01333	0.004902	0.002919	0.057773
	51469.000000	0.003312	0.00331	0.003536	0.002962	0.026364
ITALY	60169.000000	0.000409	0.00040	0.007451	0.002150	0.000281
	60269.000000	0.000145	0.00014	0.003067	0.001468	0.001263
	60369.000000	0.000059	0.00005	0.002604	0.001201	0.000140
	60469.000000	0.0	0.0	0.003108	0.001330	0.0
	60569.000000	0.000451	0.00045	0.005202	0.002027	0.000944
	60669.000000	0.002105	0.00210	0.017341	0.003787	0.001627
	60769.000000	0.014193	0.01419	0.009050	0.002707	0.016824
	60869.000000	0.005527	0.00552	0.005931	0.002268	0.021813
	60969.000000	0.000086	0.00008	0.004430	0.001700	0.000439
	61069.000000	0.000515	0.00051	0.006288	0.002388	0.002242
	61169.000000	0.000104	0.00010	0.004287	0.001854	0.000286
	61269.000000	0.002034	0.00203	0.005280	0.002252	0.004593
	61369.000000	0.011864	0.01186	0.004998	0.002202	0.025716
	61469.000000	0.002506	0.00250	0.005385	0.002570	0.022418
G.B.	70169.000000	0.001517	0.00151	0.003758	0.002134	0.003541
	70269.000000	0.001313	0.00131	0.002480	0.001826	0.005683
	70369.000000	0.000119	0.00011	0.001923	0.001482	0.001076
	70469.000000	0.000931	0.00093	0.002977	0.002112	0.003074
	70569.000000	0.001181	0.00118	0.004022	0.002510	0.002863
	70669.000000	0.016096	0.01609	0.005811	0.002532	0.010048
	70769.000000	0.013846	0.01384	0.004130	0.002362	0.030217
	70869.000000	0.002389	0.00238	0.003782	0.002021	0.013279
	70969.000000	0.002634	0.00263	0.003108	0.002177	0.009667
	71069.000000	0.002340	0.00234	0.003422	0.002597	0.006520
	71169.000000	0.000526	0.00052	0.002106	0.001773	0.004516
	71269.000000	0.003842	0.00384	0.004468	0.002484	0.018891
	71369.000000	0.009567	0.00956	0.002592	0.001963	0.069308
	71469.000000	0.001799	0.00179	0.003740	0.004101	0.017681
SWEDEN	80169.000000	0.001722	0.00172	0.009883	0.004057	0.002242
	80269.000000	0.001297	0.00129	0.006416	0.003589	0.003289
	80369.000000	0.000151	0.00015	0.004875	0.003183	0.000499
	80469.000000	0.000455	0.00045	0.006608	0.003820	0.000991
	80569.000000	0.003562	0.00356	0.008617	0.004280	0.006425
	80669.000000	0.004483	0.00448	0.021598	0.004866	0.006673
	80769.000000	0.010611	0.01061	0.011293	0.004532	0.026190
	80869.000000	0.001288	0.00128	0.006854	0.004159	0.008954
	80969.000000	0.002331	0.00233	0.008246	0.004150	0.009152
	81069.000000	0.006971	0.00697	0.008121	0.004724	0.021371
	81169.000000	0.001147	0.00114	0.007385	0.004332	0.003125
	81269.000000	0.004890	0.00489	0.007443	0.004589	0.023673
	81369.000000	0.015703	0.01570	0.007374	0.004630	0.071365
	81469.000000	0.011475	0.01147	0.007507	0.004748	0.012178

Variables

Country	Observation	TARIF	EMPL	SALES	CONTROL
CANADA	169.000000	0.0	229000.000000	7777.730469	0.216644
	269.000000	12.200000	100000.000000	1718.417236	0.303186
	369.000000	17.699997	130000.000000	1501.869141	0.229714
	469.000000	9.799999	134000.000000	2239.996582	0.228572
	569.000000	4.599999	117000.000000	3113.953125	0.218372
	669.000000	6.900000	18000.000000	1591.588623	1.077539
	769.000000	7.900000	75000.000000	2497.571533	0.711891
	869.000000	4.700000	27000.000000	621.832764	0.787993
	969.000000	9.200000	51000.000000	1129.497070	0.457726
	1069.000000	4.500000	113000.000000	3202.711426	0.299746
	1169.000000	11.500000	125000.000000	2608.617188	0.284059
	1269.000000	8.400000	93000.000000	1961.060059	0.842911
	1369.000000	7.700000	128000.000000	2565.984375	0.583402
	1469.000000	4.900000	113000.000000	4531.597656	1.025686
United States	10169.000000	0.0	1649000.000000	79512.937500	0.0
	10269.000000	17.199997	1108000.000000	23570.992188	0.0
	10369.000000	17.299988	1514000.000000	23071.992188	0.0
	10469.000000	5.799999	844000.000000	16035.996094	0.0
	10569.000000	3.299999	639000.000000	20971.992188	0.0
	10669.000000	6.799999	142000.000000	22085.992188	0.0
	10769.000000	9.400000	1170000.000000	50090.984375	0.0
	10869.000000	5.200000	265000.000000	7295.996094	0.0
	10969.000000	13.099999	590000.000000	14358.996094	0.0
	11069.000000	5.599999	1209000.000000	43570.996094	0.0
	11169.000000	8.400000	1422000.000000	36479.980469	0.0
	11269.000000	5.799999	1998000.000000	52983.996094	0.0
	11369.000000	7.900000	1819000.000000	43919.996094	0.0
	11469.000000	4.500000	1171000.000000	46500.000000	0.0
JAPAN	20169.000000	0.0	980000.000000	13873.613281	0.004541
	20269.000000	10.099999	1187000.000000	9347.242188	0.000535
	20369.000000	15.000000	334000.000000	1970.725342	0.000507
	20469.000000	8.299999	696000.000000	5422.394531	0.000369
	20569.000000	7.799999	310000.000000	4005.765381	0.002247
	20669.000000	16.299988	36000.000000	3033.927490	0.518470
	20769.000000	10.200000	487000.000000	9755.929688	0.034646
	20869.000000	7.000000	149000.000000	1307.660645	0.003059
	20969.000000	11.000000	490000.000000	4103.015625	0.000487
	21069.000000	8.099999	624000.000000	14153.195313	0.000071
	21169.000000	9.500000	687000.000000	5973.324219	0.000167
	21269.000000	10.099999	966000.000000	9583.867188	0.041111
	21369.000000	10.099999	1039000.000000	11329.480469	0.004590
	21469.000000	14.299999	754000.000000	11713.382813	0.000171
BELGIUM	30169.000000	0.0	107000.000000	2862.579346	0.054496
	30269.000000	9.000000	131000.000000	1010.379639	0.027712
	30369.000000	10.400000	97000.000000	732.179932	0.020487
	30469.000000	5.599999	48000.000000	360.395752	0.016648
	30569.000000	5.299999	26000.000000	284.279785	0.014071
	30769.000000	7.599999	63000.000000	724.031738	0.459925
	30869.000000	4.000000	8000.000000	72.679947	0.825537
	30969.000000	9.700000	69000.000000	677.579346	0.029517
	31069.000000	4.200000	118000.000000	1424.723145	0.065276
	31169.000000	7.700000	61000.000000	318.137939	0.069152
	31269.000000	6.400000	115400.000000	1036.591797	0.248893
	31369.000000	8.400000	59500.000000	474.162354	0.274168
	31469.000000	11.300000	71100.000000	909.861084	0.249489
GERMANY	40169.000000	0.0	468000.000000	17130.894531	0.026735
	40269.000000	9.000000	486000.000000	4614.000000	0.040529
	40369.000000	10.400000	516000.000000	4532.878906	0.035518
	40469.000000	5.599999	268000.000000	4052.479004	0.011845
	40569.000000	5.299999	194000.000000	2372.500000	0.017703
	40669.000000	5.799999	32000.000000	10753.675781	0.203093
	40769.000000	7.599999	336000.000000	11793.476563	0.053335
	40869.000000	4.000000	108000.000000	996.479492	0.047166
	40969.000000	9.700000	350000.000000	4051.439697	0.035276
	41069.000000	4.200000	74000.000000	7772.398438	0.022387
	41169.000000	7.700000	540000.000000	7446.496094	0.007789
	41269.000000	6.400000	1042000.000000	12703.246094	0.076988
	41369.000000	8.400000	892000.000000	5955.597656	0.071529
	41469.000000	11.500000	582000.000000	6668.996094	0.234518

Variables

Country	Observation	TARIF	EMPL	SALES	CONTROL
FRANCE	50169.000000	0.0	500000.000000	10949.957031	0.031050
	50269.000000	9.000000	482000.000000	2570.488037	0.036180
	50369.000000	10.400000	447000.000000	3481.487549	0.039925
	50469.000000	5.599999	246000.000000	1760.495850	0.035785
	50569.000000	5.299999	136000.000000	1083.367920	0.042460
	50669.000000	5.799999	69000.000000	8148.523438	0.153402
	50769.000000	7.599999	320000.000000	5145.332031	0.120109
	50869.000000	4.000000	63000.000000	899.329834	0.124537
	50969.000000	9.700000	283000.000000	1473.536865	0.054291
	51069.000000	4.200000	187000.000000	4115.671875	0.027699
	51169.000000	7.700000	464000.000000	2085.194824	0.030693
	51269.000000	6.400000	719000.000000	7221.019531	0.120343
	51369.000000	8.400000	355000.000000	3463.250000	0.112322
	51469.000000	11.500000	452000.000000	3836.010254	0.038060
ITALY	60169.000000	0.0	203000.000000	5067.386719	0.036705
	60269.000000	9.000000	415000.000000	2851.080566	0.018589
	60369.000000	10.400000	253000.000000	1416.393555	0.019062
	60469.000000	5.599999	125000.000000	753.800049	0.039798
	60569.000000	5.299999	71000.000000	952.971680	0.030431
	60669.000000	5.799999	19000.000000	1179.677246	0.817173
	60769.000000	7.599999	244000.000000	4394.351563	0.090571
	60869.000000	4.000000	55000.000000	623.033691	0.046546
	60969.000000	9.700000	222000.000000	1711.089111	0.023961
	61069.000000	4.200000	237000.000000	3531.934326	0.041337
	61169.000000	7.700000	182000.000000	1654.260742	0.045942
	61269.000000	6.400000	235000.000000	2779.445313	0.149670
	61369.000000	8.400000	191000.000000	1985.573486	0.160155
	61469.000000	11.500000	261000.000000	3429.516357	0.018662
G.B.	70169.000000	0.0	805000.000000	11739.257813	0.078710
	70269.000000	12.700000	734000.000000	5570.957031	0.080776
	70369.000000	15.299999	581000.000000	3072.777832	0.091123
	70469.000000	6.599999	288000.000000	2503.311768	0.017577
	70569.000000	7.500000	232000.000000	2752.361328	0.017803
	70669.000000	2.700000	52000.000000	2846.610352	0.996975
	70769.000000	7.200000	514000.000000	6559.363281	0.234321
	70869.000000	6.299999	131000.000000	1134.552734	0.236216
	70969.000000	11.000000	352000.000000	2756.491211	0.099039
	71069.000000	6.799999	592000.000000	8366.207031	0.071717
	71169.000000	12.000000	726000.000000	4112.757813	0.109172
	71269.000000	9.099999	1094000.000000	10509.355469	0.163568
	71369.000000	11.500000	915000.000000	5786.214844	0.121841
	71469.000000	11.700000	678000.000000	7327.558594	0.249606
SWEDEN	80169.000000	0.0	72000.000000	2725.343018	0.010641
	80269.000000	9.000000	37000.000000	470.023926	0.010638
	80369.000000	10.400000	52900.000000	502.859863	0.009943
	80469.000000	2.799999	74800.000000	1092.393311	0.009154
	80569.000000	2.000000	61200.000000	1365.840576	0.008786
	80769.000000	4.599999	36000.000000	776.477783	0.110757
	80869.000000	6.299999	13200.000000	161.939484	0.271706
	80969.000000	6.000000	42900.000000	576.626465	0.010405
	81069.000000	1.400000	64700.000000	1345.072021	0.007435
	81169.000000	6.000000	76700.000000	1008.193359	0.006943
	81269.000000	6.000000	123100.000000	1658.491455	0.092252
	81369.000000	6.000000	64000.000000	841.615723	0.034458
	81469.000000	3.000000	55100.000000	1119.099854	0.0

APPENDIX C

Table 1 APPENDIX C

Regressions relating degree of specialisation in exports to OECD-EUROPE, S_{AEI}, of 13 manufacturing industries to the explanatory variables

$S_{A,E,I} = a_0 + a_1\,(RARB) + a_2\,(IWA/VA) + a_3\,(I\ TARIFF) + a_4\,(I\ CONTROL) + a_5\,D_{A\ OEUR}$

EXPorting country	a_0	a_1 (RARB)	a_2 (IWA/VA)	a_3 (I TARIFF)	a_4 (I CONTROL)	a_5 $D_{A\ OEUR}$	R^2	No. of observations
	Net regression coefficients of independent variables and (t statistics).							
Canada	-0.059 (-0.1)	0.334 (9.0)*	-0.835 (-1.2)	0.577 (1.3)	0.197 (0.5)	——	0.94 *	13
US	1.516 (0.8)	0.377 (0.8)	-1.030 (-0.7)	-0.166 (-0.3)	——	——	0.18	13
Japan	3.011 (1.8)	-0.082 (-0.5)	-1.490 (-1.4)	-0.253 (-0.3)	-0.475 (-1.5)	——	0.47	13
Belgium	1.649 (1.6)	0.265 (3.3)*	-1.568 (-1.8)	0.212 (0.3)	0.210 (1.0)	——	0.69 *	12
Germany	0.509 (0.5)	-0.037 (-0.3)	0.064 (0.2)	0.543 (0.6)	-0.057 (-0.3)	——	0.07	13
France	2.080 (3.2)*	0.067 (0.8)	-0.175 (-1.3)	-0.598 (-1.1)	-0.339 (-3.0)*	——	0.66 *	13
Italy	-4.172 (-1.1)	-0.057 (-0.2)	7.710 (2.2)*	-2.080 (-1.9)	-0.402 (-0.5)	——	0.48	13
UK	3.893 (2.1)*	-0.217 (-1.5)	-1.044 (-0.7)	-1.644 (-2.0)	0.163 (0.1)	——	0.43	13
Sweden	-0.529 (-0.4)	0.485 (2.3)*	3.566 (2.1)*	-3.182 (-2.2)*	0.005 (0.6)	——	0.72 *	12
Total sample	0.977 (2.5)*	0.240 (5.5)*	-0.001 (-0.0)	-0.208 (-0.7)	-0.066 (-0.6)	-0.004 (-1.8)	0.24 *	115

Note:* Significant at 0.05 level

Industry 1 - Food and beveridge was not included because of data problem.

Table 2 APPENDIX C

Regression relating degree of specialisation in EXPorts, S_{AI}, to World outside OECD to the EXPlanatory variables

$S_{A,W-oecd,I}$ = a_0	+ a_1 (RARB)	+ a_2 I(WA/VA)	+ a_3 (I TARIFF)	+ a_4 (I CONTROL)	R^2	Number of observations
EXPorting country	Net Regression coefficients of independent variables and (t statistics)					

EXPorting country	a_0	a_1 (RARB)	a_2 I(WA/VA)	a_3 (I TARIFF)	a_4 (I CONTROL)	R^2	Number of observations
Canada	1.862 (1.4)	0.433 (8.5) *	-1.068 (-1.1)	-0.840 (-1.4)	-0.044 (-0.1)	0.92 *	14
US	0.141 (0.2)	0.214 (1.0)	0.823 (1.3)	-0.412 (-1.5)	———	0.44	14
Japon	2.132 (1.3)	0.259 (1.7)	-1.203 (-1.2)	0.160 (0.2)	-0.232 (-0.7)	0.51	14
Belgium	-2.965 (-0.9)	0.825 (3.0) *	0.203 (0.1)	2.023 (0.8)	0.213 (0.3)	0.58	13
Germany	0.300 (0.3)	0.129 (1.1)	-0.059 (-0.2)	0.695 (0.7)	-0.159 (-0.8)	0.14	14
France	2.279 (1.5)	-0.121 (-0.6)	0.052 (0.2)	-1.159 (-0.9)	0.092 (0.9)	0.10	14
Italy	-6.15 (-2.1) *	0.091 (0.9)	7.646 (2.8) *	-1.267 (-1.9)	0.899 (1.5)	0.60	14
UK	0.652 (0.5)	-0.038 (-0.3)	-0.069 (-0.1)	0.249 (0.9)	0.275 (0.8)	0.08	14
Sweden	3.943 (0.6)	0.618 (1.8)	-4.137 (-0.6)	-0.430 (-0.2)	0.27 (0.6)	0.52	13
Total sample	-1.805 (-1.2)	1.603 (9.7) *	-0.063 (-0.1)	0.219 (0.2)	0.531 (1.5)	0.45 *	124

Note: * Significant at 0.05 level

APPENDIX D

APPENDIX D

<u>Constant Market Share analysis of exports (CMS)</u>

1) The change of exports due to increase in world trade:

$$EXWT^{*}_{A,W,I} = EX_{A,W,I} \quad \frac{EX'_{TT}}{EX_{TT}} - 1$$

2) The change of exports due to commodity composition:

$$EXCC^{*}_{A,W,I} = EX_{A,W,I} \quad \frac{EX'_{TI}}{EX_{TI}} - 1$$

3) The change of exports due to market distribution:

$$EXMD^{*}_{A,W,I} = \sum_{B=1}^{7} \frac{EX'_{TI(B)}}{EX_{TI\ B}} - 1 \circ EXT_{A,(B)} - EX_{A,W,I} \quad \frac{EX'_{TI}}{EX_{TI}} - 1$$

4) The change of exports due to increased competitive capacity:

$$EXCC^{*}_{A,W,I} = EX'_{A,W,I} - EX_{A,W,I} - \sum_{B=1}^{7} \frac{EX'_{TI(B)}}{EX_{TI(B)}} - 1 \quad EXT_{A(B)}$$

$$EX'_{T1(B)} = \sum_{A=CA}^{SW} EX'_{A,I,B}$$

Deflated value of total exports of industry I to market B in period 2.

$$EX_{TT} = \sum_{I=1}^{13} EX_{T,I}$$

Deflated value of total exports of all countries and all industries in period 1.

$$EX'_{TT} = \sum_{I=1}^{13} EX_{T,I}$$

Deflated value of total exports of all countries and all industries in period 2.

(I = 1....13)

1 - Food and drink industry
2 - Textile
3 - Clothing & footware
4 - Wood products
5 - Paper products
6 - Petroleum products
7 - Chemical
8 - Non-metalic minerals
9 - Primary metals
10 - Fabricated metal product
11 - Machinery (except electrical)
12 - Electrical products
13 - Transport Equipment

<u>The symbols are defined:</u>

A = Country of origin (A = Canada; US; JApan; BElgium; GErmany; FRance; ITaly; G.B.; SWeden)

B = Country or market area of destination (B = CA; US; JA; EEC; EFTA; OECD Europe except (EEC + EFTA); World outside OECD, world).

$EX_{A,W,I}$ = Deflated value of A's exports of industry I to market W(= world) in period 1.

$EX'_{A,W,I}$ = Deflated value of A's exports of industry I to market W in period 2.

$EXT_{A(B)}$ = Deflated value of total A's exports to market B in period 1.

$EX_{TI} = \sum_{A=CA}^{SW} EX_{A,W,I}$, Deflated value of total exports of industry I in period 1.

$EX'_{T1} = \sum_{A=CA}^{SW} EX_{A,W,I}$, Deflated value of total exports of industry I in period 2.

$EX_{TI(B)} = \sum_{A=CA}^{SW} EX_{A,I,B}$ Deflated value of total exports of industry I to market B in period 1.

TECHNOLOGICAL INNOVATION STUDIES PROGRAM

PROGRAMME DES ETUDES SUR LES INNOVATIONS TECHNIQUES

REPORTS/RAPPORTS

	AUTHOR(S)/AUTEUR(S)	UNIVERSITY/UNIVERSITE	REPORT TITLE/TITRE DE L'OUVRAGE
1.	I.A. Litvak C.J. Maule	Department of Economics, Carleton University.	Canadian Entrepreneurship: A Study of Small Newly Established Firms, October, 1971.
2.	Harold Crookell	School of Business Administration, University of Western Ontario.	The Transmission of Technology Across National Boundaries, February, 1973.
3.	M.H.E. Atkinson	Faculty of Graduate Studies, University of Western Ontario.	Factors Discriminating Between Technological Spin-Offs and Research and Development Personnel, August, 1972. (M.A. Thesis)
4.	R.M. Knight	School of Business Administration, University of Western Ontario.	A Study of Venture Capital Financing in Canada, June, 1973.
5.	Blair Little R.G. Cooper R.A. More	School of Business Administration, University of Western Ontario.	The Assessment of Markets for the Development of New Industrial Products in Canada, December, 1971.
6.	F. Zabransky J. Legg	School of Business Administration, University of Western Ontario.	Information and Decision Systems Model for PAIT Program, October, 1971.
7.	K.R. MacCrimmon W.T. Stanbury J. Bassler	Faculty of Commerce and Business Administration, University of British Columbia.	Risk Attitudes of U.S. and Canadian Top Managers, September, 1973.
8.	James C.T. Mao	Faculty of Commerce and Business Administration, University of British Columbia.	Computer Assisted Cash Management in a Technology-Oriented Firm, March, 1973.
9.	J.W.C. Tomlinson	Faculty of Commerce and Business Administration, University of British Columbia.	Foreign Trade and Investment Decisions of Canadian Companies, March, 1973.
10.	Gérard Garnier	Faculty of Management University of Sherbrooke	Characteristics and Problems of Small and Medium Exporting Firms in the Quebec Manufacturing Sector with Special Emphasis on Those Using Advanced Production Techniques, August, 1974.
11.	I.A. Litvak C.J. Maule	Department of Economics, Carleton University.	A Study of Successful Technical Entrepreneurs in Canada, September, 1972.
12.	Y. Allaire, J.M. Toulouse	Faculty of Management Sciences, University of Ottawa.	Psychological Profile of French-Canadian M.B.A. Students: Consequences for a Selection Policy, December, 1972.
13.	Carl Prézeau	Faculté d'administration, Université de Sherbrooke.	The Portfolio Effect in Canadian Exports, May, 1973.
14.	M.R. Hecht J.P. Siegel	Faculty of Management Studies, University of Toronto.	A Study of Manufacturing Firms in Canada: With Special Emphasis on Small and Medium Sized Firms, December, 1973.
15.	Blair Little	School of Business Administration, University of Western Ontario.	The Development of New Industrial Products in Canada. (A Summary Report of Preliminary Results, Phase I) April, 1972.
16.	A.R. Wood J.R.M. Gordon R.P. Gillin	School of Business Administration, University of Western Ontario.	Comparative Managerial Problems in Early Versus Later Adoption of Innovative Manufacturing Technologies, (Six Case Studies), February, 1973.
17.	S. Globerman	Faculty of Administrative Studies, York University.	Technological Diffusion in Canadian Manufacturing Industries, April, 1974.
18.	M. James Dunn Boyd M. Harnden P. Michael Maher	Faculty of Business Administration and Commerce, University of Alberta.	An Investigation into the Climate for Technological Innovation in Canada, May, 1974.
19.	K.R. MacCrimmon A. Kwong	Faculty of Commerce and Business Administration, University of British Columbia.	Measures of Risk Taking Propensity, July, 1972.
20.	I.A. Litvak C.J. Maule	Department of Economics, Carleton University.	Climate for Entrepreneurs: A Comparative Study, January, 1974.

AUTHOR(S)/AUTEUR(S)	UNIVERSITY/UNIVERSITE	REPORT TITLE/TITRE DE L'OUVRAGE
21. J. Robidoux Gerard Garnier	Faculte d'administration, Université de Sherbrooke.	Factors of Success and Weakness Affecting Small and Medium-Sized Manufacturing Businesses in Quebec, Particularly those Businesses using Advanced Production Techniques, December, 1973. Facteurs de Succes et Faiblesses des Petites et Moyennes Entreprises Manufacturieres au Québec, Specialement des Entreprises Utilisant des Techniques de Production Avancees, decembre, 1973.
22. I. Vertinsky K. Hartley	Faculty of Commerce and Business Administration, University of British Columbia.	Project Selection in Monolithic Organizations, August, 1974.
23. Yvan Allaire J.M. Toulouse	Faculty of Management Sciences, University of Ottawa.	A Comparative Study of the Values and Needs of French-Speaking and English-Speaking M.B.A. Students, August, 1973.
24. Jean Robidoux	Faculte d'administration, Université de Sherbrooke.	Analytical Study of Significant Traits Observed Among a Particular Group of Inventors in Quebec, August, 1974. Etude Analytique de Traits Significatifs Observes Chez un Groupe Particular D'Inventeurs au Québec, Août, 1974.
25. Blair Little	School of Business Administration, University of Western Ontario.	Risks in New Product Development, June, 1972.
26. Blair Little R.G. Cooper	School of Business Administration, University of Western Ontario.	Marketing Research Expenditures: A Descriptive Model, November, 1973.
27. Blair Little	School of Business Administration, University of Western Ontario.	Wrecking Ground for Innovation, February, 1973.
28. J.W.C. Tomlinson	Faculty of Commerce and Business Administration, University of British Columbia.	Foreign Trade and Investment Decisions of European Companies, June, 1974.
29. Blair Little	School of Business Administration, University of Western Ontario.	The Role of Government in Assisting New Product Development, March, 1974.
30. R.G. Cooper	Faculty of Management, McGill University.	Why New Industrial Products Fail, January, 1975.
31. M.E. Charles D. MacKay	The C.E.R.C.L. Foundation, 200 College Street, Toronto, Ontario. M5S 1A4	Case Studies of Industrial Innovation in Canada, February, 1975.
32. M.R. Hecht	Faculty of Management Studies, University of Toronto.	A Study of Manufacturing Firms in Canada: With Emphasis on Education of Senior Officers, Types of Organization and Success, March, 1975.
33. I.A. Litvak C.J. Maule	Department of Economics, Carleton University.	Policies and Programmes for the Promotion of Technological Entrepreneurship in the U.S. and U.K.: Perspectives for Canada, May, 1975.
34. R.R. Britney E.F.P. Newson	School of Business Administration, University of Western Ontario.	The Canadian Production/Operations Management Environment: An Audit, April, 1975.
35. R.F. Morrison P.J. Halpern	Faculty of Management Studies, University of Toronto.	Innovation in Forest Harvesting by Forest Products Industries, May, 1975.
36. J.C.T. Mao	Faculty of Commerce and Business Administration, University of British Columbia.	Venture Capital Financing for Technologically-Oriented Firms, December, 1974.
37. J.W.C. Tomlinson C.S. Willie	Faculty of Commerce and Business Administration, University of British Columbia.	Guide to the Pacific Rim Trade and Economic Database, September, 1975.

	AUTHOR(S)/AUTEUR(S)	UNIVERSITY/UNIVERSITÉ	REPORT TITLE/TITRE DE L'OUVRAGE
38.	D.A. Ondrack	Faculty of Management Studies, University of Toronto.	Foreign Ownership and Technological Innovation in Canada: A Study of the Industrial Machinery Sector of Industry, July, 1975.
39.	James C.T. Mao	Faculty of Commerce and Business Administration, University of British Columbia.	Lease Financing for Technology-Oriented Firms, July 1975.
40.	John A. Watson	Faculty of Business Administration and Commerce, University of Alberta.	A Study of Some Variables Relating to Technological Innovation in Canada, June, 1975.
41.	Gary A. Sheehan Donald H. Thain Ian Spencer	School of Business Administration, University of Western Ontario.	The Relationships of Long Range Strategic Planning to Firm Size and to Firm Growth, August, 1975.(Ph.D. Thesis)
42.	John P. Killing	School of Business Administration, University of Western Ontario.	Manufacturing Under License in Canada, February, 1975. (Ph.D. Thesis)
43.	Peter R. Richardson	School of Business Administration, University of Western Ontario.	The Acquisition of New Process Technology by Firms in the Canadian Mineral Industries, April, 1975. (Ph.D. Thesis)
44.	Steven Globerman	Faculty of Administrative Studies, York University.	Sources of R&D Funding and Industrial Growth in Canada, August, 1975
45.	R.G. Cooper	Faculty of Management, McGill University.	Winning the New Product Game, June, 1976.
46.	Petr Hanel	Department of Economics, University of Sherbrooke.	The Relationship Existing Between the R&D Activity of Canadian Manufacturing Industries and Their Performance in the International Market, August, 1976

Reports may be obtained by writing

Program Manager
Technological Innovation Studies Program
Office of Science and Technology
Department of Industry, Trade and Commerce
112 Kent Street
Ottawa, Ontario
K1A 0H5

5