August 8, 1985
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DISCUSSION PAPER

CANADIAN TRADE IN HIGH-TECHNOLOGY:

AN ANALYSIS OF ISSUES AND PROSPECTS

Policy and Strategy Branch
Ministry of State for
Science and Technology

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PREFACE

This report is prepared as a contribution to knowledge on Canadian trade issues. In particular, it looks at the high-technology dimension of Canadian trade with other countries. While the report deals with the issues and prospects of Canada's high-technology sector it does not attempt to assess various trade options which are available to us.

The view presented in this report should not in any way be construed as representing the official view of the Ministry of State for Science and Technology on Canada's trade position.

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EXECUTIVE SUMMARY

The present study reviews issues related to Canadian trade in high-technology products[1] and assesses its prospects for the next several years.

The principal characteristics of Canada's trade in high-technology and the context for the development of the sector are as follows:

- Canada's trade deficit in high-technology is the worst among the Economic Summit countries. It stood at about $12 billion in 1984 and continues to grow;

- Canada is the only major industrialized country with trade deficits in all high-technology commodity groups;

- Canada ranks 8th in terms of market shares of OECD exports of high R&D-intensity (i.e. high-technology) products. Moreover, Canada is losing its market share over time, from 4.4% in 1970 to 3.5% in 1983;

- Canada ranks 8th in terms of gross expenditures on R&D (GERD) as a percentage of GNP, trailing the U.S., F.R.G., Japan, U.K., Sweden, France, and the Netherlands;

[1] Services are also looked into but could not be analyzed fully because of the lack of data.

- On the question of tariffs, except for telephone equipment, Canadian and U.S. tariffs on high-technology commodities are generally quite low, and some will be reduced further as a result of the 1979 Tokyo Round agreement;

- Tariffs do not constitute a major problem faced by the Canadian high technology industry. Non-tariff barriers, nevertheless, constitute an issue of concern in areas such as product standardization, government procurement policy, and especially access to technology;

- Canada may not benefit from the ever-increasing U.S. defence-related R&D budget to a significant extent due to the non-tariff barriers created by U.S. national security considerations.

- Since foreign subsidiaries, by and large, are set up in Canada primarily to serve the Canadian market, the branch plant nature of the Canadian high-technology sector is not conducive to a high level of R&D activities. This is evidenced by the low R&D expenditures/sales ratios of foreign-controlled high-technology companies compared to those of their domestically- controlled counterparts. Since R&D is the "centre of gravity" of a high-technology company, Canada's large trade deficit in high-technology products appears to be partly due to the high level of foreign ownership in the sector;

- The high technology trade deficit of close to $12 billion in 1984 is equivalent to a loss of approximately 120,000 jobs to Canadians or 10% of the current unemployed labour force.

Given the present state of affairs, there are not many options to improve Canadian trade in high-technology in the short-term because of its structural nature.

Nevertheless, there is a need to evaluate the emerging trade negotiation positions of the U.S. and other countries in terms of their impacts on access to technology and access to markets. There is also a need to encourage the development of joint international R&D and commercial ventures to get around trade barriers.

In the long-term, efforts should be made to further develop the high-technology sector in such a way that it can expand, find market niches, and become competitive at a world level. The cornerstones of this technology development strategy should include, at the very least, the key elements identified by members of the sector themselves, such as tax incentives, procurement policies, export/marketing assistance, and R&D grants, elements which are considered more important than the move towards free trade per se.

A stronger high-technology sector would lessen our dependence on the resource sector to maintain a healthier balance-of-payment position.

Canadian Trade in High-Technology: An Analysis of Issues and Prospects

1.0 Background

At the Quebec Summit of February, 1985, Prime Minister Brian Mulroney and U.S. President Ronald Reagan agreed to give the highest priority to finding mutually acceptable means of reducing and eliminating trade barriers and facilitating trade and investment flows between Canada and the U.S. The Prime Minister and the President also directed that action be undertaken over the following twelve months to resolve specific impediments to trade in a manner consistent with the international obligations and legislative requirements of both countries. In particular, the Prime Minister and the President called for the elimination or reduction of tariffs and non-tariff barriers to trade in high-technology goods and related services such as computers, transborder data flow, and computer-assisted design and manufacturing technology.

In addition to the commitment made in Quebec, the Minister for International Trade has released a discussion paper entitled How to Secure and Enhance Canadian Access to Export Markets (2). This paper was followed by a series of consultations conducted

around the country by the Minister and by the preparation of background documents by various federal agencies. Recently, as well, the Secretary of State for External Affairs released a review document entitled Competitiveness and Security: Directions for Canada's International Relations which, among other things, emphasizes that economic issues are assuming an increasingly prominent role in Canadian international relations (3). As a result of these exercises, it is expected that a Canadian position on trade will be formulated in the near future.

2.0 Purpose

The purpose of this report is to review the recent trends in Canadian international trade in high-technology, including both goods and services; to analyze the issues arising from these trends; and to assess, within the context of the global environment, the prospects for this area of Canadian trade.

3.0 Definition of High Technology Commodities and Services

High-technology goods have been defined by the U.S. Department of Commerce (DOC 2 List) as products receiving an above-average level of R&D. Thus, the following commodities are defined as being of a high-technology nature (13):

- aircraft and parts;
- computers and office equipment;
- electrical equipment and components;
- optical and medical equipment;
- drugs and medicines;
- plastics and synthetic materials;
- engines and turbines;
- agricultural chemicals;
- professional and scientific instruments;
- industrial chemicals; and
- radio and TV receiving equipment.

The above commodities can be grouped together in five categories as follows:

- chemicals
- office machinery
- other machinery
- aircraft and parts
- electrical products
- scientific instruments

It should be noted that the main shortcoming of the U.S. definition is that in many countries, including Canada, R&D expenditure data are not collected on the basis of commodities.

A recent OECD paper suggested that high-technology products display the following characteristics (9):

- high dependence on a strong technology base and a vigorous research effort;
- considerable strategic importance for governments;
- long lead-times from basic research to industrial application, short lead-times in commercialization, and accelerated obsolescence under competitive pressure of new product and process introductions;
- high risks and large capital investments; and
- high degree of international cooperation in R&D, production, and marketing.

While the above characteristics are common to the majority of commodities usually referred to as high-technology, they are not operationally suitable as criteria for classifying commodities.

Due to this shortcoming, the OECD recently proposed a classification of products on the basis of their R&D intensities, which are computed as OECD-weighted ratios of R&D expenditures and output of each industry (10). Thus, products are categorized as high, medium or low-R&D intensity depending on whether this ratio is greater than 4, between 1 and 4, or under 1.

Using this method, the OECD established the following groups of high R&D intensity products:

- aerospace
- automatic data processing machines and units
- electronic equipment
- telecommunications equipment
- drugs
- scientific instruments
- electrical machinery
- non-electrical machinery
- chemicals

Even though neither the U.S. definition nor the OECD approach is entirely suitable, the U.S. list has been widely used for

international comparisons. Statistics Canada (Science and Technology and Capital Stock Division) uses a slightly modified version of the U.S. definition to produce data on high-technology trade.

While much debate has taken place concerning the definition of high-technology commodities, there has been little discussion on the definition of high-technology services. For the purposes of this study, we define these services as those associated with high-technology commodities.

4.0 Trade in Commodities

4.1 Volume

Imports of high-technology commodities have been one of the main sources of Canadian trade deficit. Table 1 (Appendix A) compares the balance of trade in high-technology products with that of other groups of products: medium-technology, low-technology, resource-related, and motor vehicles and parts. As this table shows, Canadian trade in high-technology commodities in 1984 incurred a deficit of close to $12 billion[1],

[1] At the time of the fourth reprint of this report (March 1987), Statistics Canada is in the process of revising the definition of high-technology products to keep it up to date and current with the definitions used by the OECD and other countries. It is expected that under the new definition, Canada's trade deficit in high-technology products is still massive and fast growing.

trade in resource-related products and in motor vehicles and parts resulted in surpluses of $15 billion and $3 billion respectively.

Canada's trade deficit in high-technology commodities has become steadily worse over the last fifteen years. Within the high-technology commodity group, machinery products accounted for about $6 billion in 1984 or over 55% of the whole trade deficit of the sector, as compared to 45% contributed by other commodities such as chemicals, aircraft and parts, electrical products, and scientific instruments. This intra-group comparison is given in Table 2.

Table 2 also shows that among Canada's export markets, the only market in which Canada has a trade surplus in high-technology is the group of countries other than the U.S., Japan, and the EEC. However, even in this market, Canada's trade surplus has dropped substantially from $1.07 billion in 1980 to $430 million in 1984.

Tables 3 and 4 give export and import values of high-technology commodities in 1984.

These tables show the following characteristics:

i) Canada's trade deficit in high-technology in 1984 was highest with respect to the U.S., followed by Japan and the EEC; Canada had a trade surplus in this sector with regard to the rest of the world;

ii) The most important groups of exported products were:

-	Telecommunications equipment	$2,348 m
-	Aircraft and parts	1,781
-	Office machines	1,377
-	Other inorganic chemicals	1,040
-	Agricultural machinery and tractors	655
-	Synthetic rubber and plastic materials	629
-	Drilling, excavating, mining machinery	490
-	Other general-purpose industrial machinery	421
-	Other measuring, lab equipment	420
-	Electric lighting and distribution system	376

iii) The most important groups of imported products were:

- Electronic computers	$ 4,105 m
- Aircraft and parts	2,230
- Agricultural machinery and tractors	1,768
- Other telecommunications equipment	2,141
- Electronic tubes and semi-conductors	1,428
- Plastic materials, not shaped	842
- Televisions, radios, and equipment	834
- Other photographic goods	763
- Other measuring, lab equipment	758
- Auxiliary electric equipment for engines	574

It appears that except for electronic computers and electronic tubes and semi-conductors, Canada does export all other major high-technology products. However, only in telecommunications equipment did Canada have a large trade surplus. The import value of electronic computers, and electronic tubes and semi-conductors amounted to over $5.5 billion, or close to 50% of the Canadian trade deficit in high technology in 1984. In other words, it can be stated that approximately one half of Canada's trade deficit in high-technology in 1984 was due to the

Canadian dependence on some key products produced by other countries, such as electronic computers and electronic tubes and semi-conductors; the other half was due to the generally low degree of international competitiveness of Canadian high-technology products.

The picture of Canadian trade in high-technology commodities is even bleaker when compared to that of other industrialized countries. Recent OECD data indicate that among the ten most industrialized countries of the world, Canada alone had, in 1983, a trade deficit in all high-technology sectors including drugs, scientific instruments, electrical transmission equipment, communications equipment and components, office machines and computers, and aircraft and parts. All other countries had a trade surplus in at least two or more of the above sectors, as shown in Table 5.

In terms of market share, except for computers, electronic equipment and chemicals, Canada's shares of total OECD exports of all other high-technology commodity groups fell substantially between 1970 and 1983, as shown in Table 6. For example, while Canada accounted for 6.8% of total OECD exports in telecommunications equipment in 1970, this share dropped to 3.1% in 1983. Likewise, Canada's share of OECD exports of scientific instruments fell from 3.1% to 2.0%.

In the case of computers and chemicals, Canada's export shares increased from 5.6% to 5.8% and from 0.8% to 2.3% respectively while the share in electronic equipment dropped slightly, from 1.9% to 1.8%.

Among the export-oriented industries in Canada, that of defense has experienced a substantial growth in sales to other countries, in particular to the U.S. Indeed, as Table 7 shows, Canadian exports of defence-related products to the U.S. almost tripled between 1980 and 1984, from $481.7 million to $1,360.5 million. During the same period, Canada's exports to other countries increased by 66%, from $240.0 million to $392.9 million.

Defence-related exports accounted for over 15% of total Canadian high-technology exports in 1984.

The substantial rise in Canadian defence exports was more than matched by the rise in Canadian imports of U.S. defence products, from $489.3 million in 1980 to $1,737.7 million in 1984. As indicated in Table 8, while the Canada-U.S. Defence Production Sharing Programme was responsible for the significant increase in the volume of trade in defence-related products between the two countries, it also led to a large increase in Canada's trade deficit in these products, from $7.6 million in 1980 to $377.2 million in 1984.

4.2 Tariffs

The tariffs applied on high-technology commodities traded between Canada and the U.S. are covered under the General Agreement on Tariffs and Trade (GATT). GATT applies to all trade except for items purchased by governments and not intended for resale, such as transportation items and heavy electrical machinery. Exceptions are also allowed under Article 15 of the Agreement for items affecting the essential interests of the signatories, also for defence, for actions under the U.N. Charter, and in such fields as nuclear materials.

Most of the tariffs on high-technology commodities traded between Canada and the U.S. are either very low or nil, except for telephone equipment and colour TV receiving sets and associated parts. The Tokyo Round of 1979 will further reduce these tariffs by 1987, leaving telephone equipment as the only item still subject to a high Canadian tariff. Examples of some typical high-technology commodity tariffs are given in Table 9.

5.0 Trade in Services

5.1 Volume

Recently, much attention has been focused on the services sector and its role in the national economy. According to a recent study conducted by Canada for the OECD (5), the services sector accounted for 65% of Canadian GNP in real terms and 64% of total employment in 1978. World trade in services amounted to US $350 billion in 1980 while world merchandise trade stood at US $1,650 billion (6). A comparison of Canada's services trade with merchandise trade is given in Table 10. As this table shows, while Canada had a surplus in merchandise trade of $21 billion in 1984, the deficit in services trade for the same year amounted to $20 billion. It also shows that services exports and merchandise exports accounted for 5% and 29% of our gross domestic product (GDP) respectively.

It should be noted that a major proportion of Canada's services trade deficit is due to remittances from Canadian subsidiaries to their parent firms and interest payments to foreign investors (over $13 billion in 1984 in total). Given that the level of interest payments is determined by past borrowings from other countries which usually entail long-term commitments, the

"structural" nature of the services trade deficit will remain largely unchanged, as long as foreign ownership of Canadian industries is significant. This situation can only be corrected over a long period of time without placing heavy pressures on the value of the Canadian dollar in international monetary markets (16).

Since the classification of high-technology services is relatively new, systematic data have not been compiled. Consequently, data on high-technology services are very sketchy. They are presented in this report whenever available.

The balances of trade of some related services in 1981 are given in Table 11.

Table 11 shows that consulting and other professional services is the only services group with a trade surplus while other groups such as management and administrative services, scientific research and development services, and computer services, all display a trade deficit.

5.2 Tariffs

At the present time, services trade is not covered under GATT. Foreign citizens or firms operating in Canada as Canadian subsidiaries are not subject to import tariffs. Nevertheless, they are liable to pay income taxes to the Canadian government like any other Canadian citizen or corporation, except for those individuals who operate under special tax-exemption arrangements, such as U.N. and foreign diplomatic personnel. If foreign firms and individuals are required to declare in their home countries the income earned in Canada, a foreign tax credit will be given to them under Double Taxation Treaties. Thus, among the four groups of services discussed above, only services embodied in goods are subject to tariffs to the same extent as the goods which carry them.

6.0 Issues

6.1 Tariff Barriers

As discussed in Section 4.2 above, except for telephone equipment and colour television sets and their accessories, Canadian and U.S. import duties on high-technology commodities under GATT are already very low. After 1987, most of these duties and

those applied on other commodities will be reduced further or even eliminated, leaving 80% of all Canadian exports to the U.S. and 65% of U.S. exports to Canada with no duty whatsoever.

Although the tariff on imports of telecommunications equipment into Canada remains substantially high, at 17.5%, a recent interdepartmental study of the Canadian computer services/ "informatics sector" pointed out (1) that telecommunications equipment manufacturers do not consider this tariff to be of importance to their viability, given the small size of the Canadian market and their overdependence on foreign markets. Even a low tariff rate such as the 3.9% applied to computer-hardware imported by Canada does not satisfy everyone. According to a recent study conducted by Rodney de C. Grey (7), the Canadian software producers would like to see it eliminated completely to lessen the financial burden that falls upon them as users of imported hardware.

6.2 Non-Tariff Barriers

As the Tokyo Round commits the GATT signatories to reduce tariffs, many of them are tempted to resort to non-tariff barriers to reduce their vulnerability to economic measures

taken by other countries. Thus, the impact of the Tokyo Round on Canada may not be as positive as it was intended to be. This point was made clear by the Standing Senate Commitee on Foreign Affairs when it stated (12):

> "The Tokyo Round has, in effect, left Canadian industry in the worst of both possible worlds: with the tariff too low to be an effective protection and, at the same time, still without free access to a huge assured market as enjoyed by its competitors, the EEC, Japan, and the U.S."

There are numerous non-tariff barriers to trade, in commodities as well as in services. Essentially they can be grouped together on the basis of their common justifications as follows.

(i) Industry Support

(a) Promotion and Development: subsidization, R&D support, export marketing and financing, and discriminatory procurement policies applied by various countries are regarded as non-tariff barriers to trade. For example, the Industrial and Regional Development Program (IRDP) and the Program for the Advancement of Industrial

Technology (PAIT) operated by the government of Canada have been reviewed as such barriers by other countries.

U.S. examples include:

Buy American Restrictions

- Federal Buy American Act of 1933;
- Buy American provisions of federal appropriations acts;
- State or local Buy State or Buy American preferences

Set-Asides

The U.S. government and several state governments set aside between 5% and 15% of their contracts for either U.S. small businesses, minority-owned businesses or businesses located in "labour-surplus" areas.

Other Restrictions

The U.S. Department of Defence often applies a 50% preference for U.S. products under its International Balance of Payments Programme. This is applied on purchases for use outside the U.S.

(b) Protection: investment and establishment regulations (e.g. FIRA), countervailing measures.

ii. Legal

(a) Copyright Laws: the protection of ownership of computer software programmes, packages, and databases may constitute a non-tariff barrier to trade in these products.

(b) Privacy/Access to Information: concerns for personal data stored in foreign data banks may be used to justify protectionist measures.

(c) Immigration: restrictions on transborder movement of professionals, due to their impact on the availability of highly skilled labour for the development and application of high technology, are usually seen as a barrier to trade.

iii. Regulatory

(a) Competition Policy: the discouragement of competition, on the part of regulatory agencies for example, can be seen as a barrier to trade.

(b) Access to Networks, Data Flows: any restriction on access to telecommunications networks or on transborder data flows (TBDF) is a non-tariff barrier to trade, especially in the services area.

iv. Technical

(a) Interconnect Requirements and Standards: the U.S. Federal Communications Commission (FCC) must approve the design of telecommunications equipment such as telephone and private branch exchanges (PBX) before they may be connected to U.S. public telephone networks. Similarly, all U.S. radio frequencies are subject to FCC emission standards. To the extent that there is a difference between U.S. and Canadian interconnect requirements and standards, a non-tariff barrier to trade will result.

(b) Access to Technology: restrictions to technology transfer may present obstacles to trade since the development, production, and marketing of high technology products depend in part on the acquisition of, and access to, technology. These restrictions are particularly serious in the high-technology sector, due to its sophistication and high turn-over rate.

v. National Security

National security is often invoked to justify restrictions to trade. For example, the U.S. government maintains a large number of restrictions against foreign firms or products in its procurement.

vi. Contingency Measures

Although these measures are usually of a short-time nature, they are nonetheless seen as serious non-tariff barriers to trade. Examples of these include:

(a) Countervailing Duty: duty imposed by the U.S. on imports which are believed to cause material injury to an American industry.

(b) Anti-Dumping Duty: duty levied by the U.S. on imports which are believed to be sold in the U.S. at less than fair market value.

(c) Enforcement of U.S. Rights and Response to Foreign Violations of International Trade Rules: the recent introduction of the Telecommunications Bills in the U.S. Congress to deal with "unfair and discriminating trade practices" in foreign countries.

A more elaborate discussion of all the above non-tariff barriers to trade is given in Appendix B.

While the barriers to trade discussed so far pertain to commodities, it is expected that the issues related to services trade will become more and more prominent in the next several years. For example, the U.S. has attempted to include services in forthcoming GATT negotiations, yet this is resisted by developing countries such as India and Brazil which see services as an area in which they still have an opportunity to effectively compete against developed countries. If trade in services is included in GATT negotiations, the outcome of these negotiations will have an impact on Canadian exports of services, for example by consulting firms involved in CIDA's aid projects. It is therefore important that Canada develop a position on trade in services to assist in the development of the services industries which are seen by many as an area of great export potential.

6.3 Research and Development and Trade

There is a strong relationship between the extent of R&D activities and the volume of trade in high-technology products, as shown in Figure 1 (Appendix A). A recent OECD study confirms

that the higher a country's R&D expenditures as a percentage of total value added, the higher is its high-technology share in manufactured exports(10). Figure 1 shows that those countries with high R&D intensities, such as the U.S., Japan, the Federal Republic of Germany, and France all have very large trade surpluses in high-technology commodities. On the other hand, Canada and Italy, two countries with low R&D intensities, experienced substantial high-technology trade deficits over the last several years. Table 12 gives the ranking of OECD countries according to market shares of high R&D intensity products in 1983. Canada ranked 8th, behind the U.S., Japan, the F.R.G., the U.K., France, Italy, and the Netherlands.

Canada's poor performance in high-technology trade can partially be explained by the low value of our ratio of gross expenditure on R&D (GERD) to gross domestic product (GDP), as compared to other countries, and as shown in Table 13. Even on a sectoral basis we do not compare favourably with other countries. As shown in Table 14, the R&D expenditures as a proportion of the value of production of all Canadian high-technology industries in 1980 were lower than those of most major OECD countries.

Despite the above facts, some people still argue that our current level of R&D expenditures is adequate. For example, Palda, in a book recently published by the Fraser Institute (11), maintains that Canada carries out sufficient R&D. He comes to this conclusion after making a "correction" for the Canadian industry structure on the assumption that resource industries are more important to Canada's economy than is the case of other OECD countries, and these industries traditionally spend a lower proportion of their sales on R&D.

A calculation done by the Ministry of State for Science and Technology[1] found that even after making such a "correction", Canada only spent 0.7% of the domestic product industry (DPI) on industrial R&D. This level is still significantly lower than what other OECD countries spent in 1979, the reference year (1.3% to 2.0%).

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1. Internal study, Ministry of State for Science and Technology, May, 1985.

The above international comparisons clearly establish the close relationship between the intensity of the research activities of a country on the one hand and the share of high-technology products in its exports on the other. The role of R&D activities in economic growth, however, goes beyond trade. It is also pervasive in other aspects of a national economy. Recently, an internal study conducted by the Ministry of State for Science and Technology showed that for both industry groups and individual industries in Canada, the increases in value added, total shipments, employment, and labour productivity are greater the higher the research intensity of the group or industry. These relationships are depicted in Tables 15 and 16.

Among technology-related factors affecting trade in high-technology, there are those which affect trade directly such as human resources, creativity, and productivity. There are also other factors, such as foreign ownership, which have an indirect bearing on trade, partly due to their impact on R&D. These factors are discussed below.

6.3.1 Human Resources

The number of scientists and engineers engaged in R&D is another indicator of the R&D intensity of a country. This, as we have

seen above, affects the share of high-technology products in its exports. On this measure, Canada does not fare well compared to other OECD countries, as indicated in Table 17. This table shows that while the proportion of scientists and engineers engaged in R&D in the labour force of almost all OECD countries increased substantially between 1973 and 1979, that of Canada remained virtually unchanged during the same period. This partly explains the relatively low share of high-technology products in Canadian exports.

6.3.2 Creativity

Another factor affecting the growth of high-technology industries of a country and hence its trade balance is the creativity of its people. If the number of patents granted, normalized by population, can be used as an index of creativity, as shown in Table 18, it can be seen that compared to other OECD countries, Canada is one of the three least creative countries.

6.3.3 Productivity

The application of high-technology in the resource, manufacturing, and service sectors is responsible for growth of

many countries in the last several years. Technology alone, however, does not guarantee productivity increase. Other factors such as labour skills, work stoppages, investment climate, taxation policy, etc. can also affect productivity. Table 19 gives the change in productivity of some selected OECD countries in the 1979-1983 period. This table shows that while other countries exhibited moderate to high productivity growth, Canada actually experienced a drop in productivity level.

6.3.4 Foreign Ownership

A major portion of the Canadian manufacturing sector is owned by non-residents. Statistics Canada's CALURA report (Corporations and Labour Unions Returns Act) does not give data on foreign ownership of the Canadian high-technology sector separately. The data drawn from the above report and represented in Table 20, however, show a substantial degree of foreign ownership of some components of the Canadian high-technology sector such as machinery, electrical products, and chemicals and chemical products.

Foreign-ownership does not only mean an outflow of a country's wealth in the forms of dividend and interest payments to non-residents. It also means a low degree of R&D efforts

necessary to enhance the international competitiveness of the country's industry.

A study conducted by the Economic Council of Canada in 1983 (4) found, on the basis of 1979 data, that domestically-controlled firms in the high-technology sector generally spent more on R&D, as a proportion of sales, than foreign-controlled firms. This finding remains valid with more recent data. For example, the R&D expenditures/sales ratio of domestically-controlled firms producing business machines in 1983 was five times as large as that of foreign-controlled firms. In the case of firms producing scientific and professional equipment, the ratio is 12:1. Data on other key high-technology industries are given in Table 21.

The generally low R&D intensity in the Canadian high-technology sector appears to be at least partly responsible for the low levels of creativity and productivity growth, and hence Canada's growing trade deficit in this sector, during the last several years.

Palda in the book referred to earlier argues that Canada imports $600-$700 million worth of R&D via parent-subsidiary transfers, which does not show up in R&D expenditures and that, therefore, Canada does not need to conduct more R&D. What is not addressed

by Palda is the cost of this imported R&D, in terms of product transfer prices and lost export opportunities. In addition, in making comparisons with other countries, the author neglects to take into account these countries' imports of R&D in the same manner.

Existing statistics show that in 1980 foreign-controlled firms accounted for $6.6 billion worth of high-technology products imported into Canada or 67.7% of total Canadian imports in this category. In other words, these firms have a much higher propensity to import than Canadian-controlled firms. The existing data, however, do not allow a differentiation of import transactions which are intra-firm from those between unrelated firms operating at arms-length. It is expected that statistical information on the extent of inter-affiliate trade will become available for the first time in the 1985 data year[1].

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1. Statistics Canada, Canadian Imports by Domestic and Foreign-Controlled Enterprises (Cat. No. 67-509), May, 1985.

7.0 Prospects

7.1 Recapitulation of Salient Points

Before discussing the prospects for Canada's high-technology trade, it is useful to recapitulate some of the facts pertinent to this sector of the Canadian economy.

- Canada's trade deficit in high-technology commodities is the worst among the Economic Summit countries. This deficit stood at over $12 billion in 1984 and continues to grow;

- Canada is the only major industrialized country with trade deficits in all high-technology commodity groups;

- Canada ranks 8th in terms of market shares of OECD exports of high R&D-intensity (i.e. high-technology) products in 1983. Moreover, Canada is losing its market share over time, from 4.4% in 1970 to 3.5% in 1983;

- Canada ranks 8th among OECD countries in terms of gross expenditures on R&D (GERD) as a percentage of GDP, trailing the U.S., F.R.G., Japan, U.K., Sweden, France, and the Netherlands;

- On the question of tariffs, except for telephone equipment, Canadian and U.S. tariffs on high-technology commodities are generally quite low, and some will be reduced further as a result of the 1979 Tokyo Round agreement;

- While tariffs do not constitute a major problem faced by the Canadian high technology industry, non-tariff barriers do. These may become increasingly serious in the future. A recent example is the proposed Telecommunications Bill currently under consideration by the U.S. Congress. While the thrust of this bill is not directed specifically at Canada, it may nevertheless have an adverse impact on Canadian exports of telecommunications goods and services to the U.S.;

- Except for consulting services, Canada has an overall trade deficit in high-technology services;

- Canadian firms may not benefit significantly from the ever-increasing U.S. defence-related R&D budget due to the non-tariff barrier created by the U.S. national security considerations.

- The branch plant nature of the Canadian manufacturing sector is not conducive to a high level of R&D activities in the country. This is evidenced by the low R&D expenditures/sales ratios of foreign-controlled

high-technology companies compared to those of their domestically-controlled counterparts. Since R&D is the "centre of gravity" of a high-technology company, Canada's large trade deficit in high-technology products appears to be a consequence of the high level of foreign ownership in the sector.

A summary of Canada's standing within the OECD with respect to various indicators of R&D performance is given in Table 22. In sum, Canada's relatively poor performance in the high-technology sector is resulting in a large and worsening trade deficit in this area.

7.2 Implications

Canada's large and growing trade deficit in high technology does not simply mean a drain of Canadian resources to other countries. It also means job losses to Canadians. In fact, the Canadian Independent Computer Services Association (C.I.C.S.) has estimated that while $1 million of exports in oil and gas created approximately one job in Canada, the same value of imports in computer equipment costs upwards of 10 Canadian

jobs.[1] This estimate seems consistent with the findings of a survey recently conducted by the Canadian Advanced Technology Association.[2]

The trade deficit of close to $12 billion in high technology products in 1984 is therefore equivalent to a loss of about 120,000 jobs to Canadians or 10% of the present unemployed labour force in Canada.

Serious as it is, this deficit cannot be corrected in the short-term since it is structural in nature. Among the factors contributing to this deficit, as discussed above, are the relatively low level of R&D support in Canada compared to other major OECD countries and the extensive foreign ownership of Canadian high-technology industries. Other factors which are intrinsic and therefore difficult to influence include the small size of the sector, the limited domestic base, and the long development and commercialization time for new products.

Up to the present time, Canada has relied on the resource sector to enhance its balance of trade. The continued reliability of

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1 Canadian Independent Computer Services Association (C.I.C.S.), "Indications of Canadian Job Loss through Transborder Data Processing," August, 1984.

2 Canadian High Technology Association (CATA), Canada's High Tech Industry, 1985-1990, March, 1985.

this "anchor" of Canadian trade may become shaky in the long run due to the emergence of such stresses as:

- "soft" markets (as in mining);
- increased competition from developing countries;
- increased U.S. protectionism;
- environmental problems such as acid rain and soil erosion and their potential adverse impacts on the sector's development.

It is therefore only prudent for Canada to move into new areas and develop as complete a trade portfolio as possible, as an insurance against the threats to its resource sector.

Compared to other OECD countries, Canadian high-technology industries are still at a very embryonic stage. In fact, as Table 23 shows, Canada ranks behind the U.S., Japan, the F.R.G., France, the U.K., and Italy in terms of the shares of most high-technology industries in total OECD output. If left to itself, the sector is not expected to improve its trade deficit to any significant extent in the foreseeable future. In other words, it must grow before it can compete.

To improve trade in high-technology, there is a need to try to remove as many non-tariff barriers to trade as possible, especially the 'access to technology' barrier. Given the

prevalence of these barriers and the difficulty in removing them, one should not place too much hope on effectively removing such barriers in the short turn. Therefore, it is desirable to develop a strategy to strengthen the sector, in addition to assessing trade negotiation options.

7.3 Technology Development as a Trade Strategy

The CATA survey mentioned earlier shows that Canadian high-technology industries in general do not consider the government's action to initiate free trade as their most pressing need at the present time. In fact, in terms of priority, this initiative is ranked below tax incentives, procurement policy, export/marketing assistance, R&D grants, education and training, incentives for investors, reduction in government regulation and reduction in red tape.[1]

While not considering a move towards free trade as their most pressing need, high-technology industries do regard access to foreign markets as one of the two prime factors affecting their business, following the health of the economic environment.

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1. CATA, op. cit., p. 115

The conclusion that can be drawn from the above findings is that Canadian high technology industries do not have any major problem in gaining access to foreign markets, as long as they can offer products built on "state of the art" technology. There are numerous Canadian high-technology firms which are world competitive. Examples of these firms include Northern Telecom, Microtel, Mitel, and I.P. Sharp at the upper end of the size scale to GEAC, Fullerton Sherwood Engineering, International Submarine Engineering, and others at the lower end. Except for Northern Telecom, these successful firms are, however, still small in size on a world scale. They alone are not able to turn around Canada's huge trade deficit in high-technlogy.

The foregoing discussion on barriers to trade shows that in the case of high-technology products, non-tariff barriers are more serious than tariff barriers. The latter are being gradually eliminated through various rounds of GATT negotiations. The question of non-tariff barriers is itself now appearing on the GATT agenda and in the bilateral arena between Canada and the U.S.

In order to be able to compete at world level, Canadian firms must possess leading-edge technology, either developed in-house or acquired from other sources. The question of access to technology is therefore an important issue and in fact

constitutes a serious non-tariff barrier to trade in high-technology. Consequently, in looking at trade negotiations from a technological perspective, the focus should be on those barriers that restrict access to technology, for example, on the basis of national security considerations.

It appears that in the short term there is a need to carry out the following tasks:

i) Evaluate the trade negotiation positions of the U.S. and other countries, as they emerge, in terms of their impact on access to technology and access to markets; and

ii) Encourage the development of international R&D and commercial joint ventures to get around trade barriers and ensure that we are maximizing the return to Canada from joint international initiatives to which we are already committed (e.g. U.S. Space Platform, Ocean Drilling Programme).

In the long-term we need to ensure that Canadian high-technology industries can compete effectively at the world level. If other countries really want Canadian technology, ways can be found to get around non-tariff barriers. This is possible through the development of leading-edge products and services. This means

more emphasis and support for the domestic high-technology sector so that it can expand, find niches, and become internationally competitive.

From a government perspective, technology development as a trade strategy means orienting our policies to nurturing this sector. These policies, as suggested by the CATA study, should include, at the very least, the following major elements:

- tax incentives;
- procurement policies;
- export/marketing assistance; and
- R&D grants.

Only in this way can we hope to redress over time a high-technology trade deficit that will continue to worsen unless action is taken now to reverse its trend.

8.0 Conclusion

In this report, we have reviewed the high-technology sector in Canada from a trade perspective, taking into consideration both commodities and services. We found that due to the high level of foreign ownership in the sector, along with the small size of the sector and the low overall level of R&D expenditures in Canada, the R&D intensity of Canadian high-technology industries

tends to lag behind that of major OECD countries. As a consequence, the sector has been experiencing a worsening trade deficit in the last few years and there is no indication of any possible reversal of this trend in the near future. Due to the structural nature of the problem, it appears that no quick solution is feasible.

On the question of barriers to trade, tariffs do not appear to be a serious problem since the tariffs imposed by Canada and the U.S. - our chief trade partner - on high-technology commodities are already very low, except for telecommunications equipment. Non-tariff barriers, on the other hand, constitute an issue of some concern. These barriers are concentrated in such areas as product standardization, government procurement policy, and especially access to technology.

There is not much hope that non-tariff barriers to trade could be removed quickly since all trading countries in the world practice them, albeit to varying degrees. Nevertheless, even if all the barriers to trade in high-technology products were removed, the sector would continue to experience a large trade deficit since Canadian high-technology industries, by and large, are still in an embryonic stage. They first need to grow before they can compete effectively.

Given the present state of affairs, there are not many options to improve our high-technology trade in the short term.

Still, there is a need to evaluate the emerging trade negotiation positions of the U.S. and other countries in terms of their impacts on access to technology and access to markets. There is also a need to encourage the development of joint international R&D and commercial ventures to get around trade barriers.

In the long term, efforts should be made to further develop the high-technology sector in such a way that it can expand, find market niches, and become competitive at a world level. The cornerstones of this technology development strategy should include, at the very least, the key elements identified by members of the sector themselves, such as tax incentives, procurement policies, export/marketing assistance and R&D grants, elements which are considered more important than any move towards free trade per se.

A stronger high-technology sector would lessen our dependence on the resource sector to maintain a healthier balance-of-payment position.

APPENDIX A

Tables and Figures

TABLE 1

Balance of Trade in High-Technology
and Other Manufactured Products: 1980, 1984

(Millions of Dollars)

	1980	1984
High Technology	-8,157	-11,974
Medium Technology	-4,628	-6,114
Low Technology	-2,821	-4,453
Resource-Related	13,243	15,262
Motor Vehicles and Parts	-2,661	2,994
Total	-5,024	-4,335

Source: Statistics Canada, Technology and Trade Statistics: Part I, July, 1985.

TABLE 2

Balance of Trade in High-Technology Products, by Industry Group: 1980, 1984

(Millions of Dollars)

	U.S.		JAPAN		EEC		OTHER COUNTRIES		TOTAL	
	1980	1984	1980	1984	1980	1984	1980	1984	1980	1984
Chemicals	-444	-364	13	19	159	-125	428	230	154	-237
Office Machinery	-1,205	-2,820	-45	-168	40	24	62	-26	-1,148	-2,989
Other Machinery	-3,170	-2,221	-116	-177	-408	-464	368	254	-3,329	-2,618
Aircraft & Parts	-643	-749	5	-3	11	57	213	244	-412	-449
Electrical Products	-1,314	-1,884	-377	-1,094	7	-4	-39	-220	-1,722	-3,199
Scientific Instruments	1,362	-1,843	-244	-389	-163	-197	39	-52	-1,727	-2,482
TOTAL	-8,138	-9,881	-764	-1,812	-354	-709	1,071	430	-8,184	-11,974

Note: Totals may not add due to rounding errors.

Source: Statistics Canada, Summary of External Trade and Technology and Trade Statistics (Part 1)

TABLE 3

Exports of High-Technology Commodities, 1984

(Millions of Dollars)

COMMODITY	EXPORTS TO THE U.S.	JAPAN	EEC	OTHER COUNTRIES	TOTAL
Chemicals:					
Chemical elements	124	17	77	11	228
Other inorganic chemicals	868	38	60	72	1,040
Synthetic rubber and plastic materials	395	5	30	199	629
Plantic basic shapes and forms	224	0	8	35	266
Medical and pharmaceutical products, in dosage	24	8	19	68	120
SUB-TOTAL	1,635	68	194	385	2,283
Office Machines	1,057	23	167	130	1,377
SUB-TOTAL	1,057	23	167	130	1,377
Machinery:					
Engines and turbines, general purpose	114	11	19	80	223
Electric generators and motors	85	0	3	16	104
Other general purpose industrial machinery	335	2	16	69	421
Drilling, excavating, mining	306	3	26	155	490
Construction machinery and equipment	99	1	6	34	141
Pulp and paper industries machinery	57	2	4	13	75
Agricultural machinery and tractors	586	1	11	57	655
SUB-TOTAL	1,582	20	85	424	2,109

TABLE 3 (cont'd)

Exports of High-Technology Commodities, 1984

(Millions of Dollars)

COMMODITY	EXPORTS TO THE U.S.	JAPAN	EEC	OTHER COUNTRIES	ALL COUNTRIES
Aircraft:					
Aircraft complete with engine	207	0	2	136	345
Aircraft engines and parts	472	0	98	74	646
Aircraft parts, except engines	678	0	47	64	790
SUB-TOTAL	1,357	0	147	274	1,781
Electrical Products:					
Television, radios and phonographs	173	0	1	3	178
Other telecommunicating and related equipment	1,630	21	193	505	2,348
Electric lighting and distribution equipment	277	1	19	78	376
SUB-TOTAL	2,080	22	213	586	2,902
Scientific Instruments:					
Navigation equipment and parts	156	3	30	13	204
Other measuring, cont. lab. med. and opt. equip.	274	8	68	69	420
Medical, ophthalmic and orthopedic supplies	43	4	13	21	82
Photographic goods	254	1	71	5	331
SUB-TOTAL	727	16	182	108	1,037
TOTAL ALL GROUPS	8,438	149	988	1,907	11,489

Source: Statistics Canada, Summary of External Trade.

TABLE 4

Imports of High-Technology Commodities, 1984

(Millions of Dollars)

COMMODITY	IMPORTS FROM THE U.S.	JAPAN	EEC	OTHER COUNTRIES	ALL COUNTRIES
Chemicals:					
Inorganic chemicals	379	18	71	31	498
Synthetic and reclaimed rubber	178	8	18	2	207
Plastics materials, not shaped	730	7	87	18	842
Other plastics, basic shapes and forms	234	3	22	6	264
Medicinal and pharmaceutical products	196	2	102	79	378
Plastic film and sheet	283	11	19	19	331
SUB-TOTAL	2,000	49	319	155	2,520
Office Machines:					
Electronic computers	3,752	114	113	127	4,105
Other office machines and equipment	125	77	30	29	260
SUB-TOTAL	3,877	191	143	156	4,365
Machinery:					
Engines and turbines, diesel, general purpose (g.p.)	93	4	27	1	126
Engines and turbines, g.p., not elsewhere stated (nes)	163	11	56	11	243
Electric generators and motors	240	42	39	14	335
Compressors, blowers and vacuum pumps	121	0	22	5	148
Pumps, except oil well pumps	136	4	11	11	162
Other g.p. industrial machinery	249	7	41	16	312
Drilling machinery and drill bits	291	0	21	34	347
Power shovels	120	38	50	1	210
Bulldozing and similar equipment	32	2	5	1	41
Front end loaders	242	7	11	9	270
Other excavating machinery	118	4	12	1	135

TABLE 4 (cont'd)

Imports of High-Technology Commodities, 1984

(Millions of Dollars)

COMMODITY	IMPORTS FROM THE U.S.	JAPAN	EEC	OTHER COUNTRIES	ALL COUNTRIES
Machinery (cont'd):					
Mining, oil and gas machinery	204	2	38	10	255
Construction and maintenance machinery	158	5	18	3	185
Pulp and paper industries machinery	128	10	28	25	190
Agricultural machinery and tractors	1,508	61	170	29	1,768
SUB-TOTAL	3,803	197	549	171	4,727
Aircraft:					
Aircraft, complete with engines	860	0	2	10	871
Aircraft engines and parts	536	0	50	12	599
Aircraft parts, except engines	710	5	38	7	760
SUB-TOTAL	2,106	5	90	29	2,230
Electrical Products:					
Telephone and telegraph equipment	184	41	3	42	271
Televisions, radios and equipment	296	198	11	330	834
Electronic tubes and semi-conductors	1,259	47	37	85	1,428
Electric lighting fixtures and portable lamps	166	4	13	33	215
Other telecommunications equipment	1,004	804	95	238	2,141
Switch-gear and protective equipment	87	3	25	23	139
Industrial control equipment	107	1	6	4	119
Other electric lighting distribution equipment	310	8	18	45	382
Auxiliary electric equipment for engines	551	10	8	6	574
SUB-TOTAL	3,964	1,116	216	806	6,103

TABLE 4 (cont'd)

Imports of High-Technology Commodities, 1984

(Millions of Dollars)

COMMODITY	IMPORTS FROM THE U.S.	JAPAN	EEC	OTHER COUNTRIES	ALL COUNTRIES
Scientific Instruments:					
Electrical property measuring instruments	199	7	21	6	232
Miscellaneous measuring, controlling instruments	344	5	24	10	383
Medical and related equipment	321	10	34	15	381
Navigation equipment	63	3	4	2	72
Other measuring, lab equipment	591	35	92	39	758
Medical, ophthalmic, orthopedic supplies	419	12	84	42	558
Unexposed photographic film and plates	211	86	61	12	372
Other photographic goods	422	247	59	35	763
SUB-TOTAL	2,570	405	379	161	3,519
TOTAL ALL GROUPS	18,320	1,963	1,696	1,478	23,464

Source: Statistics Canada, Summary of External Trade.

TABLE 5

Ratio of Exports to Imports of High-Technology Industry Groups, 1983

COUNTRY	DRUGS	SCIENTIFIC INSTRUMENTS	ELECTRICAL TRANSMISSION EQUIPMENT	COMMUNICATIONS EQUIPMENT & COMPONENTS	OFFICE MACHINES & COMPUTERS	AIRCRAFT AND PARTS
Canada	0.40	0.26	0.53	0.47	0.44	0.65
France	1.96	0.75	1.40	1.27	0.65	1.50
F.R.G.	1.77	1.40	2.07	1.16	0.91	0.08
Italy	1.00	0.59	1.11	0.90	0.89	1.37
Japan	0.28	6.06	3.92	6.92	5.01	0.09
Netherlands	1.21	1.05	0.92	1.29	0.75	0.70
Sweden	1.32	0.57	0.83	1.94	0.82	0.44
Switzerland	3.71	2.88	2.70	0.86	0.36	0.18
United Kingdom	2.19	0.92	1.27	0.83	0.66	1.57
United States	2.04	0.88	1.67	0.76	1.80	4.26

Source: MOSST, Science, Technology and Economic Development - A Working Paper, 1985.

TABLE 6

Canadian Export Market Shares of High R&D Intensity Products: 1970, 1983

(% of Total OECD Exports)

Aerospace	1970	5.9
	1983	3.5
Computers	1970	5.6
	1983	5.8
Electronic Equipment	1970	1.9
	1983	1.8
Telecommunications Equipment	1970	6.8
	1983	3.1
Drugs	1970	2.1
	1983	1.7
Scientific Instruments	1970	3.1
	1983	2.0
Electronic Machinery	1970	1.7
	1983	1.2
Non-Electrical Machinery	1970	10.6
	1983	10.5
Chemicals	1970	0.8
	1983	2.3

Source: OECD - Trade in High-Technology Products, DSTI/SPR/84.66, January 1985

TABLE 7

Defence Exports by Industry Sector

(Millions by Dollars)

Product	1980 U.S.	1980 Overseas	1980 Total	1984 U.S.	1984 Overseas	1984 Total
Aerospace	181.4	64.2	245.6	415.5	187.8	603.3
Armanent	20.5	69.3	89.8	75.5	28.1	103.6
Electrical & Electronics	191.7	67.9	259.3	450.2	148.8	599.0
General Purchasing	13.8	9.7	23.5	27.0	2.8	29.8
Shipbuilding	39.1	12.6	51.7	97.5	15.2	112.7
Vehicles	35.2	16.6	51.8	294.8	10.2	305.0
	481.7	240.0	721.7	1,360.5	392.9	1,753.4

Source: Internal Document, Ministry of State for Science and Technology, July, 1985.

TABLE 8

Canada-U.S. Defence Production Sharing Procurement: 1980, 1984

(Millions of Dollars)

	1980	1984
U.S. Procurement in Canada	481.7	1,360.5
Canadian Procurement in the U.S.	489.3	1,737.7
Balance	(7.6)	(377.2)

Source: Internal Document, Ministry of State for Science and Technology, July, 1985

TABLE 9

GATT Tariffs on some Representative High-Technology Commodities

Commodity	Tariff No.	Import Duty Rates (%)	
		Canada	U.S.
Telecommunications Equipment			
- Telephone apparatus and parts	44508-1[1]	17.8 (17.5)[3]	
- Telephone apparatus instruments and parts	684.62[2]		8.5 (8.5)
- Domestic colour T.V. receiving sets and parts thereof	44533-4	15.0 (7.5)	
- Complete colour T.V. receivers and parts	685.11		5.0 (5.0)
Computer Equipment and Parts			
- Computers and software programs	41417-1	3.9 (3.9)	
- Accounting, computing and other data processing machines	676.15		4.5 (3.9)
- Peripheral equipment, magnetic disks and tape storage units	41417-2	free (free)	
- Office machines not specifically provided for	676.30		4.2 (3.7)
Aircraft			
- Aircraft not including engines	44045-1	7.5 (free)	
- Civil aircraft and parts thereof	694.41		free free
Electronic Components			
- Transistors and other semi-conductor devices, parts thereof	44544-1	free (free)	
- Other, independent parts not specifically provided for:			4.2
. parts of semi conductors	687.85		(4.2)
. other	687.87		

TABLE 9 (cont'd)

GATT Tariffs on some Representative High-Technology Commodities

Commodity	Tariff No.	Import Duty Rates (%)	
		Canada	U.S.
Electronic Computers (cont'd)			
- Hybrids, linear audio amplifiers, diodes, silicon controlled rectifiers, voltage multipliers	44544-2	6.8 (4.0)	
- Transistors and other related electronic crystal components:			
. transistors	687.70		4.2
. diodes and rectifiers	687.72		(4.2)
. monolithic integrated circuit	687.74		.
. other integrated circuit	687.77		.
. other	687.81		.
			.
- Cathode ray tubes for the manufacture of graphic or data display terminals	44595-1	free (free)	
- Cathode ray tubes and parts thereof	687.54		6.0 (6.0)

1. Canadian tariff code
2. U.S. tariff code
3. Figures in brackets represent 1987 "final" rates.

Sources: United States International Trade Commission, Summary of Trade and Tariff Information; Department of Finance, Tariff Commissions Agreed By Canada in the MTNs under the GATT.

TABLE 10

Services Trade, Merchandise Trade, and Gross Domestic Product, 1984

(Millions of Dollars)

Services	
Exports	19,357
Imports	-39,028
Trade Balance	-19,671
Merchandise	
Exports	112,511
Imports	-91,679
Trade Balance	20,832
Gross Domestic Product (GDP)	392,369
Services Exports/GDP	0.05
Merchandise Exports/GDP	0.29

Source: Statistics Canada, Quarterly Estimates of the Canadian Balance of International Payments, 1984.

TABLE 11

Balance of Trade in Selected Services, 1981

(Millions of Dollars)

	U.S.	EEC[1]	OTHER COUNTRIES	TOTAL
Consulting and Other Professional Services	-143	1	226	84
Management and Administrative Services	-476	2	-3	-477
Scientific Research and Product Development	-177	-18	-6	-201
Computer Services	-39	-3	1	-41

Source: Statistics Canada, Quarterly Estimates of the Canadian Balance of International Payments, 1983.

TABLE 12

Market Shares of OECD Exports of High R&D Intensity Products, 1983

Country	Market Share	Rank
United States	27.4	1
Japan	16.3	2
F.R.G.	15.0	3
United Kingdom	9.0	4
France	8.1	5
Italy	4.3	6
Netherlands	4.0	7
Canada	3.5	8
Switzerland	3.2	9
Sweden	2.0	10
TOTAL OECD	100.0	

Source: OECD, DSTI/IND/84.60

TABLE 13

Gross Expenditures on R&D (GERD) as a percentage of GDP, 1982

United States	2.70
F.R.G.	2.58
Japan	2.47
United Kingdom	2.46
Sweden	2.23
France	2.06
Netherlands	1.88
Canada	1.39
Italy	1.08

Source: Department of External Affairs, Competitiveness and Security: Directions for Canada's International Relations, 1985.

TABLE 14

Research Intensity of High-Technology Industries of OECD Countries, 1980

(R&D Expenditures/Value of Production)

COUNTRY	INDUSTRY						
	Aerospace	Office Mach. & Comp.	Electronic Components	Drugs & Medicine	Instruments	Electronic Machineries	Chemicals
U.S.	0.278	0.166	0.127	0.094	0.092	0.065	0.017
Japan	0.014	0.051	0.052	0.079	0.023	0.029	0.029
F.R.G.[1]	0.254	-	0.104	-	0.026	-	0.050
France	0.168	0.117	0.129	0.057	0.028	0.019	0.009
U.K.[2]	-	0.140	0.133	0.100	0.018	0.020	0.022
Italy	0.201	0.035	0.042	0.062	0.048	0.006	0.009
Canada	0.106(5)[3]	-	0.104(4)	0.048(7)	0.010(9)	0.017(6)	0.008(8)
Australia[2]	-	-	0.012	0.023	0.026	0.017	0.008
Sweden[1]	-	-	0.061	0.186	-	-	0.017
Belgium[1]	-	-	0.087	0.099	0.098	0.070	-

1. 1979
2. 1978
3. Canada's rank

Sources: R&D figures: OECD, International Survey of the Resources Devoted to R&D by OECD Member countries, July 1984.

Production figures: OECD, Science and Technology Indicators, Competitive Position Indicators of Manufacturing Industries, March 1985.

TABLE 15

Relationship of R&D Intensity to Growth in Value Added and Employment by Manufacturing Sector

Industry	Current R&D Exp. (1981) / Value Added (1981)	Value Added [1] (1981) / Value Added (1972)	Employment [1] (1981) / Employment (1972)	Direct Mfrg. Employment (1981) / Direct Mfrg. Employment (1972)
1. Communications	16.80	1.46	1.15	1.35
2. Aircraft	13.81	2.44	1.66	1.94
3. Business Machines	6.85	1.90	1.60	1.37
4. Petroleum Products	6.17	2.51	1.47	1.29
5. Drugs	4.85	1.23	1.12	1.19
6. Primary Metals (Non-Ferrous)	2.87	1.33	1.10	1.04
7. Electrical Equip.	2.23	1.14	1.01	0.99
8. Machinery	1.94	1.74	1.37	1.42
9. Scientific Equip.	1.77	1.35	1.45	1.49
10. Chemicals	1.70	1.65	1.23	1.23
11. Transportation Equip.	.90	0.96	1.04	1.01
12. Rubber & Plastic Prod.	.79	1.29	1.25	1.26
13. Forest Products	.67	1.32	1.09	1.04
14. Primary Metals (Ferrous)	.65	1.24	1.10	1.06
15. Food & Tobacco	.45	1.20	1.06	1.08
16. Textiles	.44	1.13	0.91	0.88
17. Non-metallic Minerals	.40	1.07	1.06	0.98
18. Metal Fabricating	.31	1.29	1.15	1.13
19. Other Industries	.09	1.24	1.05	-
TOTAL		1.29	1.11	1.08

1. All figures were converted to 1971 dollars using GNP implicit price index.

Source: Internal MOSST study, "Relationship Between R&D Expenditures and Economic Variables", May, 1985.

TABLE 16

Relationship of R&D Intensity to Growth in Value Added, Shipments, and Employment by Industry Group

A	B	C	D	E
Industry	Value Added (1981)[1] / Value Added (1972)	Shipments (1981)[1] / Shipments (1972)	Employment[1] (1981) / Employment (1972)	Productivity B/D
Research Intensive (Industries 1-5)	1.88 [1]	2.65 [2]	1.35	1.39
Medium R&D Intensity (Industries 6-10)	1.46	1.53	1.19	1.23
Low R&D Intensity (Industries 11-18)	1.19	1.33	1.08	1.10
Other Industries (19)	1.24	1.27	1.05	1.18

1. All figures were converted to 1971 dollars using the GNP implicit price index.

2. If petroleum products are excluded, change in Value Added is 1.67 and in Shipments 1.61.

Source: Internal MOSST study, "Relationship Between R&D Expenditures and Economic Variables", May, 1985.

TABLE 17

Number of Scientists and Engineers Engaged in R&D in Selected OECD Countries: 1973, 1979

(Per 10,000 Labour Force Population)

Country	1973	1979
U.S.	56.5	58.0
Japan	54.8	65.6
F.R.G.	37.4	46.1
Netherlands	29.7	36.9
Switzerland	30.8	36.1
France	28.4	31.6
Canada	23.2	23.3

Source: OECD, Science and Technology Indicators, Basic Statistical Series, Vol. C, Total R&D Personnel DSTI/SPR/82.59, Paris, 1982.

TABLE 18

Number of Patents Granted per 100,000 of Inhabitants, 1980-1982

Country	Creativity Index
Japan	34.33
Switzerland	27.65
Sweden	17.42
U.S.	15.82
France	14.24
F.R.G.	13.33
U.K.	9.44
Canada	6.02
Netherlands	3.36
Italy	3.17

Source: European Management Forum (EMF) Foundation, Report on International Competitiveness.

TABLE 19

Growth in Productivity of Selected OECD Countries: 1979-1983

Country	Growth in Productivity, 1979-83
U.S.	0.4
Japan	2.8
F.R.G.	1.7
France	1.8
U.K.	1.5
Italy	0.9
Canada	-0.1

Source: Ministry of State for Science and Technology, Science, Technology and Economic Development - A Working Paper, 1985.

TABLE 20

Foreign Control of Canadian Manufacturing, 1982

(%)

Industry	Assets	Sales
Machinery	45	49
Electrical Products	53	63
Chemical and Chemical Products	75	77
Miscellaneous	43	43
Total Manufacturing	45	50

Source: Statistics Canada, Corporations and Labour Unions Returns Act, Part I - Corporations, 1985.

TABLE 21

In-House R&D Expenditures as a Proportion of Sales, Canadian and Foreign-Controlled Firms, 1983

(%)

Firm	Canadian-Controlled	Foreign-Controlled
Business machines	10.92	2.19
Other machinery	3.65	1.34
Aircraft and parts	19.03[1]	5.22 [1]
Other electrical products	3.26	1.28
Communications equipment	16.19	6.28
Drugs and medicines	16.44	3.97
Other chemical products	1.45	0.90
Scientific and professional equipment	16.41	1.43

1. 1979

Source: Statistics Canada: RDCI Survey, Science and Technology Statistics Division, July, 1985.

TABLE 22

Summary of Canada's R&D Performance within OECD
(Based on Latest Data)

Measure	Canada's Rank
GERD/GDP	8
R&D Expenditures/Values of Production	
- Chemicals	8
- Electronic Machinery	6
- Aerospace	5
- Electronic Components	4
- Drugs and Medicine	7
- Instruments	9
Number of R&D Scientists and Engineers	7
Creativity	8
Productivity	7
Market Share of OECD Exports of High R&D Intensity Products	8

Source: from various tables in this report.

TABLE 23

Share of High-Technology Industries in OECD Output, 1980

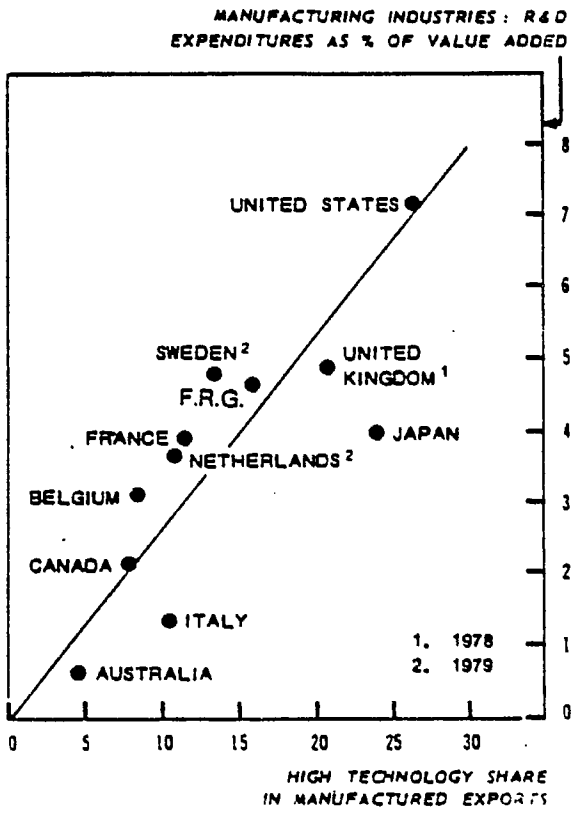
COUNTRY	INDUSTRY						
	Aerospace	Office Mach. & Comp.	Electronic Components	Drugs & Medicine	Instruments	Electrical Machineries	Chemicals
U.S.	60.6	48.6	33.3	33.2	44.1	31.2	43.6
Japan	1.0	17.0	28.8	18.5	26.0	23.0	14.3
F.R.G.	5.8	10.3	9.0	13.9	13.0	12.4	13.0
France	14.3	5.8	8.1	13.2	4.3	9.2	7.8
U.K.	10.2	6.3	7.5	7.7	7.2	8.1	7.3
Italy	1.6	6.0	4.6	6.3	1.4	7.4	4.3
Canada	2.5(5)[1]	0.7(11)	1.4(9)	1.5(8)	1.5(6)	2.5(7)	2.3(8)
Australia	0.9	1.0	0.6	1.1	0.5	1.0	1.2
Sweden	1.5	1.2	1.8	1.0	0.7	1.5	0.8
Netherlands	1.6	1.8	3.3	1.8	0.8	2.3	3.2
Belgium	-	0.9	1.2	1.4	0.03	0.9	1.9

1. Canada's rank

Source: OECD, Science and Technology Indicators II - Resources Devoted to R&D, Technological Performance and Industrial Competitiveness, June 1985.

FIGURE 1

R&D INTENSITY AND HIGH-TECHNOLOGY
SHARE IN EXPORTS 1980



Source: MOSST, Science, Technology and Economic Development - a Working Paper, 1985.

APPENDIX B

Classification of Non-Tariff Barriers to Trade

CLASSIFICATION OF NON-TARIFF BARRIERS TO TRADE

Non-tariff barriers to trade can be classified, on the basis of their justifications, under the following groups: industry-support, legal, regulatory, technical, national security, and contingency measures.

(i) Industry Support

(a) Promotion and Development: subsidies, R&D support, export marketing and financing programmes, procurement;

The Industrial Regional Development Program (IRDP), for example, has been criticized by the U.S. as constituting export subsidies in the cases where the subsidized industries also export their products[1]. The Canadian counter-argument is that the IRDP is designed to influence the location of investment in new facilities within Canada and it is not intended to stimulate exports.

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1. GATT, Inventory of Non-Tariff Measures, October 1981

The production of computer hardware and software in the U.S. has been substantially subsidized through NASA and the defence program, through state industrial development programs and through the assistance provided by the U.S. government via the tax-free status of industrial revenue bonds issued by states or municipalities. With regard to government procurement, the following restrictions against foreign competition practiced by United States governments have been viewed by Canada as constituting non-tariff barriers to trade.

Buy American Restrictions

- The Federal Buy American Act of 1933 and implementing regulations, which generally require U.S. federal agencies to provide a 6% margin of preference to products of U.S. origin, 12% if the lowest bidder offering to supply U.S.-originated products is a U.S. small business, minority-owned business or a business located in a "labour-surplus" (i.e., high unemployment) area;

- Buy American provisions of federal appropriations acts, such as the Surface Transportation Assistance Act of 1978, which require the recipients of such

federal funds (usually state, regional or municipal governments) to apply the Buy American provisions contained in the Acts to projects funded under them;

- State or local Buy State or Buy American preferences: at least thirty-four states have Buy American laws, regulations or practices.

Set-Asides

- The U.S. federal government and several state governments set aside between 5 and 15% of their total contracts for either U.S. small businesses, minority-owned businesses (e.g. women or black-owned) or businesses located in " labour-surplus" areas.

Other Restrictions

- The Department of Defence often applies a 50% preference for U.S. products under its "international balance of payments" programme. This is applied on purchases for use outside the U.S.

(b) Protection: investment and establishment regulations, countervailing measures.

The very existence in Canada of a foreign-investment review mechanism, either under FIRA or under its new, less restrictive version, Investment Canada, can be seen as a barrier to trade by the U.S. Examples of recently-adopted U.S. countervailing measures are given below.

(ii) Legal

(a) Copyright Laws

This issue mainly concerns the ownership of computer software programs, packages, and databases. For example, one country could prohibit the importation of software programs produced in another because these programs may infringe upon domestic intellectual property rights.

(b) Privacy/Access to Information

The concerns for privacy and security of personal data stored in foreign data banks are understandably legitimate, but there is a possibility that they may be used as an excuse for protectionist measures. According to Grey (7), there are those in the U.S. computer industry who believe that the Canadian Bank Act requirement that foreign banks operating in Canada hold certain data in Canadian computer facilities is a protectionist measure which was put in place mainly to protect Canadian computer service firms. This interpretation appears to be unfounded, since the Act only requires banks to process certain records in Canada in order that the Inspector General may effectively carry out his statutory responsibilities.

(c) Immigration

The restrictions on transborder movements of professionals, especially of those who are in a highly mobile field such as computers, are seen by many as a non-tariff barrier to trade, since they inhibit the free flow of high-technology commodities which require

special user-support services. These restrictions also inhibit trade in computer services.

An example of this restriction is the enforcement of U.S. immigration laws. These laws provide that an alien having a residence in a foreign country, which he has no intention of abandoning, and who is entering the U.S. temporarily for business, be allowed a type "B1" visa. The term "business" refers to legitimate activities of a commercial or professional character. It does not include local employment or labour for hire.

There has been a marked increase in the number of Canadian businessmen being detained or denied entry into the U.S. on the basis that they require temporary working visas. Such visas must be petitioned for by a U.S. employer and can take a considerable length of time to obtain.

The businessmen concerned are employed by Canadian firms, have no intention of abandoning their homes and are not receiving renumeration from a U.S. source. Yet, U.S. immigration officials have deprived them the use of a type "B1" visa without providing adequate explanation or reasons.

(iii) Regulatory

(a) Competition Policy

Discussions on the U.S. and Canadian competition policies are well illustrated by developments in the field of telecommunications. With the divestiture of AT&T, the U.S. is following a liberal policy, not only in the production of telecommunications equipment, but also in the provision of message toll services. In Canada, the decisions of the Canadian Radio-television and Telecommunications Commission (CRTC) on enhanced services, and on the CNCP application - for permission to interconnect to local exchange facilities of Bell Canada and B.C. telephone for purposes of providing public interexchange services - will have a strong impact on the telecommunications industry, and hence on Canadian trade. For example, if competition in enhanced and message toll services is allowed and encouraged, new carriers will have to purchase equipment, either in Canada or from foreign countries, to provide these services.

(b) Access to Networks, Data Flows

Any restriction on access to telecommunications networks or on transborder data flows (TBDF) will in effect constitute a non-tariff barrier to trade, especially in the services area. This type of barrier is at present relatively not widespread, since Canadian message toll users already have access to the U.S. long distance networks, through switches located in border U.S. cities, to take advantage of the lower prices of the competitive U.S. long distance telephone market. Furthermore, restrictions on TBDF appear unlikely because of the close integration of the U.S. and Canadian telecommunications networks and the large volume of data and information involved.

(iv) Technical

(a) Interconnect Requirements and Standards

The U.S. Federal Communications Commission (FCC) must approve the design of telecommunications equipment such as telephones and private branch exchanges (PBX) before they may be connected to the U.S. public telephone

networks. Similarly, all U.S. radio frequency devices are subject to emission standards of the FCC under the Communications Act. To the extent that there is a difference between U.S. and Canadian interconnect requirements and standards, a non-tariff barrier to trade will result. At present, the equipment markets in Canada and the U.S. are already open for competition from domestic and foreign suppliers. In addition, there is very close harmonization of network standards applied by both the FCC and the CRTC. Interconnect requirements and standards therefore do not constitute a major barrier in U.S./Canada trade.

(b) Access to Technology

Restrictions on technology transfer, according to the OECD (8), may present obstacles to trade since the development, production, and marketing of high-technology products depend in part on the acquisition of, or access to, technology. These problems are particularly significant in the case of high-technology, due to its sophistication and high turn-over rate.

(v) National Security

National security is often invoked to justify restrictions on trade. For example, the U.S. government maintains the following restrictions against foreign firms or products in its procurement.

- Many defence contracts are classified as "NORFORN" (no foreign) for national security reasons;
- The Department of Defence is prohibited from procuring foreign vessels or major components of the hull or superstructure of vessels;
- The Department of Defence may only use U.S. flagships for transport of supplies or officers by sea, unless the cost involved is unreasonable;
- Procurement for military assistance programmes are often restricted to U.S. concerns.

These restrictions are particularly injurious to non-U.S. companies since an estimated one half of the total U.S. R&D expenditures are under the control of the U.S. government.

(vi) Contingency Measures

In addition to the above types of non-tariff trade barriers, which have also been discussed at length elsewhere (1, 2), there are more recent U.S. countervailing measures.

Since the conclusion of the Tokyo Round in 1979, the U.S. has adopted a number of administrative measures, officially referred to as "import relief" (15). These measures are specified in the Trade Agreements Act of 1979, which is essentially an amendment to the Trade Act of 1930.

In summary, the Trade Agreements Act of 1979 provided for a number of measures that the U.S. Administration is required to take to address the concerns raised by the American industry or public on possible injury by imports. These consist of two specific duties and a general countervailing measure.

(a) Countervailing Duty

Under this provision, countervailing duties are imposed when the Department of Commerce (DOC) determines that a country under the agreement on subsidies and

countervailing measures[1] is providing a subsidy to merchandise imported into the U.S., and the U.S. International Trade Commission (ITC) determines that an industry in the U.S. is materially injured by imports of that merchandise. In the case of countries which are not under the GATT agreement on subsidies and countervailing measures, if the Secretary of Commerce determines that a subsidy is being granted in such countries, a countervailing duty can be levied on dutiable commodities without the Commission's investigation and determination of material injury.

An example of the application of countervailing duties is the decision by the U.S. Treasury department to impose such duties on imports from Honeywell's plant in Canada (8). This company received a grant from the federal government under the Program for the Advancement of Industrial Technology (PAIT) to develop

[1] The term "agreement on subsidies and countervailing measures" means the Agreement on Interpretation and Application of Articles VI, XVI, and XXIII of the GATT with respect to subsidies and countervailing measures (15).

a mechanism to prevent oil-tank vehicles and distribution tanks from overfilling. Honeywell's competitor in the U.S., Scully Electronic Systems, claimed that the grant had the effect of assisting foreign exports into the U.S. at a lower cost than would otherwise be possible because the basic technology was already known. The Treasury Department agreed that the grant given to Honeywell enabled the company to reduce its pre-production expenditures and, therefore, countervailing duties were deemed necessary. This is an example of how R&D expenditures are exported in a trade context.

(b) Anti-Dumping Duty

Anti-dumping duties will be levied if the DOC determines that an imported commodity is being sold in the U.S. at less than fair market value, and the ITC determines that an industry in the U.S. is materially injured by imports of that commodity.

(c) Enforcement of U.S. Rights and Response to Foreign Trade Violations

In addition to the above duties, the Trade Agreements Act of 1979 also provides for the enforcement of U.S. rights under trade agreements, and U.S. responses to foreign violations of international trade rules or practices which restrict or discriminate against U.S. commerce. Under this provision, the President of the United States, upon determining a foreign violation, shall take action as appropriate to enforce such U.S. rights or eliminate unfair foreign practices. Action under this provision may be applied to all countries or solely against the products or services of the country involved. The President is permitted to suspend or withdraw trade-agreement concessions or impose duties and other restrictions on the imports in question.

Aside from the measures taken following the Tokyo Round agreement, there has been a growing concern in the U.S. regarding the country's worsening trade balance. This concern is reflected in the Telecommunications Bill (officially referred to as the Telcommunications Trade Act of 1985) recently submitted to the U.S.

Congress. Essentially, the authors of the Bill (Senators Danforth, Bentsen, Lautenber, Wilson, and Inouye) found that (14):

(1) Many foreign markets for telecommunications products, services, and investment are characterized by extensive government intervention (including restrictive import practices and discriminatory procurement services); and

(2) Unfair and discriminatory trade practices in foreign countries may result in the loss of jobs in the U.S. telecommunications industry.

The Bill therefore proposes an investigation of foreign trade barriers in the telecommunications field by the U.S. Trade Representative, and provides for actions by the U.S. President to deal with these barriers, to achieve the following purposes:

(1) to foster economic and technological growth of the U.S. telecommunications industry and all U.S. persons who benefit from a high-quality telecommunications network;

(2) to ensure that countries which have made commitments to open telecommunications trade fully abide by those commitments; and

(3) to achieve a more open world trading system for telecommunications products and services through negotiation and achievement of substantially equivalent competitive opportunities for U.S. telecommunications exporters and their subsidiaries in those markets in which barriers exist to free international trade.

The Telecommunications Bill is only one example of the U.S. responses to non-tariff barriers to trade practiced by other countries. It is expected that as the U.S. trade deficit worsens, albeit also due to other factors besides the unfair trade practices of other countries as perceived by the U.S., other similar correcting measures will be imposed.

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