AN EMPIRICAL TEST OF PROPOSITIONS ON CROSS-COUNTRY DETERMINANTS OF INTRA-INDUSTRY TRADE IN CANADA

by

TANG,YENG YUEN
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[redacted]
DEAN
DATE Jan 29, 86

We accept this thesis as conforming
to the required standard

[redacted]

Dr. D.G. Ferguson

[redacted]

Dr. J.C.H. Jones

[redacted]

Dr. J.J. McRae

[redacted]

Dr. W.M. Ross

UNIVERSITY OF VICTORIA

December 1985

Supervisor: Dr. D.G. Ferguson

ABSTRACT

A substantial proportion of international trade takes the form of a two way exchange of commodities belonging to the same industrial category. Such intra-industry trade falls outside the domain of the traditional theories of comparative advantage which are concerned with inter-industry trade based on countries specializing in different industries. Earlier informal explanations for intra-industry trade have recently been supplemented by the development of formal trade-theoretic models.

The objective of this thesis is to test those predictions of the new theory which relate the overall level of intra-industry trade between countries to the countries' characteristics. In this respect, the theoretical literature suggests that the level of intra-industry trade between countries will be greater (i) the more similar are the countries' comparative advantage, (ii) the more similar their per capita incomes, and (iii) the higher their per capita incomes. The tests are carried out using data on Canada's trade in seventy (three digit SIC) manufacturing industries

with forty countries. The results provide strong support for the first two propositions but only weak support for the third.

Intra-industry trade has attracted interest not only because of its extent and its theoretical implications, but also because of its implications for the effects of trade liberalization. In particular, in conformity with the experience of countries entering the EEC and other trade liberalization arrangements, the results obtained here suggest that trade liberalization is more likely to lead to increased intra-industry trade, rather than inter-industry specialization, if the countries involved are at similar levels of development and have a similar comparative advantage.

Examiners:

[redacted]

Dr. D.G. Ferguson

[redacted]

Dr. J.C.H. Jones

[redacted]

Dr. J.J. McRae

[redacted]

Dr. W.M. Ross

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Chapter I

INTRODUCTION

International trade flows can be divided into two distinct categories: inter-industry trade and intra-industry trade. The inter-industry exchange of commodities refers to situations in which products of one industry are exchanged for products of a different industry. An example is the exchange of French wine for German machinery. In the case of intra-industry trade, products of a particular industry are exchanged for outputs of its foreign counterparts. The exchange of automobiles between countries is perhaps a good illustration of intra-industry trade. For example, France exports Renault to the United States while importing American made Ford; Germany exports Volkswagen to France and the United States while at the same time importing Renault and Ford from France and the United States.

Intra-industry trade, specifically trade in manufactures, is an empirical phenomenon which has received increasing attention in recent literature.[1] There are three major are-

[1] Interest in this phenomenon stems mainly from the observation that a large proportion of intra-industry trade is not only between countries that have relatively similar

as of interest. The first area of interest is the empirical assessment of the magnitude of intra-industry trade in international trade. In particular, the importance of intra-industry trade among industrialized countries has been well documented [Balassa (1967); Alder (1970); Grubel and Lloyd (1975); Hesse (1974); Aquino (1978); Greenaway (1983)].

Although early researchers concentrated on the measurement of intra-industry trade, greater emphasis is now placed on providing a theoretical underpinning for this observed phenomenon. Hence, a number of models that attempt to explain and predict the emergence of intra-industry trade have been developed [Balassa (1967); Grubel (1970); Gray (1973, 1980); Grubel and Lloyd (1975); Krugman (1979, 1980); Lancaster (1980); Helpman (1981); Brander (1981); Either (1982)]. This is the second major area of interest.

Finally, a number of econometric studies have been undertaken to test the various theories of intra-industry trade. Specifically, the effects of inter-industry differences on intra-industry trade have been studied extensively [Pagou-

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factor endowments but also involves two-way exchange of goods that are produced with similiar factor proportions. This observation thus brings into question the adequacy of the Heckscher-Ohlin-Samuelson theory of trade. The Heckscher-Ohlin- Samuelson theory attributes the basic cause of trade to the relative differences in countries' factor endowments and industries' factor intensities.

latos and Sorensen (1975); Lundberg (1982); Toh (1982); Caves (1981); Loertscher and Wolter (1980)].

1.1 Objectives

The approach of this thesis falls within the third area of interest since its emphasis is on the empirical testing of a set of propositions which are derived from the theoretical literature.

The objective of this thesis is to test a set of propositions which stress the differences in cross-country characteristics, rather than inter-industry differences, as determinants of the level of intra-industry trade. The propositions are tested using 1980 data for Canada's trade with each of 40 different countries in 70 industries classified at the 3 digit level of the Standard Industrial Classification(SIC). In constructing the indices of intra-industry trade the data is further disaggregated to the 4 digit level of the SIC. In both of these respects, the test of cross-country propositions and the use of Canadian trade data, this thesis represents a departure from previous work.

1.2 Outline

In Chapter 2 some of the major studies which have identified the significance of the phenomenon of intra-industry trade will be reviewed. Trade in manufactures will be emphasized. The importance of manufactures in world trade is shown by a general analysis of the world's commodity and manufacturing trade patterns for the year 1980. In addition, a study of the pattern of trade and specialization of seventy Canadian manufacturing industries from 1966 to 1980 is incorporated into this chapter.

The derivation of three major testable propositions is presented in Chapter 3. Since these three propositions are drawn mainly from a new class of trade models which incorporate differentiated products, increasing returns and imperfect market structures, a review of the basic structure of such models, mainly those by Krugman (1979, 1980) and Helpman (1981), will be carried out.

The principal theme emerging from these models is that trade between two countries tends to be predominantly inter-industry in nature when the countries differ significantly in their comparative advantage and intra-industry in nature the more similar is the countries' comparative advantage. This provides a basis for synthesizing the explanations of intra-industry trade with explanations of inter-industry trade based on conventional theories of comparative advantage. This point is of significance not only for the derivation of the propositions in Chapter 3 but also for overcoming a problem discussed in the subsequent chapters.

Chapter 4 addresses two problems of measurement which arise in testing the propositions. The first concerns the choice of an appropriate index to measure intra-industry trade and the level of disaggregation to be used in constructing the index. The nature of this problem and how it has been dealt with elsewhere is discussed. The second problem arises from the lack of consistent international data on factor endowments - data which is necessary to incorporate the factor proportion theory of comparative advantage, which is now the dominant theory. This problem is dealt with by using countries' revealed comparative advantage and the formal structure of the factor proportion theory to construct proxy variables for the countries' factor endowments. The procedure for doing so, and its rationale would be presented in this chapter.

In Chapter 5, the estimation procedure, the empirical model and the problems encountered in estimating the model are described. The empirical results will be outlined and their use in testing the propositions will be presented in the final section of that chapter.

Chapter II

THE PHENOMENON OF INTRA-INDUSTRY TRADE

Intra-industry trade in manufactured goods is a growing phenomenon in international trade. The main purpose of Section 1 of this chapter is to discuss the significance of this phenomenon by reviewing a number of studies that have analysed trade flows within regional trade arrangements among industrialized nations, Central American developing countries and countries with centralized economies. The review concentrates on regional trade arrangements because a major proportion of the studies on intra-industry trade are centred on the trade pattern of countries which are members of these regional trade arrangements. Having established the significance of intra-industry trade in manufactured products, Section 2 presents a general overview of the international trade pattern in total commodities and manufactured products for the year 1980. Since this study is based upon Canadian data, it is therefore appropriate that an analysis of Canadian trade performance in its manufacturing sector be carried out. This is done in Section 3.

2.1 Survey of the Empirical Evidence of Intra-Industry Trade

Economists, such as Harberler (1936), have long been aware of the existence of intra-industry trade between countries. However, it was only after world trade liberalization measures such as the General Agreement on Tariff and Trade, and as a result of the establishment of regional trade arrangements in the post-war period that a noticeable growth in intra-industry trade took place. Evidence of the significance of intra-industry trade, particularly trade in manufactures, can by found in studies by Verdoorn (1960), Balassa (1965, 1966), Grubel (1967), Lloyd (1971), Alder (1970), Willmore (1972), Grubel and Lloyd (1975), and Pelzman (1978). All of these studies concentrate their analyses on intra-industry trade of manufactured goods between countries which are members of a regional trade arrangement.

2.1.1 Intra-Industry Trade in Regional Arrangements of Industrialized and Developing Nations

The earliest study that examined the effects of the formation of custom unions on trade and production in Western Europe was carried out by Verdoorn (1960). He observed that trade expansion following the formation of the Benelux custom union tended to be intra-industry in nature. A similar finding was made by Alder (1970) in his study of the changes in the types of specialization and trade pattern of ten major steel products of the European Coal and Steel Community. His results showed that trade liberalization following the formation of this community did not result in increased concentration of steel production in any single member country. Instead, there was a manifestation of increased intra-industry specialization in production among all of the countries in the community. The level of intra-industry trade was found to be increasing over the 15-year period studied.

Studies of the trading pattern of the European Economic Community (EEC) have been carried out by Balassa (1965, 1966), Grubel (1967), and Grubel and Lloyd (1975). Balassa (1966) analyzed the changes in the trade pattern of the intra-EEC manufacturing sector for 91 regrouped industrial categories.[2] For each year from 1958 to 1963, an unweighted index indicating the average level of inter-industry trade was computed for each country within the EEC.[3] He found that the value of the index had declined for all of the

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[2] The regrouping of industrial categories was based upon the the elasticity of substitution. Commodities with the same elasticity of substitution were classified within the same category.

[3] For a more detailed discussion on the computation of the index, see Section 4.1 of Chapter 4.

countries over the period studied, indicating that the reduction in duties after the establishment of the community resulted in an increase in intra-industry trade for all of the countries involved.

Grubel (1967) utilized two different approaches to draw inferences on the type of trade and specialization that had taken place following the formation of the EEC. The first involves observing the variance of the relative shares which each country holds in intra-EEC exports of an individual industry. If trade expansion has taken place through inter-industry specialization, then the individual countries will concentrate their production and exports in one or more industries while importing all(or most) of the other industrial products. The relative shares of the products which each country specialized in will increase while the relative shares of the other industrial products will decrease. Consequently, the variance of the distribution of the relative shares will increase. However, if the variance does not change or decreases over time, then it can be concluded that national concentration in individual industries fails to occur and that the observed trade expansion is due to national specialization in commodities within the same industrial category.

The second approach analyzes the export-import or import-export (whichever is greater) ratios of all of the industries in each country. If trade liberalization leads to inter-industry specialization, then the Heckscher-Ohlin-Samuelson theory[4] would predict an increase in the values of the export-import (or import-export) ratios for each country.

Using the first approach, Grubel (1967) found that the variance of the relative shares which each country held in the intra-EEC exports of individual industries fell in 1955, 1958 and 1963. The analysis based upon the second approach showed that the export-import (or import-export) ratios for all of the industries of the countries under investigation tended to approach unity. On the basis of these two results, he concluded that the formation of the EEC did not result in national specialization in any particular industry and that trade had taken on an increasingly intra-industry nature.

Grubel's (1967) results were further supplemented by a more detailed study undertaken by Grubel and Lloyd (1975). Some of their important results showing the relationship

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[4] The Heckscher-Ohlin Samuelson theory states that a country will export a good that uses relatively intensively the country's relatively abundant factor since the country has a comparative advantage in producing that good.

between the growth of intra-industry trade and that of total trade among the EEC countries for 1959 and 1967 are summarized below.

(1) Total intra-EEC trade had increased more rapidly than the trade of the EEC countries with non-members.

(2) Intra-industry trade as a percentage of the total trade among the EEC member countries rose from 53% in 1959 to 65% in 1967.

(3) Total intra-industry trade as percentage of the total trade of the EEC countries with all trading partners outside the EEC rose from 44% in 1959 to 53% in 1967.

Studies of the trade pattern for regional arrangements other than those in Western Europe have produced similar results. Lloyd (1971) showed that following the formation of the New Zealand-Australian Free Trade Agreement in 1966, the level of intra-industry trade between Australia and New Zealand was higher than that of Australia with any other trading partner. For example, in 1968, the intra-industry trade level between Australia and New-Zealand was about 30.5% while that between Australia and Canada was only about 17.6%.

2.1.2 Intra-Industry Trade Among the Central American Developing Countries

The General Treaty of 1960 established the Central American Common Market (CACM), and by June 1966, led to the removal of nearly all barriers to trade among its members: Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica. Willmore (1972) examined the changes in the pattern of intra-CACM trade that occurred over the period from 1959 to 1967 for some 59 commodities of the manufacturing sector. By measuring the correlation coefficients between commodities exported to other CACM members for pairs of countries in different years, he concluded that the export pattern of member countries became increasingly more uniform over time. Using Balassa's measure of the level of inter-industry trade for these 59 industries, he observed that the level of intra-industry trade among the developing countries of the CACM was not only substantial but had also increased rapidly after the formation of the CACM. Moreover, the share of intra-industry trade within the CACM for manufactured goods was comparable to the corresponding share found in EEC countries for 1967.

2.1.3 Intra-Industry Trade Among Countries of the Centralized Market Economies

Intra-industry trade is not limited to the market economies of the West. Pelzman (1978), utilizing international trade data classified under the Uniform Foreign Trade Commodity Nomenclature, studied the intra-industry specialization in Soviet-COMECON trade that occurred during the period 1958 to 1973. His analysis revealed the following findings:

(1) Soviet intra-industry trade with the world within this period averaged about 37%, while that between the Soviet Union and COMECON members was about 27%.

(2) Further examination of the intra-industry trade flows between the Soviet Union and COMECON indicated that intra-industry trade prevailed in all sectors, and was particularly significant in the machinery, equipment and chemical sectors.

The findings of the above studies can be summarized as follows: First, the formation of regional arrangements results in intra-industry rather than inter-industry trade.[5]

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[5] This empirical finding tends to contradict the hypothesis postulated in the theory of Custom Unions. In simple terms, this theory predicts that with a multilateral reduction in duties, comparative advantages enjoyed by each member country would create market forces that would result in a reallocation of resources from import-competing to export industries. Activities of the former

Second, the level of intra-industry trade in manufactured products of member countries of a regional trade arrangement is not only a significant component of their trade flows but this component has also increased in importance over time.[6]

2.2 International Trade Patterns

This section provides an overview of the world trade pattern. Two types of trade patterns for 1980 will be examined: the trade in total commodities and the trade in manufactured goods. These patterns are analyzed in current dollar values.

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would diminish while expansion would occur in the latter. Inter-industry specialization and trade would then result. This refutation of the hypothesis would imply that earlier analysis of trade liberalization had understated the potential gains from trade and its welfare effects. In fact, intra-industry specialization increased welfare both by offering consumers a wider variety of goods and by reducing adjustment costs (Balassa (1967) pp. 91).

[6] This result was also obtained by Pagoulatos and Sorensen (1975) in their study of United States trade. They found that intra-industry trade accounted for 47.9% of the total United States trade in manufactures in 1963, 50% in 1965 and 54.1% in 1967. In addition, over the 1963-1967 period, two third of the sample industries used by Pagoulatos and Sorensen showed an increase in the level of intra-industry trade.

2.2.1 World Trade Pattern of Total Commodities

The growth in world trade in the 1970's was spectacular. Between 1970 and 1980, world trade in total commodities (in terms of the dollar value of total exports) increased six-fold from US$312 billion to US$1993 billion.[7] In 1980, about US$1819 billion of the total exports came from countries classifed as market economies.[8] This amounts to about 91% of the world's total exports. About 63%, or US$1261 billion, of the world's total exports came from countries of developed market economies. About 23% or US$558 billion of the world's total exports are from countries within developing market economies. The remaining 8% or US$175 billion of the world's exports came from countries with centrally

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7 These figures are obtained from the United Nation Monthly Bulletin of Statistics. The figure for 1970 is not given in Table 2.1.

8 According to the United Nation Statistical Classification, market economies include countries from the developed as well as the developing market economies. Countries within these two categories are as follows:

Developed Market Economies: North America, Europe (other than Eastern Europe), Australia,Israel, New Zealand and South Africa.

Developing Market Economies: Caribbean, Central and South America, Africa (other than South Africa), Asian Middle-East, and East and South-East Asia (other than Israel and Japan).

planned economies[9] (see Table 2.1).

Countries of the developed economies imported about 70% or US$390 billion of the total exports of the countries with developing economies and about 32% or US$56 billion of the total exports of the countries with centrally planned economies. At the same time, countries with developed market economies exported about 23% or US$293 billion and 5% or US$61 billion of their total goods to countries with developing market economies and the centrally planned economies, respectively. In addition, a significant proportion of the developed market economies' traded goods, about 71% or US$894 billion, were sold to countries with the same type economy.

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9 Centrally Planned Economies: Bulgaria, Czechoslovakia, German Democratic Republic, Hungary, Poland, Romania and U.S.S.R.

Table 2.1: Distribution of World Trade in Total Commodities for 1980 (Billions of $US)

Export to / Import from	World	Dev. Mkt. Econ. *	Depng.Mkt. Econ. **	Cent. Pl. Econ. ***
World	1993	1341	466	168
Dep. Mkt. Econ. *	1261	894	293	61
Depng. Mkt. Econ. **	558	390	141	21
Cent. Pl. Econ. ***	175	56	32	85

Note:

*   Dep. Mkt. Econ. = Developed Market Economies
** Depng. Mkt. Econ. = Developing Market Economies
*** Cent. Pl. Econ. = Centrally Planned Economies

Values might not add up because certain values are not reported by individual countries.

Source: United Nation Monthly Bulletin of Statistics, Volume 36B (May-August 1982).

2.2.2 World Trade Pattern of Manufactured Goods

Trade in manufactured products[10] exhibits a trend similar to that of trade in total commodities. The value of the world's total manufactured exports increased by four and one-half times from US$269 billion in 1970 to US$1472 billion in 1980. Even though the share of manufactured exports in total exports declined from 86% in 1970 to 74% in 1980, the former still represented a significant proportion of the world's total trade.[11]

In 1980, countries with market economies provided about 92% or US$1357 billion of the world's total manufactured exports. The major contributors were countries classified as developed market economies which exported about 81% or US$1199 billion of the world's total manufactured exports. Countries with developing market economies contributed about

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10 Manufactured Good is classified under section 5 - 8 of the Standard International Trade Classification. The commodities included in this classification are as follows:
Manufactured Trade: Chemical, Machinery and Transport Equipment, Passenger Road Vehicles and Their Parts, Other Manufactured Goods, Textile Yarns and Fabrics, Iron and Steel, Non-Ferrous Metals, Other Manufactured Metal Products and Clothing.

11 These figures are obtained from the Unitied Nation Monthly Bulletin of Statistics. Figures for 1970 are not given in Table 2.2.

Table 2.2: Distribution of World Trade in Total Manufactures for 1980 (Billions of $US)

Export to / Import from	World	Dev. Mkt. Econ. *	Depng.Mkt. Econ. **	Cent. Pl. Econ. ***
World	1472	973	366	129
Dep. Mkt. Econ. *	1199	848	290	59
Depng. Mkt. Econ. **	158	96	55	5
Cent. Pl. Econ. ***	115	27	20	66

Note:

*   Dep. Mkt. Econ. = Developed Market Economies
** Depng. Mkt. Econ. = Developing Market Economies
*** Cent. Pl. Econ. = Centrally Planned Economies
Values might not add up because certain values are not reported by individual countries.

Source: United Nation Monthly Bulletin of Statistics, Volume 36B (May-August 1982).

11% or US$158 billion. The remaining 8% or US$115 billion were exported from countries with centrally planned economies. Countries with developed market economies are also major importers of manufactured goods from countries with developing market economies. In 1980, countries with developed market economies absorbed about 61% or US$96 billion of the total exports of the countries with developing market economies. At the same time, they also imported about 17% or US$27 billion of the total manufactured exports from countries with centrally planned economies. Countries with developed market economies exported about 24% or US$290 billion and 5% or US$59 billion of their total manufactured exports to countries with developing and centrally planned economies, respectively. A high proportion, about 71% or US$848 billion, of the manufactured exports of the developed economies are to countries within the same category. A significant proportion, about 35% or US$55 billion, of the manufactured exports from countries with developing market economies were sold in countries of the same category. Likewise, about 57% or US$66 billion of the manufactured exports of centrally planned economies were imported by countries in the same category.

The above analysis of the world trade pattern does not indicate precisely the existence of two-way trade of commodities with the same category, but the findings do suggest that a significant proportion of total world commodities and manufactured goods are traded among countries which are very similar in their level of economic development. This is particularly true for the industrialized nations which have relatively similar resource endowments, a point which is of significiance in light of the first proposition discussed in the next chapter.

2.3 Canada's Manufacturing Trade

The significance of Canada's manufactured exports can be seen as follow: In 1980, Canada's total exports amounted to about US$65 billion. A significant proportion, about 61% or US$40 billion of these total exports, are from the manufacturing sectors. In addition, Canada's manufactured exports formed about 3% of the world's total manufactured exports, surpassing that of Australia and New Zealand, and those of the developing countries in Africa and South America (see Table 2.3).

In this section an analysis of Canada's manufacturing trade performance over the period 1966 to 1980 is presented. Industrial data based upon the 1970 Standard Industrial Classification will be used. This analysis is divided into two parts. The first part describes the performance trend of the manufacturing sector as a whole. The second part analyzes seventy industries selected from the manufacturing sector. These seventy industries are compatible with those to be used in the latter part of this study.

Table 2.3: Distribution of Global Exports for 1980 (Billions of $US)

	Total Commodity Exports	Total Manufacture Exports	Percentage of (1)	(2)	(3)
World	1993	1472	100	100	100
OPEC	306	7	15	0.5	0.4
Europe Developed Market	809	793	41	54	40
EEC	657	645	33	44	33
EFTA	116	111	6	8	6
Canada	65	40	3	3	2
US	213	166	11	11	8.5
Japan	175	170	9	12	8.5
Australia & New Zealand	27	9	1	0.6	0.5
Developing Africa	94	9	5	0.6	0.5
Developing America	109	29	5	2	1.5
Developing Asia	142	106	7	7	5

Note:
(1) = Percentage distribution of country or group of countries total commodity exports to the world's total commodity exports
(2) = Percentage distribution of country or group of countries total manufacture exports to the world's total manufacture exports
(3) = Percentage distribution of country or group of countries total manufacture exports to the world's total commodity exports

Source: United Nation Monthly Bulletin of Statistics, Volume 36B (May-August 1982).

2.3.1 Trade Performance of the Canadian Manufacturing Sector

Canada's diversified export pattern is similar to that of the other major trading nations within the category of developed market economies. However, in comparison with the other trading nations, a somewhat higher percentage of Canada's exports are composed of food items, fuels, lumber, wood pulp and metal ores. This is due to the fact that Canada is a resource abundant country with a sparse population, and has a large area endowed with substantial agricultural, forest and mineral resources. Nevertheless, over the past fifteen years, the manufacturing sector has played an increasingly dominant role in the structure of Canada's trade.

According to a study by the Ministry of Industry, Trade and Commerce (1978) on Canada's trade performance between 1965 and 1977, about 70% of the total merchandise exported and 84% of that imported were manufactured products. During the period from 1966 to 1980, the total manufactured output (shipments) had increased by over 4 times, from $37.3 billion in 1966 to $168.1 billion in 1980 (see Table 2.4). Manufactured exports within this period also increased from $7 billion to $51 billion, growing at an average rate of 14.5% per annum. During the same period, manufactured

Table 2.4: Canadian Manufacturing Trade Trends 1966 - 1980 (Value in Millions of Current Dollars)

Year	Manufacturing Sector Exp. (1)	Manufacturing Sector Ship. (2)	Selected Industries* Exp. (3)	Selected Industries* Ship. (4)	R1 (5)	R2 (6)	IT** (7)	IT*** (8)
1966	7011	37303	6495	32199	92.6	86.3	7.1	50.7
1967	8225	38955	7636	33646	92.8	86.4	3.9	44.7
1968	9842	42062	9180	38410	93.3	91.3	1.8	39.7
1969	11168	45930	10302	39463	92.3	85.9	3.5	37.8
1970	12162	46381	11206	40314	92.1	86.9	1.9	38.7
1971	12724	50276	11694	44061	91.9	87.6	1.8	36.3
1972	14502	56191	13686	48696	94.4	86.7	4.5	38.1
1973	17749	66674	16306	58162	91.9	87.2	5.1	37.5
1974	20588	82455	18909	71658	91.8	86.9	10.4	40.5
1975	21149	88427	19125	76663	90.4	86.7	12.6	39.4
1976	25756	98281	23649	85870	91.8	87.7	7.4	38.0
1977	31057	108882	28658	95846	92.3	88.0	5.0	36.8
1978	39244	128889	35822	113043	91.3	87.7	2.7	35.7
1979	46105	152133	41349	132464	89.7	87.1	5.3	38.2
1980	51388	168062	46195	145051	89.9	86.3	1.7	39.1

Notes:

Exp. = Exports
Ship. = Shipmments
R1 = Ratio of column (3)/(1)
R2 = Ratio of column (4)/(2)
* = values calculated for the selected seventy industries
IT** = Inter-industry trade index for the manufacturing sector
IT*** = Inter-industry trade index for the seventy industries calculated at the 3-digit level

Source: Manufacturing Trade and Measures 1966-1983 (Statistical and Data Base Services Policy, Department of Regional Industrial Expansion).

imports had been increasing at an average rate of 13.7% per annum, from $8.1 billion to $53.2 billion. The total turnover[12] of the manufacturing sector for 1980 was about $104.2 billion.

The measures of export orientation[13] and import penetration[14] also registered an increase within this period. Export orientation rose from 18.8% in 1966 to 30.6% in 1980, while import penetration of the Canadian market increased from 21% to 31.3%. These two increases, coupled with a slight change in the ratio of the shipments to the Canadian market, indicate an increase in trade involvement of the Canadian manufacturing sector. Furthermore, the rise in export orientation for manufactured products was just about offset by the advance in import penetration.

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[12] Trade turnover = export + import

[13] Export orientation is defined as the ratio of the value of exports to the value of total output (shipments).

[14] Import penetration is defined as the ratio of the value of imports to the Canadian market. Canadian Market = Shipments - Exports + Import

2.3.2 Trade Performance of the Seventy Selected Industries

Seventy industries are selected from the Canadian manufacturing sector.[15] The significance of these industries can be inferred from their share in total output (shipments) and exports of the manufacturing sector over the 15-year period (as shown in Table 2.4). The ratio of the exports of these seventy industries to the total exports of the manufacturing sector remained relatively stable at around 92% over this time period. A similar trend is observed in the ratio of the output of the seventy selected industries to the total output (shipments) of the manufacturing sector. On the average, the seventy selected industries produced about 87% of the manufacturing sector output.

The Balassa index is used to investigate the nature of the manufacturing trade that has taken place over the period from 1966 to 1980.[16] The measure of inter-industry trade for each industry is first obtained by expressing the absolute difference between the dollar value of exports and imports of an industry as a percentage of the dollar value of total exports and imports of that industry. To measure the inter-industry trade for the manufacturing sector or for

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15 A listing of the seventy selected industries is given in Appendix A.

16 A more detailed discussing of the Balassa index is given in Section 4.1 of Chapter 4.

a group of industries, the arithmetic mean of the industries' indices is computed as shown by the formula.

$$IT = \frac{1}{n} \sum \frac{|(Xi - Mi)|}{(Xi + Mi)} \times 100 \qquad ......(2.1)$$

where

IT = index for inter-industry trade for the manufacturing sector or a group of industries

Xi = dollar value of exports of the ith industry of n industries

Mi = dollar value of imports of the ith industry of n industries

The greater the value of the overall index, the higher the level of inter-industry trade in the country. In the extreme, a value of one indicates complete inter-industry trade since the country does not export and import the same commodity. An increase in the index implies growth in inter-industry trade while a decline implies an increase in intra-industry trade.

The level of inter-industry trade of the manufacturing sector as well as the seventy selected industries are computed using the Balassa index. These results are presented in columns (7) and (8) in Table (2.4). The values in column (7) indicate a low level of inter-industry trade for the manufacturing sector as a whole. This may be due to the use of highly aggregated data. Although the indices calculated for the seventy industries using the 3-digit level of the Standard Industrial Classification show a higher level of inter-industry trade, the general conclusion is that intra-industry trade is prevalent in the manufacturing sector.

2.3.3 Summary

The findings of this chapter can be summarized as follows:

(1) The observed phenomenon of intra-industry trade, particularly in manufactured products, is found not only in the trade among industrialized nations but also in trade among developing countries and those countries of centrally planned economies.

(2) A major proportion of the industrialized nations' trade is in manufactured products and a high percentage of these goods are traded between countries within this category.

(3) For Canada, intra-industry trade is predominant in the trade of manufactured products.

The above analysis provides a basis for the study of trade in the manufacturing sector, as well as a rationale for the use of the seventy selected industries in the latter part of the study.

Chapter III

PROPOSITIONS ON THE DETERMINANTS OF INTRA-INDUSTRY TRADE

In recent years, a number of new theories have been advanced to explain intra-industry trade. The purpose of this chapter is to draw a set of testable propositions from the new theoretical literature.

In the literature, two lines of argument can be identified. First, given any trading partner, variations in the level of intra-industry trade across industries would depend upon the commodity-specific demand and supply characteristics. Second, variations in the overall level of intra-industry trade across countries would depend on the country-specific characteristics of the trading partners. The focus of this thesis is on the second issue, that is, identifying the characteristics of countries which determine the overall amount of intra-industry trade which occurs between them.

The theoretical explanations for intra-industry trade can also be divided into two categories: those dealing with homogeneous products and those dealing with differentiated products. The discussion below will concentrate upon the latter. Explanations for intra-industry trade in homogeneous products, in particular those pertaining to border trade, cyclical trade, seasonal trade, entrepot trade and strategic trade,[17] will not be discussed here since they are peripheral to the central concerns of international trade theory and recent theoretical developments.

Section 1 of this chapter describes the general nature of the new class of trade models. Their implications are summarized in the form of three propositions in Section 2. These propositions are tested empirically in Chapter 5.

3.1 Background to the New Trade Models: Differentiated Products, Imperfect Competition and Economies of Scale

In the real world, goods and services have infinitely variable specifications. They are often produced by and sold under imperfectly competitive market structures. This reality has led to the development of theoretical models

[17] Grubel and Lloyd(1975) suggested that border trade, cyclical trade, seasonal trade, and entrepot trade can be fitted into the analytical framework of the Heckscher-Ohlin model by relaxing some of its assumptions to include considerations of transportation, storage and selling costs, economies of joint production, and time differentiations. Strategic trade can be explained by a model developed by Brander(1981). In his model, the cause of intra-industry trade in homogeneous products is due to the strategic interaction among firms in different countries.

which emphasize the crucial roles of economies of scale, imperfect competition and product differentiation in the explanation of intra-industry trade. Examples of such models are those by Krugman (1980), Dixit and Norman (1980), Lancaster (1979), and Helpman (1981). These models are intended to complement rather than replace the traditional explanations for inter-industry trade based on the theory of comparative costs.

Basically, the explanation of intra-industry trade in these models may be outlined in the following way. It is assumed that consumers in each country have a demand for a large number of varieties of any particular good. A country is prevented from producing the whole range of varieties under increasing returns because of economies realized by specialization. Therefore, each country specializes in producing only a subset of all the varieties. To acquire the other varieties, countries must trade with one another. By its nature, this type of trade takes the form of an exchange of similar goods which belong to the same product group. In other words, it is intra-industry trade.

The existence of product differentiation and internal economies of scale are inconsistent with perfect competition. The modelling of intra-industry trade to incorporate imperfect competition presents a problem because of the lack of a generally accepted theory of imperfect competition. Therefore, in trade theory there are alternative ways by which imperfect competition is modelled.[18]

The simplest model of imperfect competition is that of pure monopoly which avoids the game theoretic difficulties associated with oligopoly. Pure monopoly is a market structure in which consumers act as price-takers and their behaviour determines the downward sloping demand curve of the monopolist. The monopolist then maximizes his profit over this market demand curve.[19]

Next to pure monopoly in the theoretical work on imperfect market structure is oligopoly. The outcome of competition in this market structure depends on two assumptions:

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[18] A choice will have to be made among the different ways by which imperfect competition is to be modelled. It is obvious that any conclusions depend on the particular specification chosen. Hence, to arrive at a general theory of trade under imperfect competition seems to be impossible. The most that one can hope for is a catalogue of special models.

[19] Examples of the analysis of international trade using this framework are studies by Corden(1966) and Bhagwati(1964) on the effects of tariffs and quotas on domestic monopoly; by Auquier and Caves(1979) on the second-best policy of trading off domestic monopoly welfare losses against profits from exports. In addition, Jacquenmin(1982) examined the role of international openess as a means to limit domestic monopoly power. International cartels have also been extensively studied using this framework.

first, the non-cooperative behaviour of the market participants and second, the conditions of entry into and exit from the industry. Included in this category of market structure are Cournot oligopoly, Bertrand oligopoly, contestable markets, and monopolistic competition. These different market structures are briefly examined.

Cournot's central assumption is that each firm acts as if their rivals' outputs are fixed. Hence, it maximizes profit at an optimal output level by taking other firms' outputs as given.[20] In contrast, firms in the Bertrand setting obtain a profit- maximizing price by assuming that prices of the rivals are kept constant. The Bertrand type of behaviour is adopted by firms in the contestable market structure and monopolistically competitive structure. In the contestable market structure, firms can costlessly enter into and exit from the industry. The threat of easy entry forces average-cost pricing to be undertaken by firms in this market structure. In monopolistic competition, it is assumed that firms are able to differentiate their products such that these products are not perfect substitutes for either the products of existing competitors or products of potential entrants. The ability of the firms to differentiate their products allows each firm to have a somewhat unique good to offer,

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20 Brander's model(1981) on strategic trade was developed using this framework.

and thereby some influence over its price. As a result, firms in the monopolistically competitive setting face a downward-sloping demand curve.

Within the monopolistically competitive model, two alternative cases of entry can be considered. The first is when entry is restricted, so that there may be economic profits in this imperfectly competitive market structure. This case is in effect one of oligopoly. The second case arises when there exists free entry by firms into the industry, resulting in prices being driven down to a point such that each firm earns zero economic profits. This variant is Chamberlin "large group" case.

The imperfectly competitive market structure that is most amenable for the analysis of intra-industry trade theory is that of Chamberlinian monopolistic competition. It is this form which is incorporated into the studies by Krugman (1979, 1980), Dixit and Norman (1980), Lancaster (1980), and Helpman (1981). As suggested by Krugman (1979), the Chamberlinian formulation has several advantages. First, it yields a very simple model; the analysis of increasing returns and trade is hardly more complicated than the 2-good Ricardian model. Second, in spite of imperfect competition, the equilibrium of the model is determinate in all essential aspects because the nature of demand rules out strategic interdependence among firms. Third, the model's picture of trade in a large number of differentiated products fits well with the empirical literature on intra-industry trade.[21]

3.2 The Cross-Country Propositions

From the recent literature on intra-industry trade in differentiated products, the following set of testable propositions emerges.

3.2.1 Similarity of Relative Factor Endowments

Proposition (1): Trade between countries that have similar relative factor endowments and hence similar industrial structures will be mostly intra-industry trade, whereas trade between countries with very different factor endowments will be mostly inter-industry in nature. Hence, the smaller the difference in relative factor endowments between two countries, the higher will be the proportion of intra-industry trade.

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[21] In particular, those studies on the empirical assessment of intra-industry that had been cited in introduction of Chapter 1.

This proposition is a special case of the more general conclusion that the smaller the difference in comparative costs between countries, the greater the extent of intra-industry trade. Traditionally, theories of comparative costs are based either on comparative productivity (the Ricardian theory) or relative factor endowments (the Heckscher-Ohlin theory). Proposition (1) is related to the latter which is now the dominant theory.

Recent literature has also examined the first theory of comparative costs based upon comparative productivity. Using the Ricardian model, Krugman (1979,1980) distinguished between two types of trade: inter-industry trade based upon comparative advantage and intra-industry trade based on economies of scale and product differentiation. In his models, he adopted a modified version of the Dixit and Stiglit (1977) model of monopolistic competition. The production of each variety of a differentiated good is subjected to increasing returns to scale that results when an element of fixed cost is added to labour costs which are proportional to outputs.[22] Krugman's model showed that when two imper-

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[22] In his models, it is assumed that all goods are produced with the same cost function:

$$li = a + bXi$$

where $a, b > 0$

fectly competitive economies of this kind are allowed to trade, increasing returns will produce trade and gains from trade even if the economies have identical tastes, technology and factor endowments. Each country will be a net exporter in industries in which it has a comparative advantage, thus giving rise to inter-industry specialization and trade. However, in the presence of increasing returns, a distinct set of differentiated products will be produced in each country, thereby, resulting in intra-industry specialization. Each country will import some products even in industries in which it is a net exporter and vice versa because of intra-industry specialization. Intra-industry trade will be greater as a proportion of total trade the smaller is the difference in the countries' relative productivity; that is, the smaller is inter-industry trade based on comparative productivity.

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i = 1, 2 ......n

a = fixed cost

li = labour used in producing the ith good

Xi = outputs of that good

While the marginal cost is assumed to be constant, the average cost declines at a diminishing rate at all levels of outputs.

The Helpman (1981) model of intra-industry trade provides an integration of the Heckscker-Ohlin approach to international trade with a Chamberlin-type approach to product-differentiation, economies of scale and monopolistic competition. The Heckscher-Ohlin theory is used to explain intersectoral trade while the Chamberlin model is used to explain intra-industry trade.

In Helpman's model, the structure of preferences is similar to that of Lancaster's(1979) theory of demand for differentiated goods. Helpman's model has the familiar two goods (Food and Manufactures) and two factors (Capital and Labour) production structure. Food is a homogeneous good produced under constant returns to scale and perfect competition whereas manufactures is a differentiated good produced under increasing returns to scale and monopolistic competition. It is assumed that the production of manufactures is relatively capital intensive.

Helpman showed that the pattern of intersectoral trade can be predicted from factor endowments. In conformity with the Heckscher-Ohlin theory of inter-industry trade, a capital rich country will be a net exporter of the capital intensive good while a labour rich country will be a net exporter of the labour intensive good. Differentiated prod-

ucts will be imported and exported by every country. Although both countries are exporters and importers of manufactured products, the country with the higher capital-labour ratio is a net exporter of manufactured goods and a net importer of food, while the country with the lower capital-labour ratio is a net exporter of food and a net importer of manufactured products. If both countries have the same capital-labour ratios, all trade will be intra-industry trade and there is no intersectoral trade; that is, no food is exported or imported, and net exports (imports) of manufactured products are zero in each country.

In summary, Helpman showed that in the absence of a divergence in the capital-labour ratios with which countries are endowed, there will only be intra-industry trade. However, in the presence of such a divergence there will be both intra-industry and inter-industry trade. The same result was also obtained in studies carried out by Dixit and Norman(1980) and Lancaster(1980).[23]

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23 For example, Lancaster (1980), using a two-sector model with one differentiated and one homogeneous product, showed that equality of factor endowments in two countries would result in pure intra-industry trade. In the case of differing endowments, inter-as well as intra-industry trade would prevail.

3.2.2 Similarity in Per Capita Income

Proposition (2): Intra-industry trade will be greater between countries with a smaller difference in their per capita income.

This proposition can be viewed as an alternative form of proposition 1. In cross-country analysis, it can be shown that countries' level of per capita income are correlated directly with their capital -labour ratios. Hence, from proposition 1, the bilateral share of intra-industry trade is correlated with the absolute difference in the bilateral income per capita. As a result, the smaller the difference in income between countries, the more intense is the level of intra-industry trade.

This proposition has also been presented informally by Linder (1961). He argued that the income of a consumer will determine the choice of a particular product among a set of products that differ in quality (performance and style) and price. Consumer preference structures will be similar when their income does not differ greatly. Goods of countries with similar income levels will be more suited for each other's markets since similar products that differ only in quality are likely to be demanded by consumers from each country. While each country can produce the whole range of differentiated goods to satisfy its local demand, economies of scale are likely to dictate that a limited range of goods is produced by each country. The similarity in demand structure will then lead to cross-trade in differentiated products.

3.2.3 High Per Capita Income

Proposition (3): Intra-industry trade will be greater the higher are the average per capita incomes of the trading countries.

It can be argued that countries with higher per capita income tend to have a higher level of intra-industry trade. This proposition can be posited for the following reasons. First, consumer demand at low income levels is more likely to be simple and standardized with regard to product characteristics. This is because the benefits obtained by reducing the number of products to a few standardized types outweigh the utility lost by not being able to buy a wider variety of products (Lundberg (1982). Consequently, consumers are unwilling to pay for product differentiation. Second, high per capita income correlates with highly developed countries[24] which command a high capability to innovate and

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[24] With the exception of some of the oil producing countries such as those of the Middle-East region, which are not included in this study.

hence the ability to develop and produce highly differentiated goods. Consumer demand of countries with high per capita income allows the exploitation of economies of scale in the production of these differentiated products. Third, highly developed countries have advanced information and communications linkages which favour the realization and expansion of trade in differentiated products. As a result, a positive relationship is expected to exist between per capita income and the level of intra-industry trade.

Chapter IV

PROBLEMS OF MEASUREMENT

The empirical propositions outlined in the previous chapter give rise to a number of measurement problems. First, it is necessary to obtain an appropriate measure of intra-industry trade. This problem is discussed in Section 1. It is concluded that the index advanced by Aquino (1978) is the most appropriate measure. Second, it is necessary to select a level of industry disaggregation in applying any index of intra-industry trade. This is related to the broader issue of what is meant by an 'industry'. The nature of this problem is discussed in Section 2. Third, direct and consistent measures of factor endowments are not available for a large number of countries. This necessitates the use of constructed variables which serve as proxies for factor endowments. The nature and rationale for the particular constructed variables to be used are outlined in Section 3.

4.1 Measures of Intra-Industry Trade

The existence of intra-industry trade between countries is generally indicated by a similarity in the export and import values of the same industry. The extent of such trade flows can be measured by a variety of indices, such as the Balassa index (1966), the Grubel and Lloyd index (1975) and the Aquino index (1978).[25]

The Balassa index (1966), the absolute difference between the exports and imports of an industry divided by the sum of the exports and imports of that industry.

$$Bi = \frac{| Xi - Mi |}{\Sigma(Xi + Mi)} \qquad ..... (4.1)$$

and $0 << Bi << 1$

where Xi = Exports of the ith industry

Mi = Imports of the ith of industry

$|Xi - Mi|$ = Absolute value of inter-industry trade in the ith industry

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[25] A more detailed discussion of other indices and their disadvantages can be found in Grubel and Lloyd (1975, pp. 24-28).

(Xi + Mi) = Value of net trade of the ith industry

As the level of intra-industry trade increases, Bi will approach zero. On the other hand, as the level of inter-industry trade increases, Bi will tend toward one since either Xi or Mi tends toward zero.

The Balassa index can be extended to provide a summary measure of the overall level of intra-industry trade of a country, which is the arithematic mean of the indices of all industries (n) in the country. As shown in the following formula, the overall level of intra-industry trade of a country is indicated by B where

$$B = \frac{1}{n} \sum_{i=1}^{n} \left(\frac{|Xi - Mi|}{(Xi + Mi)} \right) \qquad ..... (4.2)$$

and $0 << B << 1$

Likewise, an increase in the overall level of intra-industry trade will be indicated by a decrease in B. However, Balassa's measure has two drawbacks. First, it gives equal weight to all industries irrespective of whether their share in total trade (the sum of all the exports and imports of the country) is large or small. Second, it does not provide any correction for trade imbalances.

To correct for these two drawbacks, a revised version of the Balassa index has been developed by Grubel and Lloyd (1975). It has become one of the most widely used measures of a country's level of intra-industry trade with another country. Its formulation is derived from the definition that intra-industry trade of an industry is the net trade (or total trade) minus the absolute value of the net exports of that industry as a percentage of the net trade of that industry. Letting Gi be the Grubel and Lloyd index for a single industry

$$Gi = \frac{(Xi + Mi) - | Xi - Mi |}{(Xi + Mi)} \times 100 \qquad \ldots\ldots (4.3)$$

Rewriting equation (4.3), the Grubel and Lloyd index can be expressed as

$$Gi = \left(1 - \frac{| Xi - Mi |}{(Xi + Mi)}\right) \times 100 \qquad \ldots\ldots (4.4)$$

Or, by substituting equation (4.1) into equation (4.4), the Grubel and Lloyd index can be expressed in terms of the Balassa index, Bi.

$$Gi = (1 - Bi) \times 100$$

$$0 << Gi << 100$$

When an industry's exports are exactly matched by its imports, Gi will take on a value of 100, indicating that trade is totally intra-industry in nature. In the case where there is neither exports nor imports, Gi will be equal to zero, suggesting a trade structure that is wholly inter-industry in nature. In general, the extent of intra-industry (inter-industry) trade is reflected by how close the value of Gi is to the upper (lower) bound of the index.

To measure the overall level of intra-industry trade of a country, Grubel and Lloyd proposed using the mean of the distribution of Gi weighted by the shares of individual industry exports and imports in the total value of trade (that is, exports plus imports of the n industries)

$$G = \sum\left(\frac{Gi(Xi + Mi)}{\Sigma(Xi + Mi)}\right) \times 100 \quad \ldots\ldots (4.5)$$

Substituting Gi in equation (4.3) into equation (4.5) and rearranging, the following expression is obtained.

$$G = \frac{\Sigma\{(Xi + Mi) - |Xi - Mi|\}}{\Sigma(Xi + Mi)} \times 100 \ \ldots (4.6)$$

If a substantial trade imbalance exists between countries or if G is a measure for some subset of the n industries, G will be biased downward and will always be less than 100 because exports and imports in every industry do not match exactly. In this case, G will measure the level of intra-industry trade as well as the trade imbalance effect. To correct for this bias, the value of intra-industry trade (that is, $\Sigma\{(Xi + Mi)-|Xi - Mi|\}$) is expressed as a percentage of total exports and imports less the trade imbalance (that is, $\Sigma(Xi + Mi)-|\Sigma Xi - \Sigma Mi|$). This gives the Grubel and Lloyd adjusted index, Ga, where

$$Ga = \frac{\Sigma\{(Xi + Mi) - |Xi - Mi|\}}{\Sigma(Xi + Mi) - |\Sigma Xi - \Sigma Mi|} \times 100 \quad \ldots\ldots (4.7)$$

Substituting G into equation (4.7) and rearranging,

$$Ga = G \cdot \frac{\Sigma(Xi + Mi)}{\Sigma(Xi + Mi) - |\Sigma Xi - \Sigma Mi|}$$

$$= G \times \frac{1}{(1 - k)} \qquad \ldots\ldots (4.8)$$

where k = adjustment factor

$$= \frac{|\Sigma Xi - \Sigma Mi|}{\Sigma(Xi + Mi)}$$

and $0 << Ga << 100$

The adjustment factor, k, represents the overall trade imbalance as a proportion of total trade. When the trade imbalance increases, the adjustment factor k as well as the adjusted index Ga will increase.

The adjustment procedure in Ga is implicitly based on the assumption that the downward bias in G is largely due to a trade imbalance at the aggregate level. However, Aquino (1978) argues that the adjustment procedure in the Grubel and Lloyd approach can lead to inconsistent results since the bias may arise at the individual industry level. He contends that if the aggregate index G is biased downward when a substantial trade imbalance exists, then at the industry level, the index Gi is also biased downward. This is because one cannot assume that the imbalancing effect appears only at the aggregated level and not at the single commodity level. He illustrates this point by using the following example.

	Case 1		Case 2	
	Xi	Mi	Xi	Mi
Chemicals	20	10	10	10
Textiles	10	5	40	5
Machinery	40	20	20	20
Total	70	35	70	35
G	66.66%		66.66%	
Ga	100.00%		100.00%	
Q	100.00%		57.10%	

In case 1, there is no inter-industry specialization in the three industries as the ratios of exports to imports are all equal to two. In case 2, however, there is a tendency to specialize in textiles relative to chemicals and machinery; only a proportion of the total trade is intra-industry. However, in both cases, the calculated G and Ga values are equal to 66.66% and 100%, respectively. Both indices detect the same amount of intra-industry trade in the two situations which are in fact substantially different. A more accurate measure of the level of intra-industry trade is provided by the Aquino index.

The Aquino index corrects for the imbalancing effect at the single commodity level by assuming that the imbalancing effect is equiproportional in all industries. Estimates of what the values of exports and imports of each commodity would have been if total exports had been equal to total imports are computed.[26] These estimates Xi and Mi can be obtained as follows:

$$\bar{X}i = \frac{Xi \; 1/2 \sum(Xi + Mi)}{\sum Xi} \qquad \ldots\ldots (4.9)$$

$$\bar{M}i = \frac{Mi \; 1/2 \sum(Xi + Mi)}{\sum Mi} \qquad \ldots\ldots (4.10)$$

where $\sum \bar{X}i = \sum \bar{M}i = 1/2 \sum(Xi + Mi)$

and $\sum(\bar{X}i + \bar{M}i) = \sum(Xi + Mi)$

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26 However, there is no reason to expect the imbalancing effects to be equiproportional in each of the individual industries. Nevertheless, in the absence of information about inter-commodity differences and the strength of the imbalance effects, this assumption appears to be reasonable since the average imbalance effect in each industry must be equal to the overall imbalance.

replacing the Xi and Mi values of equation 4.7 with the estimated values of Xi and Mi of equations 4.9 and 4.10, would give the Aquino index, Q, where

$$Q = \frac{\sum(Xi + Mi) - |\sum\bar{X}i - \sum\bar{M}i|}{\sum(Xi + Mi)} \times 100$$

$$= \frac{\sum(Xi + Mi) - \sum|\bar{X}i - \bar{M}i|}{\sum(Xi + Mi)} \times 100$$

$$= \frac{\sum(Xi + Mi) - \sum\left|\dfrac{1/2Xi\ \Sigma(Xi+Mi)}{\Sigma Xi} - \dfrac{1/2Mi\ \Sigma(Xi+Mi)}{\Sigma Mi}\right|}{\Sigma(Xi + Mi)} x100$$

$$= \frac{\sum(Xi + Mi) - 1/2 \sum(Xi + Mi)\left|\dfrac{Xi}{\Sigma Xi} - \dfrac{Mi}{\Sigma Mi}\right|}{\Sigma(Xi + Mi)} \times 100$$

$$= 1 - 1/2 \sum \left|\frac{Xi}{\Sigma Xi} - \frac{Mi}{\Sigma Mi}\right| \times 100 \qquad ....(4.11)$$

Equation 4.11 represents the adjustment that removes the imbalancing effects. Using Aquino's example given above, in case 1, the calculated Q value is 100% while that calculated for case 2 is 57.1%. The Aquino index produces a more realistic measure of intra-industry trade than that by Grubel and Lloyd's. It is equation 4.11 which will be used below for calculating the Aquino index.

4.2 Problem of Categorical Aggregation Bias

Since intra-industry trade is defined as a country's simultaneous exports and imports of the same commodity within each industry, the identification and measurement of this phenomenon will depend upon the degree of homogeneity of the commodities included in each level of a statistical grouping.

In production theory, the problem of heterogeneity does not usually arise. An industry, by definition, is an aggregate of a number of firms all of which employ the same process or processes in the production of a single perfectly homogeneous commodity. In empirical work, the statistical equivalence of an industry is a composite of heterogeneous aggregates due to the grouping of commodities into industries that are different from the single-product, single-process industry postulated theoretically. This is because in reality, firms usually produce an overlapping continuum of commodities, which makes it impossible to clearly partition firms into groups such that all firms within each group produce the same set of commodities with the same factor intensities. Hence, various methods of classifying outputs of an economy into different industries have been developed. Two approaches are generally used: one is based on demand relationships and the other stresses supply-side features.

In industrial organization studies, economists have favoured the grouping of commodities into industries on the basis of similarities in demand, that is, the end-use of the product. Alternatively, trade theorists tend to favour the grouping of commodities into industries on the basis of supply-side features (such as the proportion of inputs demanded) because comparative costs are held to determine trade patterns. For any chosen set of demand and supply characteristics, the optimal grouping according to demand characteristics will differ from that according to supply characteristics. In fact, most of the classifications of product groups are based on an arbitrary and ad hoc mix of similarity in material input coefficients and substitutability in demand.

Heterogeneity within each product group implies that the measured level of intra-industry trade consists of two components. One is an economic component which is the result of a real process of specialization stemming from the interaction between differences in commodities' characteristics and countries' attributes. The other component is purely a statistical phenomenon due to the classification of commodities into the same industry that are not homogenous or are produced with dissimilar factor inputs. Gray (1980) calls this component categorical aggregation bias.

The common practice in empirical studies is to pay little attention to the heterogeneity problem by assuming that the available data series is homogeneous or at least sufficiently so as not to seriously affect any conclusions drawn. This approach could greatly fault the interpretation of the empirical results if the presence of the statistical component is pervasive in the data series. Without any assessment or adjustment undertaken, it could be that one is simply explaining a random measurement error rather than an economic phenomenon. Therefore, a prerequisite when examining the importance of intra-industry trade or testing any models of intra-industry exchange is that the measurement of the level of two-way trade must be as accurate as possible. Various approaches have been adopted in an attempt to evaluate and reduce the degree of heterogeneity present in any given data set.

Finger (1975) studied the variation in the input requirements within 81 3-digit SITC (Standard Industrial Trade Classification) groups in the United States by matching 4-digit U.S. SIC (Standard Industrial Classification) categories with the 3-digit SITC groups. Proxies for the input requirements for the 4-digit SIC categories were obtained: physical capital intensity is approximated by non-wage value-added per employee, human capital intensity is measured by the average wage and, economies of scale is measured by the value-added per establishment. Using the analysis of variance approach, he showed that nearly 40 percent of the variation among the 4-digit SIC categories in physical and human capital intensity was within the 3-digit SITC groups. Of the total variation in the scale economies measures, more than 60 percent was within the 3-digit SITC groups. A similar study was also carried out by Rayment (1976) on the U.K. SIC categories.

The general conclusion drawn from these studies is that there exists a great deal of variability in the factor input ratios within the 3-digit statistical level of aggregation of the SITC data. This conclusion indicates that categorical aggregation bias is clearly present at the 3-digit level of the Standard Industrial Classification.[27]

The values of the various indices discussed in the previous section are presented in Table 4.1. The percentage differences between these indices are reported in Table 4.2. In general, the Aquino index (Q) is greater than the Grubel and Lloyd index (G) but smaller than the Grubel and Lloyd adjusted index (Ga). The reduction in the value of the Ga and Q indices in going from the 3- to the 4-digit level is indicative of the presence of the aggregation bias. The differences between the indices at different levels of aggregation are shown by the summary statistics reported in Table 4.3. As indicated by the means of the indices, the aggregation bias is reduced by using the 4-digit level instead of the 3-digit level. For this reason, the 4-digit level data will be used to compute the Aquino index for the hypothesis testing in Chapter 5.

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27 The popularity in the use of the 3-digit groups in econometric works stems partly out of the notion that they closely approximate the concept of an industry and partly because it is the lowest level of aggregation at which it is possible to obtain comprehensive data.

Table 4.1: Intra-Industry Trade Indices

	G3	Ga3	Q3	Ga4	Q4
United Kingdom	25.43	34.16	24.00	28.39	20.48
Ireland	11.30	12.69	11.68	8.90	7.77
Austria	37.66	44.39	38.44	36.34	31.24
Belgium-Luxembourg	23.15	38.47	22.55	34.16	19.48
Denmark	20.01	23.45	21.58	16.56	15.07
Finland	28.26	54.88	35.34	38.44	21.90
France	17.41	19.70	17.47	15.43	13.09
West Germany	19.20	20.97	18.87	15.87	14.01
Greece	23.35	49.57	16.96	10.76	14.68
Iceland	3.02	4.52	3.29	2.76	2.73
Italy	6.82	7.83	6.82	7.33	6.52
Netherland	20.08	65.08	39.14	47.41	32.18
Norway	19.76	24.86	20.64	19.45	16.84
Portgual	11.10	16.96	13.24	8.05	7.33
Spain	24.76	25.14	24.99	18.16	17.70
Sweden	20.45	24.31	20.84	17.70	16.42
Switzerland	12.34	26.74	23.61	23.73	19.29
Israel	17.21	19.79	16.39	16.84	14.03
Turkey	12.50	32.34	30.00	29.19	29.14
Sri Lanka	0.68	0.79	0.70	0.40	0.40
Hong Kong	26.60	59.82	34.31	31.58	17.43
India	10.91	24.77	24.21	2.53	1.78
Malaysia	20.69	22.85	19.32	19.54	17.54

	G3	Ga3	Q3	Ga4	Q4
Pakistan	3.31	6.18	4.56	4.37	2.44
Singapore	10.91	15.26	11.27	11.67	9.31
China	3.22	6.21	3.84	3.24	2.53
Indonesia	1.29	9.62	5.89	8.76	2.02
Japan	7.91	8.66	7.94	6.88	6.32
South Korea	6.38	6.74	6.45	5.03	4.77
Philippines	11.55	16.72	11.35	12.81	7.57
Taiwan	6.33	14.1	9.97	11.73	8.40
Thailand	2.33	8.18	3.72	3.61	1.15
Australia	11.93	14.22	12.26	7.87	6.67
New Zealand	7.30	11.8	8.50	9.43	7.34
Argentina	10.22	30.51	14.09	8.81	3.49
Brazil	10.22	11.84	10.10	8.19	7.28
Chile	5.08	69.60	7.77	59.97	4.02
Venezula	3.00	5.86	4.65	5.84	2.19
Mexico	17.33	28.36	18.85	18.71	11.56
United States	41.69	63.19	51.35	52.45	34.66

Note:
G3 = Grubel and Lloyd index calculated at the 3-digit level
Ga3 = Grubel and Lloyd adjusted index calculated at the 3-digit level
Q3 = Aquino index calculated at the 3-digit level
Ga4 = Grubel and Lloyd adjusted index calculated at the 4-digit level
Q4 = Aquino index calculated at the 4-digit level

Table 4.2: Percentage Difference Between Various Intra-Industry Indices

	Ga34	Q34	G3Q3	Ga3Q3	G3Ga3	Q4Ga4
United Kingdom	-16.89	-14.67	5.96	42.33	-25.56	-27.86
Ireland	-29.87	-33.48	-3.25	8.65	-10.95	-12.70
Austria	-18.14	-18.73	-2.03	15.48	-15.16	-14.03
Belgium-Luxembourg	-11.20	-13.61	2.66	70.60	-39.82	-42.97
Denmark	-29.38	-30.17	-7.28	8.67	-14.67	-9.00
Finland	-29.96	-38.03	-20.03	55.29	-48.51	-43.03
France	-21.68	-25.07	-0.34	12.77	-11.62	-15.17
West Germany	-24.32	-25.76	1.75	11.13	-8.44	-11.72
Greece	-78.29	-13.44	37.68	192.28	-52.90	36.43
Iceland	-38.94	-17.02	-8.20	37.39	-33.19	-1.09
Italy	-6.39	-4.40	0.00	14.81	-12.90	-11.05
Netherland	-27.15	-17.78	-48.70	66.28	-69.15	-32.12
Norway	-21.76	-18.41	-4.26	20.45	-20.52	-13.42
Portgual	-52.54	-44.64	-16.16	28.10	-34.55	-8.94
Spain	-27.76	-29.17	-0.92	0.60	-1.51	-2.53
Sweden	-27.19	-21.21	-1.87	16.65	-15.88	-7.23
Switzerland	-11.26	-18.30	-47.73	13.26	-53.85	-18.71
Israel	-14.91	-14.40	5.00	20.74	-13.04	-16.69
Turkey	-9.74	-2.86	-58.33	7.80	-61.35	-0.17
Sri Lanka	-49.36	-42.85	-2.86	12.86	-13.92	0.00
Hong Kong	-47.20	-49.19	-22.47	74.35	-55.53	-44.81
India	-89.78	-92.64	-54.94	2.31	-55.96	-29.64

	Ga34	Q34	G3Q3	Ga3Q3	G3Ga3	Q4Ga4
Malaysia	-14.48	-9.21	7.09	18.27	-9.45	-10.24
Pakistan	-29.28	-46.49	-27.41	35.53	-46.44	-44.17
Singapore	-23.52	-17.39	-3.19	35.40	-28.51	-20.22
China	-47.82	-34.11	-16.12	61.72	-48.13	-21.91
Indonesia	-8.94	-65.71	-77.95	63.33	-86.50	-76.94
Japan	-20.55	-20.40	-0.31	9.07	-8.60	-8.14
South Korea	-25.37	-26.05	-1.09	4.50	-5.34	-5.17
Philippines	-23.38	-33.30	1.76	47.31	-30.92	-40.91
Taiwan	-16.80	-15.74	-36.51	41.42	-55.11	-28.39
Thailand	-55.86	-69.09	-37.37	119.89	-71.52	-68.14
Australia	-44.65	-45.60	-2.69	15.99	-16.10	-15.25
New Zealand	-20.08	-13.64	-14.11	38.82	-38.14	-22.16
Argentina	-71.12	-75.23	-27.47	116.54	-66.50	-60.39
Brazil	-30.82	-27.92	1.19	17.23	-13.68	-11.11
Chile	-13.83	-48.26	-34.62	795.75	-92.70	-93.30
Venezula	0.34	-52.90	-35.48	26.02	-48.81	-62.50
Mexico	-34.02	-38.67	-8.06	50.45	-38.89	-38.22
United States	-17.00	-32.50	18.81	23.06	-34.02	-33.92

Note:
Ga34 = percentage difference between Ga4 and Ga3
Q34 = percentage difference between Q4 and Q3
G3Q3 = percentage difference between G3 and Q3
Ga3Q3 = percentage difference between Ga3 and Q3
G3Ga3 = percentage difference between G3 and Ga3
Q4Ga4 = percentage difference between Q4 and Ga4

Table 4.3: Summary Statistics

VARIABLE NAME	MEAN	VARIANCE
G3	14.32	95.14
Ga3	24.53	334.07
Q3	16.92	132.29
Ga4	17.22	205.20
Q4	11.97	83.27

Note:
G3 = Grubel and Lloyd index calculated at the 3-digit level
Ga3 = Grubel and Lloyd adjusted index calculated at the 3-digit level
Q3 = Aquino index calculated at the 3-digit level
Ga4 = Grubel and Lloyd adjusted index calculated at the 4-digit level
Q4 = Aquino index calculated at the 4-digit level

4.3 Constructed Variables for Factor Endowments

In the inter-industry trade literature, the testing of the Heckscher-Ohlin(HO) hypothesis - that a country will export the commodity that uses intensively its relatively abundant factors requires direct and independent measures of three separate concepts: factor intensities, factor abundance and trade. The Heckscher-Ohlin-Vanek equation[28] illustrates this point. The equation is

$$AT = V - sVm$$

where A = matrix of factor intensities

T = vector of net exports

V = vector of factor endowments

Vm = vector of the world's factor endowments

s = the country's share in world income

Most of the studies in trade have utilized measures of two of the three variables to infer the third, and then determine the extent to which these measurements conform with the hypothesis postulated in the Heckscher-Ohlin model.[29] In

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28 Leamer(1984) suggests the use of the Heckscher-Ohlin-Vanek equation. This equation not only presents a relationship between the three different variables but also a generalization of the Heckscher-Ohlin model that applies to the 2 x 2 world as well as to the n x m world.

29 Examples of these studies are: (1) factor content studies by Leontiff (1956) and Baldwin (1971,1979) on the US economy and that by Posner (1975) using Canadian data;

particular, several studies have used the results of regressing net exports (T) on factor intensities (A) to infer a country's factor abundance (V - sVm) relative to the rest of the world as a whole.[30]

4.3.1 Data Input: Factor Endowment Variables

The testing of proposition (1) requires measures of the divergence in the level of resource endowments between Canada and each of the forty other countries. Since direct measures of the levels of resource endowments in each country are not available, proxy variables that give a general indication of the degree of similarity in resource endowments must be generated. The generation of these proxies uses an approach that is quite similar to the one used in cross-commodity regression analysis mentioned above.

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(2) cross-commodity regression studies of inter-industry trade by Branson and Monoyios (1977), Stern and Maskus (1981).

30 It has been noted (see Leamer and Bowen (1981)) that the use of this procedure to estimate relative factor endowments precludes the use of the resulting estimates in tests of the factor proportions theory itself - in other words, the theory cannot be used to generate variables which are then used in a subsequent test of the theory. However, in the application below, the constructed relative endowment variables are not being used in a test of the factor proportions theory itself.

The trade vector (T) utilized in this study is the calculated values of the 'revealed' comparative advantage indices of exports and imports.[31] It is regressed against three direct input factors, namely, physical capital, labour and human capital. The absolute values of the coefficients of the input factor intensities indicate the degree of the country's relative adundance in those factors. If the Heckscher-Ohlin hypothesis that a country will export the commodity which uses intensively its relatively abundant factor holds, then the coefficients will provide a general indication of the factor endowments of each country. Proxies for the similarity in factor endowments of each country are then generated from these coefficients.

4.3.2 Concept of Revealed Comparative Advantage

The commodity pattern of trade of individual countries reflects differences in relative costs as well as non-price factor differences. In particular, the export structure is determined by the comparative advantage that each country possesses. Balassa (1965,1977) has suggested that comparative advantage is 'revealed' by the relative export performance of individual product categories within the manufacturing sector. In general, the relative export performance of

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[31] The concept of revealed comparative advantage will be discussed in the following section.

a product category is expressed as the ratio of a country's share in the world's exports of that product category to its share in the world's exports of all manufactured goods. It is expressed as follows.

$$S_{ij} = \frac{\dfrac{X_{ij}}{\sum_{j=1}^{n} X_{ij}}}{\dfrac{\sum_{i=1}^{m} X_{ij}}{\sum_{i=1}^{m}\sum_{j=1}^{n} X_{ij}}} \qquad \text{..... (4.12)}$$

where i = ith of m industries

j = jth of n countries

where S_{ij} = Relative export performance index in industry i of country j

X_{ij} = Country j's exports of industry i

$\dfrac{X_{ij}}{\sum_{j=1}^{n} X_{ij}}$ = Country j's relative share in the world's exports of industry i

$\dfrac{\sum_{i=1}^{m} X_{ij}}{\sum_{i=1}^{m}\sum_{j=1}^{n} X_{ij}}$ = Relative share of country j in the export of all manufactured goods

Thus, a ratio of 1.10 (0.90) means that country j's share in product category i is 10% higher (lower) than its share in all manufactured exports.

4.3.3 Derivation of Endowment Similarity Indices for Canada

Using the concept of revealed comparative advantage discussed in the previous section, the relative export performance of Canada with another country in a particular product category can be defined as the ratio of the other country's share in Canadian exports of that product category to the other country's share in all Canadian exports of the seventy industries in the manufacturing sector to the other forty countries. Denoting the relative export performance of Canada with another country j in product category i by RXij,

$$RXij = \frac{\dfrac{Xij}{\sum_{j=1}^{40} Xij}}{\dfrac{\sum_{i=1}^{70} Xij}{\sum_{i=1}^{70}\sum_{j=1}^{40} Xij}} \qquad \ldots\ldots (4.13)$$

where i = ith industry of the 70 industrial categories of the manufacturing sector

j = jth country of the 40 countries

X_{ij} = Canadian exports of the ith industry to the jth country

$\sum_{j=1}^{40} X_{ij}$ = Sum of all Canadian exports of the ith industry to the 40 countries

$\sum_{i=1}^{70} X_{ij}$ = Sum of all Canadian commodities expored to the jth country

$\sum_{i=1}^{70} \sum_{j=1}^{40} X_{ij}$ = Total exports of Canada in the 70 industries

$\dfrac{X_{ij}}{\sum_{j=1}^{40} X_{ij}}$ = Share of the jth country in Canadian exports of the ith industry

$\dfrac{\sum_{i=1}^{70} X_{ij}}{\sum_{i=1}^{70} \sum_{j=1}^{40} X_{ij}}$ = Share of exports to the jth country in total Canadian exports of manufactured goods

Similarly, the imports into Canada from the other forty countries can be interpreted as the exports of these countries into Canada. Therefore, a corresponding index can be constructed as follows:

$$RM_{ij} = \frac{\dfrac{M_{ij}}{\sum_{j=1}^{40} M_{ij}}}{\dfrac{\sum_{i=1}^{70} M_{ij}}{\sum_{i=1}^{70}\sum_{j=1}^{40} M_{ij}}} \quad \ldots\ldots (4.14)$$

where RM_{ij} = Relative import performance in industry i from country j

i = ith industry of the 70 industrial categories of the manufacturing sector

j = jth country of the 40 countries

M_{ij} = Imports of the ith industry from the jth country into Canada

$\sum_{j=1}^{40} M_{ij}$ = Sum of all imports of ith industry into Canada from the 40 countries

$\sum_{i=1}^{70} M_{ij}$ = Sum of all commodities imported from the jth country into Canada

$$\sum_{i=1}^{70} \sum_{j=1}^{40} Mij$$ = Sum of imports into Canada from all 40 countries

$$\frac{Mij}{\sum_{j=1}^{40} Mij}$$ = Share of imports from the jth country in total imports of the ith industry

$$\frac{\sum_{i=1}^{70} Mij}{\sum_{i=1}^{70} \sum_{j=1}^{40} Mij}$$ = Share of imports from country j in total imports of manufactured goods into Canada

The values of RXij and RMij will be computed for the forty countries and seventy industrial categories.[32]

4.3.4 Three Direct Input Factor Intensities

The influences of the three basic input factors (physical capital, labour and human capital) on the pattern of trade and specialization, especially that of manufacturing, have

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[32] Data sources for RXij and RMij are given in Appendix C.

been studied extensively. Following the studies by Branson and Monoyios (1977) and by Stern and Maskus (1981), three direct input factors (physical capital, labour and human capital) have been obtained using 1980 data.

For each country, physical capital (Kp) is measured by the net fixed capital assets and labour (L) is measured by the total employment of each industry. Human capital (Kh) is obtained by capitalizing the excess income earned by skilled labour at a single discount rate. It is calculated by discounting the excess of the average wage in each industry, wi, over the median wage w earned in 1980 by employees with less than elementary school education (taken to represent unimproved labour) multiplied by employment Li in the industry.[33] Thus, human capital employed in each industry is computed as follows:

$$Khi = \frac{(wi - \bar{w}).\ Li}{0.10} = \frac{wi.Li - \bar{w}.Li}{0.10} \qquad \ldots\ldots (4.15)$$

where $\bar{w}$.Li = Payments to unskilled labour

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[33] Data sources for Kp, L, Li, wi and w are given in Appendix C.

$wi.Li - \bar{w}.Li$ = Excess payments to skilled labour in industry i

0.10 = Discount factor

The factor intensities for each industry are then obtained by dividing each factor by production (Vad) which is measured by the value-added in the industry.[34] The comparative advantage ratios are then regressed on these intensity measures, as in the following equation.

$$RXij = a1 + b1\ (Kp/vad)i + b2\ (La/vad)i + b3\ (Hk/vad)i. \quad (4.16)$$

$$RMij = a1 + b4\ (Kp/vad)i + b5\ (La/vad)i + b6\ (Hk/vad)i. \quad (4.17)$$

where i = ith of the 70 industries

RXij = Export comparative advantage ratio of the ith industry with respect to the jth country

RMij = Import comparative advantage ratio of the ith industry with respect to the jth country

(Kp/Vad)i = Capital intensity measure of the ith industry

(L/Vad)i = Labour intensity measure of the ith industry

(Kh/Vad)i = Human capital intensity measure of the ith industry

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[34] Data source for Vad is given in Appendix C.

The numerical magnitude of the coefficients in equations (4.17) and (4.18) implicitly reflects the respective relative resource endowments of the countries. When relative factor endowments differ between the countries, the divergence between the magnitude of the coefficients of the same variable in the two equations will be great. On the other hand, if relative factor endowments are similar, then the difference will be small. Indices for measuring the similarity in comparative advantage between Canada and the other country are created by dividing the absolute difference in the values of the coefficients by the sum of the coefficients. These are computed as follows:

$$\text{physical capital index (IKP)} = \frac{|\, b1 - b4 \,|}{(\, b1 + b4 \,)} \qquad \ldots (4.18)$$

$$\text{labour index (IL)} = \frac{|\, b2 - b5 \,|}{(\, b2 + b5 \,)} \qquad \ldots (4.19)$$

$$\text{human capital index (IKH)} = \frac{|\, b3 - b6 \,|}{(\, b3 + b6 \,)} \qquad \ldots (4.20)$$

Therefore, the more similar the comparative advantage between Canada and the other country (implicitly, the more similar the level of resource endowments), the smaller is the value of the index.

Equations 4.16 and 4.17 are estimated using the ordinary least square method and their results are reported in table 4.4 and table 4.5. The physical capital index, labour index and human capital index of equations 4.18, 4.19 and 4.20 are reported in table 4.6(along with some other variables to be discussed in the next chapter). The testing of proposition (1) on comparative advantage (or relative factor endowments) can be carried out by regressing the intra-industry trade index against these similarity indices.

Table 4.4: Regression Results of Equation (4.16)

COUNTRY	b1	b2	b3	$\bar{R}2$	F
United-Kingdom	0.4507 (3.07)	-0.3229 (-1.25)	0.9952E-2 (0.87)	0.1395	4.73
Ireland	0.4295E-2 (3.87)	-0.8240E-2 (-3.97)	-0.8090E-5 (-0.42)	0.1909	6.19
Austria	0.0193 (1.86)	-0.0808 (-2.04)	0.0254 (2.72)	0.4535	11.13
Belgium-Lexumbourg	0.2758 (7.06)	0.3686 (7.27)	-0.5865E-2 (-2.84)	0.8324	111.93
Denmark	-0.0274 (-0.23)	-0.0426 (-0.20)	0.0750 (7.86)	0.5618	6.58
Finland	0.1071 (1.67)	-0.3733 (-0.75)	-0.0270 (-1.44)	0.8190	46.25
France	0.5872 (6.96)	-0.1558 (-1.24)	-0.8151E-2 (-2.08)	0.7182	59.63
West-Germany	0.3931 (6.31)	-0.2204 (-2.13)	-0.5962 (-2.44)	0.7816	83.30
Greece	-0.0390 (-0.51)	-0.1923 (-9.70)	0.0151 (5.19)	0.6404	32.68
Iceland	-0.9605 (-6.75)	-0.6868 (-2.54)	0.1455 (15.33)	0.8569	92.85
Italy	0.0680 (2.13)	-0.0531 (-0.97)	0.3536E-2 (2.60)	0.6139	26.52
Netherland	1.3136 (11.59)	0.1928 (1.32)	-0.0191 (-3.22)	0.8302	90.11
Norway	0.2061 (12.70)	-0.0785 (-3.25)	-0.3345E-2 (-4.43)	0.8788	158.06

COUNTRY	b1	b2	b3	$\bar{R}2$	F
Portgual	-0.4699	-2.2063	0.1067	0.9143	157.44
	(-7.76)	(-2.02)	(10.88)		
Spain	0.1139	-0.0230	-0.1429E-2	0.9339	288.08
	(8.47)	(-1.03)	(2.76)		
Sweden	1.5392	-2.8761	-0.8667E-2	0.3934	14.84
	(6.56)	(-5.95)	(-1.17)		
Switzerland	0.2469	-0.0482	-0.3869E-2	0.7543	16.18
	(14.28)	(-4.85)	(-9.70)		
Israel	-0.1739	-0.1934	0.0181	0.8891	121.22
	(-0.82)	(-0.53)	(1.00)		
Turkey	0.0162	-0.3208E-2	0.0164	0.3645	6.19
	(2.01)	(-1.00)	(0.58)		
Sri Lanka	-0.2919	6.7322	-0.0324	0.9464	242.61
	(-1.18)	(23.22)	(-0.98)		
Hong Kong	-1.1019	-1.1328	0.1804	0.8275	108.12
	(-5.51)	(-4.41)	(17.20)		
India	-1.1434	2.7263	0.2322E-3	0.8512	111.61
	(-9.76)	(18.10)	(0.04)		
Malaysia	-0.8218E-3	0.7475E-3	0.6717	0.2027	5.49
	(-2.18)	(1.59)	(1.58)		
Pakistan	0.0227	0.1332	-0.1353E-2	0.4038	11.39
	(0.17)	(0.55)	(-0.94)		
Singapore	-0.1147	0.4593	0.0158	0.9156	5.95
	(-0.68)	(3.69)	(0.88)		
China	-0.1619	2.3169	-0.9468	0.9318	269.50
	(-3.18)	(53.64)	(-4.99)		
Indonesia	0.3185	-0.1319	0.3753	0.7790	65.62
	(13.89)	(-0.25)	(3.91)		
Japan	0.2663	-0.4802	-0.5685E-2	0.5222	26.14
	(2.84)	(-4.83)	(-1.15)		

COUNTRY	b1	b2	b3	$\bar{R}2$	F
South Korea	0.1790 (4.12)	-0.1342E-2 (-0.97)	0.5467E-3 (4.57)	0.9563	380.41
Philippines	-0.8029 (-9.84)	1.9307 (18.49)	0.1382E-2 (0.32)	0.2430	7.63
Taiwan	-0.9954 (-19.19)	2.0782 (26.89)	0.5151E-2 (2.13)	0.9214	251.02
Thailand	-0.2345 (-10.92)	0.4771 (15.00)	0.1340E-2 (1.33)	0.8008	77.37
Australia	0.4782 (3.24)	-0.0367 (-3.26)	-0.0169 (-1.12)	0.5357	27.16
New-Zealand	-0.4340 (-17.90)	0.8371 (19.72)	0.3048E-2 (3.99)	0.8606	138.84
Argentina	0.0700 (2.36)	-0.0136 (-0.51)	0.2196E-2 (1.70)	0.1666	4.83
Brazil	-0.0543 (-0.26)	0.7913 (0.80)	-0.5871E-2 (-0.08)	0.8883	112.29
Chile	-0.0621 (-5.39)	0.0790 (6.75)	0.2979 (2.64)	0.5933	27.74
Venezula	-0.01741 (-0.24)	-0.8077 (-3.03)	0.0518 (9.89)	0.3554	11.47
Mexico	-0.2960 (-12.08)	0.1718 (10.95)	0.0212 (7.82)	0.9283	238.20
United-States	0.0477 (1.25)	0.3473 (7.50)	0.0324 (7.10)	0.8013	78.59

Table 4.5: Regression Results of Equation (4.17)

COUNTRY	b4	b5	b6	$\bar{R}2$	F
United- Kingdom	0.1746 (1.51)	0.1045 (0.51)	0.0467 (5.17)	0.4233	17.88
Ireland	-0.0280 (-2.44)	-0.0728 (-2.54)	0.5991E-2 (11.30)	0.6601	43.72
Austria	-0.0563 (-1.11)	-0.2019 (-0.72)	0.0254 (0.28)	0.8420	55.16
Belgium- Lexumbourg	-0.2399 (-6.98)	0.4326 (9.78)	0.5907E-2 (3.28)	0.6294	38.92
Denmark	-0.0151 (-1.00)	-0.1961 (-1.95)	0.0195 (4.36)	0.2155	6.58
Finland	-0.1449 (-1.17)	-0.5869 (-3.17)	-0.0463 (-8.04)	0.5633	26.80
France	-0.6141 (-1.57)	-0.3185 (-1.24)	-0.0779 (-2.08)	0.1927	6.49
West- Germany	-0.5514 (-0.80)	-0.3930 (-0.31)	0.0707 (5.21)	0.3013	10.92
Greece	-0.0634 (-4.73)	-0.1923 (-9.70)	0.0151 (7.53)	0.6251	32.68
Iceland	1.2431 (10.89)	-2.3181 (-10.70)	-0.8886E-2 (-1.17)	0.7522	47.55
Italy	-1.0270 (-4.46)	-0.8914 (-2.26)	0.1412 (14.39)	0.7591	71.61
Netherland	-0.4859 (-10.78)	0.4221 (7.28)	0.0318 (13.48)	0.7918	90.11
Norway	-0.0413 (-5.34)	-0.0340 (-3.42)	0.6248E-2 (15.40)	0.7960	85.57

COUNTRY	b3	b4	b5	$\bar{R}2$	F
Portgual	-3.4668	59.012	-0.2501	0.8276	74.62
	(-1.23)	(10.56)	(2.88)		
Spain	-0.0200	-0.9751E-2	0.2349E-2	0.9339	73.24
	(-4.74)	(-1.39)	(14.45)		
Sweden	0.1423	-0.5133	-0.01070	0.4801	20.70
	(2.54)	(-4.45)	(-1.02)		
Switzerland	0.0833	-0.0557	0.3818E-2	0.7543	16.18
	(2.79)	(-2.19)	(3.57)		
Israel	0.0480	0.1473	0.0253	0.9704	493.52
	(0.48)	(0.17)	(0.74)		
Turkey	-0.7084	0.1031	-0.4183	0.4033	7.08
	(-3.99)	(4.43)	(-4.15)		
Sri Lanka	-0.8857E-2	-0.0121	0.2400E-2	0.7642	45.20
	(-5.57)	(-11.26)	(11.19)		
Hong Kong	-0.3486	-1.0076	0.1049	0.7579	70.90
	(-2.27)	(-5.15)	(13.15)		
India	0.0542	-0.0275	0.6428E-2	0.8070	81.87
	(4.02)	(-1.17)	(15.14)		
Malaysia	-0.1503E-3	-0.1424E-3	0.2160E-4	0.4989	18.24
	(-5.79)	(-4.41)	(7.38)		
Pakistan	-4.8477	-5.9568	0.7446	0.9583	353.63
	(-1.78)	(-1.18)	(24.98)		
Singapore	0.5373	-0.1288	-0.0337	0.1278	3.93
	(3.28)	(-0.95)	(-2.15)		
China	1.7586	-0.9565	0.0675	0.7812	71.28
	(6.69)	(-4.28)	(6.89)		
Indonesia	0.3013E-3	0.3316E-2	-0.3373E-4	0.2902	6.99
	(1.29)	(3.91)	(-4.41)		
Japan	-0.0680	-0.0373	0.8176E-2	0.7667	76.59
	(-4.83)	(-1.59)	(14.78)		

COUNTRY	b4	b5	b6	$\bar{R}2$	F
South Korea	0.5643 (4.17)	-0.0163 (-3.77)	0.1375E-3 (3.71)	0.2516	6.83
Philippines	-0.1270 (-0.72)	3.6619 (4.55)	0.1166 (2.29)	0.8492	117.39
Taiwan	-0.3870 (-7.27)	-0.3370 (-4.25)	0.0540 (21.83)	0.8882	170.49
Thailand	-0.0402 (-1.72)	-0.0520 (-1.23)	0.6278E-2 (13.67)	0.8008	77.36
Australia	-0.0367 (-3.26)	-0.0169 (-0.86)	0.4279E-2 (12.07)	0.6919	51.91
New-Zealand	-0.0215 (-3.90)	-0.0111 (-1.15)	0.2561E-2 (14.75)	0.7747	77.79
Argentina	12.371 (8.75)	-3.2864 (-2.54)	-0.0730 (-1.19)	0.5746	27.36
Brazil	0.0299 (0.44)	0.6144 (1.88)	0.0946 (4.21)	0.7869	42.36
Chile	-2.1510 (-2.90)	23.7490 (17.92)	-0.3294 (-3.97)	0.7587	112.44
Venezula	0.1020E-2 (1.41)	0.0113 (4.19)	-0.9592E-4 (-1.80)	0.6448	35.49
Mexico	-4.2344 (-7.22)	-2.7687 (-3.67)	0.5608 (18.21)	0.8475	115.83
United-States	0.0801 (2.12)	0.4990 (5.15)	0.0209 (7.10)	0.7713	78.59

Table 4.6: GNP Levels, Absolute Differences in the GNP Levels and Similarity Indices

COUNTRY	GNP	ADGNP*	IY	IKH	IKP	IL
United Kingdom	7920	2390	0.131	0.442	0.511	0.649
Ireland	4880	5430	0.358	0.734	0.797	0.997
Austria	10230	80	0.004	0.490	0.430	0.295
Belgium-Lexumbourg	12180	1879	0.083	0.144	0.125	0.000
Denmark	12950	2640	0.114	0.307	0.642	0.586
Finland	9720	590	0.030	0.150	0.223	0.264
France	11730	1420	0.644	0.022	0.343	0.811
West Germany	13590	3280	0.137	0.168	0.281	0.788
Greece	4380	5930	0.404	0.238	0.483	0.557
Iceland	1277	9033	0.780	0.128	0.543	0.885
Italy	6480	3830	0.228	0.876	0.888	0.951
Netherland	11470	1160	0.053	0.460	0.373	0.247
Norway	12650	2340	0.102	0.666	0.396	0.303
Portgual	2370	7940	0.626	0.762	0.928	0.402
Spain	5400	4910	0.313	0.701	0.405	0.244
Sweden	13520	3210	0.135	0.831	0.697	0.105
Switzerland	16440	6130	0.229	0.495	0.072	0.066
Israel	4500	5810	0.392	0.567	0.135	0.166
Turkey	1470	8840	0.750	0.742	0.873	0.926
Sri Lanka	270	10040	0.949	0.941	0.996	0.862
Hong Kong	4240	6070	0.417	0.519	0.058	0.265
India	240	10070	0.955	0.909	0.980	0.930
Malaysia	1620	8690	0.728	0.691	0.680	0.513
Pakistan	300	10010	0.944	0.991	0.956	0.996
Singapore	4430	5880	0.399	0.648	0.562	0.360
China	290	10020	0.945	0.830	0.612	0.754
Indonesia	430	9880	0.920	0.999	0.951	0.982
Japan	9890	420	0.021	0.593	0.856	0.180
South Korea	1520	8790	0.743	0.518	0.848	0.431
Philippines	690	9620	0.875	0.727	0.310	0.977
Taiwan	4200	6110	0.421	0.440	0.721	0.826
Thailand	670	9640	0.878	0.707	0.803	0.648
Australia	9820	490	0.024	0.857	0.838	0.338
New Zealand	7090	3220	0.185	0.906	0.974	0.087
Argentina	2390	7920	0.624	0.989	0.992	0.942
Brazil	2050	8260	0.668	0.290	0.126	0.883
Chile	2150	8160	0.655	0.944	0.993	0.982
Venezula	3630	6680	0.479	0.889	0.959	0.996
Mexico	2090	8220	0.663	0.869	0.883	0.927
United States	11360	1050	0.049	0.253	0.179	0.215

* ADGNP = absolute difference in the level of GNP

Chapter V

EMPIRICAL TESTING OF THE CROSS-COUNTRY PROPOSITIONS

5.1 Introduction

The purpose of this chapter is to test empirically the validity of the three major cross-country propositions that relate the effects of cross-country differences in structural characteristics to the level of intra-industry trade. The test is carried out by a cross-sectionl regression analysis of the share of intra-industry trade in Canada's trade with forty different countries. Indices that measure the level of Canada's intra-industry trade and proxy measures of the differences in cross-country structural characteristics were described in the preceding chapter, and a detailed discussion of the three testable propositions was carried out in Chapter 3.

The structure of this chapter is as follows: Section 1 is devoted to a discussion of the basic regression model used in the testing of the propositions. Explanations of the variables, and of the data and estimation procedures are also included in the discussion. The statistical results are presented in Section 2. A test for the problem of multicollinearity is also included in this section. The final section states the conclusions concerning the propositions being tested.

5.2 The Empirical Model

From the three testable propositions, the following regression equation can be specified: The level of intra-industry trade is a function of the level of income of the trading countries and the differences in their physical capital endowment, labour endowment, human capital endowment and income level. Thus, the complete model is as follows:

$$(INTRA)i = Co + C1(IKP)i + C2(IL)i + C3(IKH)i + C4(GNP2)i + C5(IY)i \quad ..... (5.1)$$

where

i = 1,2,.......40 is an index of countries

and

INTRAi = The level of intra-industry trade of Canada with country i

IKPi = The difference in physical capital endowments between Canada and country i

ILi	=	The difference in labour endowments between Canada and country i
IKHi	=	The difference in human capital endowments between Canada and country i
IYi	=	The difference in income levels between Canada and country i
GNP2i	=	The square of the per capita income of country i

The dependent variable, INTRA, is the Aquino index which is calculated using the 4-digit level of the Standard Industrial Classification as decribed in equation (4.12) in Chapter 4.[35]

The independent variables, IKP, IL and IKH are indices for measuring the differences in the levels of physical capital, labour and human capital endowments between Canada and forty different countries. The derivation of these indices was shown in the preceding chapter. These variables are used for testing Proposition 1. Since Proposition 1 postulates that trade between countries that have similar factor endowments will be mostly intra-industry in nature while trade between countries with very different factor endwoments will be mostly inter-industry in nature, a negative

[35] Chapter 4 has presented a detailed discussion of the rationale for using the Aquino index in this test.

relationship is expected to exist between these three independent variables and the level of intra-industry trade. Furthermore, both Krugman (1979,1980) and Helpman (1981) indicated that the level of intra-industry trade will be greater the less the comparative cost differences: Therefore, it is expected that a joint test on all three endowment variables will reveal that they are significant as a group.

The independent variable IY, which is an income similarity index, is derived as follows:

$$\text{Income Similarity index (IY)} = \frac{(Yi - 10310)2}{(Yi + 10310)}$$

where Yi = gross national product per capita of country i in 1980

10310 = gross national product per capita of Canada in 1980

Since Proposition 2 states that intra-industry trade will be more intense between countries with a smaller difference in their per capita income, it is expected that a negative relationship will exist between the independent variable, IY, and the dependent variable, INTRA.

Proposition 3 states that intra-industry trade will be more intense the higher the average per capita income of the trading countries. The independent variable used to test this proposition is GNP2 which is the square of the level of per capita income of each of the forty countries. A positive relationship is be expected to exist between GNP2 and INTRA.

In summary, the expected signs of the coefficients are:

Coefficients	Signs
IKP	-
IL	-
IKH	-
GNP2	+
IY	-

5.3 Empirical Results

Equation (5.1) is estimated by the Ordinary Least Squares (OLS) method. Data for the year 1980 are used. The significance of the regression coefficients is tested by a t-test at the 90% and 95% level. These t-values are given in parentheses beneath the coefficients. The joint test on the significance of the variables IKP, IL and IKH is performed using an F-test at the 1% level.

Table 5.1: Regression Results of Equation (5.1)

	Constant	Independent Variables				
	Co	IKP	IL	IKH	GNP2	IY
1a	0.2584	-0.0968	-0.0891	-0.0452		
	(8.55)**	(-1.63)*	(-2.27)**	(-0.75)		
		$\bar{R}2$ = 0.3866		F = 9.19***		
1b	0.2292	-0.1050	-0.0371	-0.0020	0.8874E-10	-0.7822E-5
	(5.08)**	(-1.79)*	(-0.80)	(-0.03)	(0.38)	(-1.52)*
		$\bar{R}2$ = 0.4183		F = 6.61***		

Note:
The t-statistics are given in parentheses.
* indicates significance at level of 90% two-tailed test.
** indicates significance at level of 95% one-tailed test.
*** The F-statistic is significant at the 99% level.

Table 5.1 presents the preliminary results of two regressions. Equation 1a includes only the indices of the differences in factor endowments whereas equation 1b also includes variables GNP2 and IY. In equation 1a, all of the coefficients are negatively and correctly signed. However, only the coefficient of the variable IL is significant at the 95% level for a one-tailed test. In equation 1b, all of the coefficients are correctly signed but the t-test does not allow us to reject the null hypothesis for any of the coefficients of interest. The F-statistics of both equations 1a and 1b indicate that the independent variables as a group are significant in explaining the variation of intra-industry trade.

An inspection of the residual plots of the preliminary regression results indicates that an outlier is present in the data sample. This outlier observation pertains to one country, Turkey. A close examination of the trade between Canada and Turkey indicates that a high level of intra-industry trade was concentrated in the communications equipment industry. In 1980, the proportion of the volume of exports of the communications equipment industry to the total volume of exports of seventy industries from Canada to Turkey was about 57.5%. In the same year, the proportion of the volume of imports of this industry to the total volume of imports of the seventy industries into Canada was about 28.9%.

In addition, communications equipment formed the largest industrial export and the second largest industrial import among the seventy industrial 3-digit SIC industries. This accounted for the high level of intra-industry trade that showed up in the Aquino index. Given the fact that the communications equipment industry is a highly advanced technological industry and that Turkey is a less developed country, it is highly improbable that such a high share of intra-industry trade exists in this category. While it is not possible to state precisely the cause of the phenomenon, this high level of intra-industry trade is likely to be the result of one-way trade that is manifested in a two-way exchange.[36] This may be due to the setting up of a communications network in Turkey which entailed the transportation of communications equipment back into Canada.

There are two ways to reduce the effect of the outlier. One is to drop the observation that produces the outlier. The other is to structure a dummy variable to reduce the outlier effect and, at the same time, to account for the outlier observation. Since the dropping of observation will cause a loss of information, this study would adopt the latter approach by adding a dummy variable to equation (5.1). The modified equation is shown as follows:

$$(INTRA)i = Co + C1(IKP)i + C2(IL)i + C3(IKH)i + C4(GNP2)i + C5(IY)i + C6(DUMM)i \quad ..... (5.2)$$

where

DUMMi = Dummy variable with a value of zero for Turkey and one for the rest

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[36] Attempts to pinpoint the exact cause of the phenomenon were unsuccessful.

Equation (5.2) is again estimated using the Ordinary Least Squares method. The results are reported in Table 5.2.

Table 5.2: Regression Results of Equation (5.2)

	Constant	Independent Variables					
	Co	IKP	IL	IKH	GNP2	IY	DUMM
2a	0.2655	-0.1102	-0.1040	-0.0394			0.2476
	(10.44)**	(-2.21)**	(-3.15)**	(-0.78)			(4.01)**
			$\bar{R}2$ = 0.5674	F = 13.79***			
2b	0.2199	-0.1049	-0.0780	-0.0214	0.2842E-9		0.2504
	(5.90)**	(-2.14)**	(-2.17)**	(-0.42)	(1.65)*		(4.15)**
			$\bar{R}2$ = 0.5875	F = 12.11***			
2c	0.2472	-0.1230	-0.0501	0.0076		-0.9741E-5	0.2569
	(10.17)**	(-2.67)**	(-1.39)*	(0.15)		(-2.74)**	(4.52)**
			$\bar{R}2$ = 0.6350	F = 14.57***			
2d	0.2350	-0.1202	-0.0473	0.0086	0.8713E-10	-0.8806E-6	0.2569
	(6.50)**	(-2.55)**	(-1.30)*	(0.17)	(0.4616)	(-2.13)**	(4.45)**
			$\bar{R}2$ = 0.6264	F = 11.90***			

Note:
The t-statistics are given in parentheses.
* indicates significance at level of 90% two-tailed test.
** indicates significance at level of 95% one-tailed test.
*** the F-statistic is significant at the 99% level.

When a dummy variable is added to the regression equation to reduce the effect of the outlier, the results improve considerably. As before, the F-statistic is significant at the 99% level. The coefficient of the dummy variable is significant at the 99% level in all the cases. This indicates that the outlier observation has exerted a significant effect on the data sample.

A joint test on the coefficients of IKP, IL and IKH was also carried out. Equation (5.2) is first estimated and its error sum of squares (ESSur) is recorded. Then the equation is re-estimated with the coefficients of IKP, IL, IKH restricted to zero. The error sum of sqaures (ESSr) is again obtained. The joint hypothesis that the coefficients of the endowment indices are all equal to zero is tested with an F-test structured as follows:

$$F = \frac{ESSr - ESSur / q}{ESSur / n - k}$$

where

q = number of restrictions

n = number of observations

k = number of parameters in the unrestricted equation

The computed F-statistic (with q=3, n-k=33) is 5.39 which is significant at the 99% level. However, the results are ambiguous in other respects. Of the three endowment variables, only the coefficient of IKP is significant at the 95% level and that of IKH is incorrectly signed. The coefficients of GNP and IY are correctly signed but that of GNP2 is insignificiant.

5.3.1 Problem of Multicollinearity

From the results given in Table 5.2, there is a general indication that multicollinearity exists. In equation 2b, the coefficients of IKP and IL are significant at the 95% level for a one-tailed test while that of GNP2 is significant at the 90% level for a two-tailed test. When both variables GNP2 and IY are included in the regression (equation 2d), results show that the coefficient of IKH is incorrectly signed and insignificant. In addition, the coefficient of GNP2 is now insignificant. The change in the sign of the coefficient of IKH and the drastic drop in the t-value of GNP2 tends to suggest that the problem of multicollinearity exists.

One quick way of detecting the presence of collinearity is to examine the simple correlation matrix of the variables, which is shown in Table 5.3.

Table 5.3: Simple Correlation Matrix of Variables

	IKH	IKP	IL	IY	GNP2
IKH	1				
IKP	.7355	1			
IL	.3039	.4808	1		
IY	.4773	.4390	.6123	1	
GNP2	-.4517	-.4855	-.5586	-.7038	1

The simple correlation between IKP and IKH is 73.55 percent and that between GNP2 and IY is 70.38 percent. These simple correlation values are greater than the adjusted R-square obtained for the regression of equation (5.2). This suggests that the problem of multicollinearity may arise from these variables.

As suggested by Farrar and Glauber (1967), a more reliable test for the presence of multicollinearity is to compare two different correlation coefficients. One correlation coefficient Ry is obtained by estimating the equation that has included in it all the independent variables. The other is the correlation coefficient Rxi which is obtained by estimating the multiple correlation coefficient between a particular independent variable with respect to the other independent variables. A ratio of Rxi to Ry is then calculated. If the ratio is close to or greater than one, it can be concluded that multicollinearity is present. The correlation coefficients for equation (5.2) are calculated and shown in Table 5.4.

Table 5.4: Values of the Correlation Coefficients

Ry	:	Correlation Coef. for equation (5.2)	= 0.8279
Rx1	:	Correlation Coef. of IKP on IL,IKH,GNP2,IY,CCF	= 0.7915
Rx2	:	Correlation Coef. of IL on IKP,IKH,GNP2,IY,CCF	= 0.6958
Rx3	:	Correlation Coef. of IKH on IKP,IL,GNP2,IY,CCF	= 0.7748
Rx4	:	Correlation Coef. of GNP2 on IKP,IL,IKH,IY,CCF	= 0.7389
Rx5	:	Correlation Coef. of IY on IKP,IL,IKH,GNP2,CCF	= 0.7754

Ratios calculated are as follows:

$$Rx1/Ry = 0.96$$
$$Rx2/Ry = 0.84$$
$$Rx3/Ry = 0.94$$
$$Rx4/Ry = 0.89$$
$$Rx5/Ry = 0.94$$

The calculated ratios are very close to one. This indicates the presence of multicollinearity although the problem is not extremely severe.

There are two common methods to correct for the problem of multicollinearity. One approach is by acquiring more data. However, as stressed by Johnston (1984), the addition of more data is useful only if these data are less collinear than the current ones. In this study, the possible source of multicollinearity might come from the collinear relationship between physical and human capital endowments (that is, between IKP and IKH). The addition of more data by increasing the number of countries in the study will not necessarily reduce collinearity since it can be expected that countries that are well endowed with physical capital would also be well endowed with human capital. The second method involves dropping variables that are highly collinear. This approach entails a loss of information and the possiblity of introducing bias into the re-estimated equation. In addition, it requires a precise knowledge of the nature and source of the multicollinearity. Noting these two points, the second method is carried out here. The regressions are performed with the endowment indices IKP, IKH and IL excluded one at a time. Results obtained by dropping these different variables are shown in Table 5.5.

In all cases where the regressions are performed with variables IKP, ILA or IHK excluded, the coefficient of GNP2 is not significant but is correctly signed. The coefficients of the other variables are correctly signed when either IKP or IL is excluded. But only in the case when the variable IKP is excluded is the coefficient of the variable IKH significant.

Table 5.5: Regression Results of Equation (5.2)

	Constant			Independent Variables			
	Co	IKP	IL	IKH	GNP2	IY	DUMM
3a	0.2564 (7.13)**	-0.1146 (-3.37)**	-0.0488 (-1.39)*		0.8570E-10 (0.46)	-0.8606E-5 (-2.20)**	0.2564 (4.01)**
			$\bar{R}2$ = 0.6370 F = 14.69***				
3b	0.2153 (6.53)**	-0.1410 (-3.17)**		-0.0249 (-0.51)	0.1264E-9 (0.67)	-0.1085E-4 (-2.82)**	0.2524 (4.36)**
			$\bar{R}2$ = 0.6195 F = 13.70***				
3c	0.2250 (5.81)**		-0.0803 (-2.14)**	-0.0785 (-1.98)*	0.1518E-9 (0.75)	-0.7181E-5 (-1.63)*	0.2463 (3.98)**
			$\bar{R}2$ = 0.5658 F = 11.16***				

Note:
The t-tatistics are given in parentheses.
* indicates significance at level of 90% two-tailed test.
** indicates significance at level of 95% one-tailed test.
*** The F-statistic is significant at the 99% level.

The sensitivity of the least squares estimates due to multicollinearity in the data can also be investigated by using a ridge regression. This procedure is based on the assumption that the least squares estimates in the presence of multicollinearity tend to be too large. The ridge solution supplements the data by stochastically shrinking the estimates[37] toward zero. As a result, the estimated coefficients from the ridge regression are biased but with a lower variance than the ordinary least squares estimates. In addition, they have a smaller mean square error.[38] Table 5.6 presents the regression results using the ridge regression.

Table 5.6: Ridge Regression Results of Equation (5.2)

Constant	Independent Variables					
Co	IKP	IL	IKH	GNP2	IY	DUMM
0.2037 (9.68)	-0.0570 (-3.48)	-0.04222 (-2.59)	-0.0316 (-1.70)	0.1543E-9 (2.04)	-0.4665 (-3.13)	0.1364 (4.01)

$\bar{R}2 = 0.5389 \qquad F = 8.60$

Note:
The above result is obtained using a k value = 0.72.

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[37] The ridge estimate of B is defined as:

$$Br = (X'X + cI)\ X'Y$$

where c (>0) is an arbitrary constant. For a more detailed discussion on the ridge regression, see Johnston (1984).

[38] The mean square error is defined as the sum of the variance and the square of the bias.

The results indicate that multicollinearity is present. The signs on all the coefficients of the variables are now correct and conform to that postulated in the three propositions.

5.4 Summary and Conclusion

As stated, the objective of this chapter is to test the three major propositions. The regression results reported above can be summarized as follows:

1. In Table 5.2, the coefficients of the endowment variables are all significant and correctly signed with the exception of the human capital endowment variable. The incorrect sign of this variable can be attributed to the presence of multicollinearity in the sample data.

The presence of multicollinearity is detected through the inspection of the simple correlation matrix of the variables and through the comparison of correlation coefficients as shown in Table 5.3 and Table 5.4 respectively. The effect of the presence of multicollinearity on the sign of the human capital endowment variable has been confirmed by two methods. First, in equation (3c) of Table 5.5, when the physical capital endowment variable is excluded from equation (5.2), the coefficient of the human capital variable is significant and negatively signed. Second, when a ridge regression is performed on equation (5.2) the human capital endowment variable is correctly signed. Therefore, Proposition 1 tends to be supported by these results.

2. A joint test on the endowment variables (physical capital, labour and human capital) as a group shows that it is significant at the 99% level. Therefore, this supports the hypothesis that these three variables, viewed jointly as determinants of costs, have an effect on the level of intra-industry trade.

3. The coefficient of the variable on the similarity of income (IY) is always significant and correctly signed. Proposition 2, therefore, is supported by this result.

4. The results of Tables 5.1, 5.2 and 5.5 do not support Proposition 3. In all the cases, even when correction has been made for the presence of multicollinearity, the coefficient of GNP2 is insignificant, though, correctly signed. However, since it is correctly signed in these equations and remains so using the ridge regression, it is possible that some remaining multicollinearity may explain its insignificant.

In summary, this study of intra-industry trade between Canada and forty other countries[39] tends to lend support to Propositions 1 and 2 while indicating very little support for Proposition 3.

In Chapter two , it was pointed out that regional trade liberalization arrangements typically lead to a significant expansion of intra-industry trade and relatively little increase in inter-industry specialization. Since such trading arrangements have involved countries at similar levels of development and with similar global comparative advantages, the results here are consistent with this observation.

Moreover, as noted by Balassa (1967), the adjustment costs associated with trade liberalization are smaller the greater the expansion in intra-industry trade relative to inter-industry specialization. This follows since it is considerably easier to shift labour and other factors of production within an industry than between industries. Further, the absence of resources reallocation across industries would further imply that the income redistribution effects of trade liberalization are small with intra-industry specialization.

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[39] In addition, other specifications of the variables for Propositions 2 and 3 have been carried out and their results are reported in the Appendix D. These results are similar to those reported above.

In addition, the increase in intra-industry trade due to trade liberalization would result in intra-industry specialization since plants in different countries, but within the same industry, can specialize in different varieties of products, thereby achieving greater scale economies within any given product line. As noted by by Harris and Cox (1983), the sizable estimates they obtained for the gains from trade liberalization with the U.S. are dependent upon the realization of those potential economies of scale. In contrast to conventional inter-industry trade models, intra-industry trade models, such as those of Krugman (1979, 1980) and Helpman (1981) which were discussed in Chapter three, do incorporate scale economies. The support for the new theoretical models found here therefore indirectly supports their use in estimating potential gains.

Since Canada and U.S. have similar per capita incomes and global comparative advantage, the results obtained in this chapter augur well for the consequences of the bilateral tariff reductions which may occur as a result of the upcoming Canada-U.S. free trade negotiation.

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Appendix A

MATCHING OF SIC CODE

INDUSTRIES	60 SIC	70 SIC	80 Sic
Meat and Poultry Product	101 103	101 1011 1012	101 1011 1012
Fish Product	111	102	102 1021
Fruit and Vegetable Processing	112	103 1031 1032	103 1031 1032
Dairy Product	105 107	104	104 1041 1049
Feed Industry Flour and Breakfast Cereal	123 124 125	105 106	105 1051 1052 1053
Bakery Product	128 129	107 1071 1072	107 1071 1072
Miscellaneous Food (1)	131 133 135 139	108	106 108 109 1061 1081 1082 1083 1091 1092 1093 1094 1099

INDUSTRIES	60 SIC	70 SIC	80 Sic
Soft Drinks	141	1091	1111
Distillery Products	143	1092	1121
Breweries	145	1093	1131
Wineries	147	1094	1141
Tobacco Products (2)	151 153	151 153	121 122 1211 1221
Rubber Products (3)	161 163 169	162 1623 1629	151 512 159 1511 1521 1599
Leather Products	172-179	172 174 175 179 1792 1799	171 1711 1712 1713 1719 2493
Cotton Yarn and Cloth Mills	183	181	1829
Wool Yarn and Cloth Mills	193 197	182	1821
Man-made Fibre, Yarn and Cloth	201	183	181
Felt and Fibre Processing (4)	211 215	185	191 192
Carpet, Mat, Rug	216	186	1911 1921
Hosiery Mills	231	231	249 2494
Knitting Mills	239	239	183 1831

INDUSTRIES	60 SIC	70 SIC	80 Sic
Men Clothing	243	243	243 2431 2432 2433 2434
Women Clothing	244	244	244 2441 2442 2443 2444 2445
Fur Goods Industry	246	246	249 2495
Foundation Garments	248	248	249 2496
Sawmills and Planning Mills	251	251	251 2511 2512
Veneer and Plywood Mills	252	252	252 2521 2522
Sash, Door and Other Mills	254	254	254 2541 2542 2543 2549
Wooden Boxes	256	256	256 2561
Coffin and Casket Industry	258	258	258 2581
Miscellaneous Wood	259	259	259 2591 2592 2593 2599 3332

INDUSTRIES	60 SIC	70 SIC	80 Sic
Furniture and Fixture Industry (5)	261 264 266 268	261 264 266 268	261 264 269 333 2611 2612 2619 2641 2649 2691 2692 2699 3332
Pulp and Paper Mills	271	271	271 2711 2712 2713 2714 2719
Paper Boxes and Bags (6)	273	273	169 273 1691 2731 2732 2733
Commercial Printing	286	286	281 2811 2819
Platemaking, Typsetting, Trade Bindery Industry	287	287	282 2821
Publishing Only	288	288	283 2831 2839
Iron and Steel Mills (7)	291-292	291-292	291-292 2911 2912 2919 2921
Iron Founderies	294	294	294 2941

INDUSTRIES	60 SIC	70 SIC	80 Sic
Smelting and Refining (8)	295	295	295 2951
Aluminium Rolling, Casting and Extrusion (8)	296	296	296 2961
Copper and Copper Alloy (8)	297	297	297 2971
Metal Rolling Casting etc.(8)	298	298	299 2999
Boiler and Plate	301	301	301 3011
Structural Metal Industry	302	302	302 3021 3023 3029
Ornamental Iron Works	303	303	303 3031 3032 3039
Metal Stamping	304	304	304 3041 3042 3049
Wire and Wire Products	305	305	305 3051 3052 3053 3059
Hardware and Tools	306	306	306 3061 3062 3063 3069
Heating Equipment	307	307	307 3071

INDUSTRIES	60 SIC	70 SIC	80 Sic
Machine Shop	308	308	308 3081
Miscellaneous Metal Products	309	309	309 3091 3092 3099
Agricultural Implement Industry	311	311	311 3111
Commercial Refrigeration	316	316	312 3121
Aircraft and Parts	321	321	321 3211
Motor Vehicle Manufacture and Parts (9)	323 325	323 325	323 325 3231 3251 3252 3253 3254 3255 3259
Major Appliances	332	332	332 3321
Small Appliances	333	331	331 3311
Radio and Television Reciever	334	334	334 3341
Communication Equipment	335	335	335 3351 3352 3359

INDUSTRIES	60 SIC	70 SIC	80 Sic
Industrial Electrical Equipment	336	336	337 3371 3372 3379
Battery Manufacture	337	339 3391	339 3391
Cement Manufacture	341	352	352 3521
Concrete Manufacture	347	354	354 3541 3542 3549 3612
Ready Mix Concrete	348	355	355 3551
Clay Products	351	351	351 3511 3512
Glass and Glass Products	356	356	356 3561 3562
Petroleum Refineries	365	365	361 3611 3612
Miscellaneous Petroleum and Coal Products	369	369	369 3699
Fertilizers	372	372	372 3722
Pharmaceuticals	374	374	374 3741
Paint and Varnish	375	375	375 3751

INDUSTRIES	60 SIC	70 SIC	80 Sic
Soap and Cleansing Compounds	376	376	376 3761
Toilet Preparation	377	377	377 3771
Industrial Chemical	378	378	371 3711 3712 3721
Scientific and Professional Equipment	381	391	391
Sporting Good and Toy	393	393	393 3931 3932
Jewellery and Silverware	392	392	392 3921 3922
Broom, Brush and Mop	399	399	399 3991

Note: Reclassification Scheme

(1) into 406
(2) into 421
(3) into 451
(4) into 491
(5) into 460
(6) into 473
(7) into 490
(8) into 495
(9) into 423

Source: Statistic Concordance
1960 SIC Classification handbook
1970 SIC Classification handbook
1980 SIC Classification handbook

Appendix B

LIST OF COUNTRIES

code	countries	code	countries
1	United Kingdom	516	Hong Kong
17	Ireland	519	India
43	Austria	524	Malaysia
44	Belgium-Luxembourg	527	Pakistan
49	Demark	528	Singapore
53	Finland	553	China
54	France	556	Indonesia
55	West Germany	559	Japan
59	Greece	564	South Korea
63	Iceland	567	Philippines
67	Italy	578	Taiwan
73	Netherland	583	Thailand
76	Norway	614	Australia
78	Portugal	622	New Zealand
82	Spain	744	Argentina
85	Sweden	752	Brazil
86	Switzerland	755	Chile
355	Israel	785	Venezula
382	Turkey	874	Mexico
513	Sri Lanka	990	United States

Source: Statistics Canada
Exports by Commodities, 65-004 1980
Imports by Commodities, 65-007 1980

Appendix C

DEFINITIONS AND DATA SOURCES

1. Xij = Canadian exports of the ith industry to the jth country

source Statistics Canada, Exports by Commodities, 65-004, 1980.

Mij = Imports of the ith industry from country j into Canada

source Statistics Canada, Imports by Commodities, 65-007, 1980

The sample consists of 70 manufacturing commodity groups at the 3 and 4 digit Standard Industrial Classification (SIC)for the year 1980. This sample is synthesized from commodity exports and imports data published by Statistics Canada. These trade data are classified under the export and import commodity classification (XCC and MCC). A concordance supplied by Statistics Canada is used for the allocation of commodities classified under the XCC and MCC system to the various industries classified under the 1980 SIC system. These 70 manufacturing industries are selected on the basis that they exhibited little or no change in their commodities composition when the SIC code switch from 1960 to 1970 to 1980.

2. Kp = Physical Capital is measured by Net Fixed Asset

Source Statistics Canada,
Corporation and Financial Statistic, 1980.

3. L = Labour is measured by Total Employment

Source Statistics Canada,
Manufacturing Industries of Canada
National and Provincial Area, 31-203, 1980.

4. Vad = Output is measured by Valued Added

Source Statistics Canada,
Manufacturing Industries of Canada
National and Provincial Area, 31-203, 1980.

5. W = Median Wage earned in 1980 by employees with less than elementary school Education

source Statistics Canada,
Census of Canada, 92-931, 1980.

Appendix D

REGRESSION RESULTS FOR OTHER SPECIFICATIONS OF PROPOSITIONS 2 AND 3 OF CHAPTER 5

Dep.	Constant			Independent	Variables	Var.	
	Co	IKP	IL	IKH	GNP	ADGNP2	DUMM
Q4	0.2584	-0.0968	-0.0891	-0.0452			
	(8.55)**	(-1.63)	(-2.27)**	(-0.75)			
			$\bar{R}^2$ = 0.3866	F = 9.19**			
Q4	0.2655	-0.1102	-0.1040	-0.0394			0.2476
	(10.44)**	(-2.21)**	(-3.15)**	(-0.78)			(4.01)**
			$\bar{R}^2$ = 0.5674	F = 13.79**			
Q4	0.1806	-0.1102	-0.0583	-0.0036	0.6227E-5		0.2545
	(4.20)**	(-2.35)**	(-1.60)	(0.07)	(2.38)**		(4.38)**
			$\bar{R}^2$ = 0.6181	F = 13.63**			

Dep.	Constant			Independent	Variables	Var.	
	Co	IKP	IL	IKH	GNP	ADGNP2	DUMM
Q4	0.2514	-0.1293	-0.0447	0.0153		-0.9914E-9	0.2605
	(10.74)**	(-2.85)**	(-1.25)	(0.31)		(-3.01)**	(4.66)**

$\bar{R}2$ = 0.6468 F = 15.40**

Dep.	Co	IKP	IL	IKH	GNP	ADGNP2	DUMM
Q4	0.2357	-0.1269	-0.0428	0.0157	0.1281E-5	-0.8662E-9	0.2606
	(4.48)**	(-2.72)**	(-1.17)	(0.31)	(0.33)	(-1.72)**	(4.60)**

$\bar{R}2$ = 0.6392 F = 12.52**

Note:
Q4 = Aquino Index calculated at the 4-digit level.
Dumm = Dummy variable for one outlier observation, namely, the observation pertaining to the country, Turkey.
ADGNP2 = Square of the absolute difference in the level of GNP between Canada and the other country.
The t-statistics are given in parentheses.
* indicates significance at level of 90% two-tailed tests.
** indicates significance at level of 95% one-tailed tests.
*** The F-statistic is significant at the 99% level.

VITA

Surname: TANG Given Names: YENG YUEN

Place of Birth: SINGAPORE Date of Birth: Mar.18, 1954

Educational Institutions Attended, with Dates of Entering and Leaving:

SIMON FRASER UNIVERSITY, B.C. 1979 to 1982

UNIVERSITY OF VICTORIA, B.C. 1982 to 1985

Degrees, Diplomas, Etc., Awarded, with Dates and Names of Institutions:

B.A.(Hon.) 1982 SIMON FRASER UNIVERSITY

Honors and Awards:

Publications:

- -