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The role of trade and technological change on the Canadian employment profile in a globalized context

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Foreword

The present study on the impact of trade and technology in Canada's changing employment structure is part of a set of country studies on the project ***"Jobs, technology and skill requirements in a globalized economy"***, undertaken by the Employment and Labour Market Policies Branch.

In this paper the author explores the role of trade and technology in Canada's changing employment structure since the last quarter of a century. Like many other countries, Canada faces a great number of changes induced, among other factors, by the transformation of the world economy. This process has been underway for more than two decades. Interdependent factors such as trade and technology have driven tremendous changes in the Canadian labour market.

The paper focuses, therefore, on the recent strategy of liberalization of continental trade as well as on the so-called "innovation gap" diagnosed in Canada and how they have affected the level and structure of employment in the Canadian economy. The paper argues that although there has been a trend towards high-skilled workers, the pace of this trend is slowing down due to a shift in the labour market adjustment strategy towards a supply-push orientation induced by a narrow labour shortage vision. The author claims that, in the context of globalization, a "high-skill path" throughout the economy should be fostered.

Other studies undertaken in this series cover changes in the structure of employment in view of increased exposure to international trade and technology in Brazil, Mexico, the Republic of Korea and Singapore

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1. Introduction: A knowledge economy in a globalized context

The present paper is one among numerous others contributing in the ongoing debate according to which trade and technological change might have an important impact on the recent trends in labour markets.

Canada, a wealthy country in which incomes are among the highest in the world, is renowned for the abundance of its natural resources and, which at the same time is a 'high unemployment' country. Recent trends in the labour market can be described as experiencing a sluggish growth in employment, while average real incomes are stagnating and the duration in unemployment is increasing substantially affecting, more especially, lower-skilled workers.

In 1989, a first wave of agreements reducing trade barriers with the United States took place under the Free Trade Agreement (FTA), and in 1994, these agreements have been extended to include Mexico as a third partner under the North American Free Trade Agreement (NAFTA). The reduction of trade barriers with the United States have, however, begun much earlier with the Auto Pact in 1965. Canada relies heavily on international trade, given the relatively small size of its domestic market which is 10 times less than the American. Canada is also characterized by an innovation gap. However, this country is slowly entering the knowledge-based model of economy in which high-skilled workers are at the core of the labour market and where technology-intensive industries are growing, although remaining small in proportion to the industrial system. These two factors – trade and technological change – have been identified as important sources of employment growth.

On the one hand, and contrary to other industrialized countries, the employment profile of the Canadian economy seems much affected by exports expansion. This is, in some ways, not surprising since Canada is a small open economy which has always relied on trade. The liberalization of continental trade does seem to have had as much influence as the whole international trade situation on the dynamics of employment creation/destruction. While the majority of Canadian trade is with the United States, some expansion with Japan and especially Asian NICs are taking place. Obviously, a question about the impact of the recent monetary and financial crisis in Asia on Canadian trade remains but this will not be answered in the present paper. On the other hand, however, for entering the new era of knowledge-based economy, Canada will have to improve its productivity level and maintain a competitive science and technology capability.

On the policy side, the labour market adjustment strategy has been shifted towards a supply-push orientation induced by a narrow labour shortage view thereof. In a context of globalization, a 'high-skill path' throughout the economy should be fostered. This proposition is argued in this paper on the basis of the findings from a series of studies on employment trends in Canada.

A brief overview of the Canadian economic situation is presented in the following section and focuses mainly on the recent strategy of liberalization of continental trade as well as on the so-called innovation gap diagnosed in Canada. The third section depicts a picture of employment change since the last quarter of century. Then follows an analysis of the industrial outputs evolution. In the fifth section, an analysis of the impact of trade on employment trends is presented and an analysis of the impact of technological change takes place in the sixth section. Finally, a policy discussion follows in the last section which shows that if there has been a trend towards high-skilled workers, the pace of this trend is slowing down but should be fostered instead of contained. In this context, different policy avenues are presented.

2. An overview of the Canadian economy

A rapid account of some important features of the Canadian economy is important for the context of our analysis. Like other countries, Canada faces a great number of changes induced, amongst other factors, by the transformation of the structure of the world economy. This process has been underway for more than two decades. Interdependent factors have driven tremendous changes in the Canadian workplace; the literature focuses on technological change and trade liberalization as being the most important forces, therefore, a special emphasis will be put on these two factors in order to shed some light on this murky debate in Canada.

Canada could be depicted as a natural-resource abundant and energy-rich country, with a small but well-educated labour force. In terms of technology, it is an importer as opposed to being a creator of technology and this importation is done mainly through licensing and foreign direct investment (FDI). The competitive strengths of Canada are located in resource-based technology, although the country has somewhat succeeded in exploiting some technological synergies from natural resources sectors within other industrial sectors, such as space and telecommunications. It has, consequently, succeeded in somewhat enhancing its science and technology knowledge base through these linkage effects.

The small and slow growing domestic market prevents this country from achieving important economies of scale. Moreover, the largest firms are still small according to international standards, and multinationals are mostly in the natural resources sector. There is a strong presence of foreign ownership, especially American multinationals. Although the country has been open to investment inflows, during the 1970s there were general concerns and worries about the loss of cultural sovereignty, especially with the United States. There is still screening of inward FDI, but this has considerably decreased in the last two decades.

In terms of trade and investment strategy, high tariffs against imports have fallen since the Tokyo Round, and Canada is strongly committed to multilateral organizations such GATT (Eden: 1994). While the public goods infrastructure, that is, education and public health is very good in Canada, it should be added that there is a sizeable government deficit and national debt, as well as a current of privatization and downsizing in the public service which begun in the 1980s, that threaten to tear apart these strengths.

One of the main challenge Canada is facing presently is its capacity to sell its products to the world, given the small domestic market and be able to sell products which are in demand. In addition, Canada has been quite slow to react to the rapidity of technological change and the slow rate of productivity is especially concerning. Productivity in most of the other large industrial countries has grown to a faster rate than in Canada over the past ten years. And the problem has been worsening, especially in that part of the economy most exposed to international competition. It has contributed significantly to the slow growth in real incomes for more than a decade, and it has had an adverse effect on employment opportunities (Economic Council of Canada: 1992).

However, one advantage is that if productivity has considerably declined over time, it nonetheless started from a high level as well as high wages. Moreover, it is worth emphasizing that if an improvement in the trade balance reflects a better competitiveness, it must, however, be accompanied with increased productivity and real income growth. Therefore, one major challenge of the Canadian economy is to improve its productivity level. This can be done through technological change, higher value-added production and by fostering domestic and foreign markets. The two following sub-sections will describe succinctly some aspects of Canadian trade – continental and international – and the general state of its technological capacity.

2.1 Liberalization of trade: FTA and NAFTA

Over the past 20 years, the rapid increase of international trade has been one of the main economic developments in Canada. However, it is not only the pace of change which is worth noting but also the shift in the pattern of international trade. As a whole, the growing regionalization of world trade as well as the change in the composition of trade have characterized the new world economy.

In Canada, two important continental sets of agreements have taken place – the FTA and the NAFTA. Since 1960s, there has been an ongoing process of economic integration of North America which started with the auto pact. Although the FTA is broad in scope, it is not a major shift in Canada-United States economic relations since about 80 per cent of bilateral trade was already duty-free (UNCTC: 1990). Five years after the bilateral FTA between Canada and the United States took place, the NAFTA came on January 1, 1994 and included Mexico as a third partner. The agreements forbid countries to discriminate against the goods and services of their trading partners and are allowed reciprocal standards of market access. On the other hand, these agreements do not impose a harmonization of policies such as in education, banking, municipal affairs, taxes and subsidies, and so on.

In theory, free trade agreements should stimulate a higher volume of trade as well as a higher specialization in industrial production between partners involved and thus, modify the income distribution within the country. However, the dynamics of income distribution in the NAFTA were different from those induced by FTA since the former commercial agreements include not only two developed economies but a much less advanced one – Mexico – which does not provide comparable living standards.

Trade Flows and Canada's Comparative Advantage

Canada's high standards of living have been reached through its comparative advantage in natural resources – forest, mineral products – as well as in natural resource-based manufacturing products such as paper. The question is therefore, whether Canada will be able to sustain this position in the future, especially within the free trade context.

The most important trading partner of Canada is the United States as shown in Table 1. While Canadian imports barely changed from 1971 to 1991, just after the FTA, Canadian exports in the United States have grown from 66 per cent in 1981 to 74 per cent in 1991.

Table 1. Geographic distribution of Canadian trade 1971, 1981, 1991

	Canadian Exports			Canadian Imports		
Geographic distribution	1971	1981	1991	1971	1981	1991
United States	68.5	65.6	73.7	71.0	72.0	70.6
Japan	4.6	5.6	6.5	5.3	5.4	5.8
European Community	14.5	11.1	8.3	12.1	8.6	10.4
Asian NICs	0.4	1.3	2.8	1.4	2.9	4.7
Rest of the World	12.0	16.5	8.8	10.3	11.1	8.5
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Economic Council of Canada (1992)

The NICs of Asia still account for a small portion of Canada's exports, but the share rose from 0.4 per cent in 1971 to 2.8 per cent in 1991. On the other hand, the share of Canadian imports from these countries rose from 1.4 per cent to 4.7 per cent during the same period. Japan is also an increasing trade partner for Canada. In contrast, trade with the European Community has relatively decreased markedly as did partners of the rest of the world as shown in Table 1.

Another series of data between 1988 and 1995 show, in Table 2, that over the period of seven years just after the FTA, the value of Canadian exports to the United States increased at a more significant rate than exports to other countries. However, the rate of Canadian exports to Asian countries has also increased substantially. On the other hand, imports from the United States into Canada are less important than exports, as it was the case a decade before the implementation of the agreements, as Table 1 illustrates. The rate is, however, higher than the rate of imports from other countries. Asian countries have also become an important trade partner since 1981.

Table 2. Canada's exports and imports trends by region, 1988-95

Percentage Change, 1988-95	United States	Europe (OECD)	Japan	Seven other Asian Countries
Exports from Canada	99.9	36.6	35.6	82.7
Imports into Canada	75.4	37.6	30.5	68.3

The seven Asian countries are Hong Kong China, Indonesia, Malaysia, Singapore, Republic of Korea, Taiwan China and Thailand.
Source: Schwanen: 1997.

Using a measure of revealed comparative advantage[1] to appraise the contribution of the FTA and NAFTA to the rapid expansion of trade between Canada and the United States as well as the shift of revealed comparative advantage in different products as it stood in 1981, 1988 and 1995, Schwanen examines the impact of these agreements on sectors liberalized versus those non-liberalized between the two countries.

In Table 3, Schwanen presents some evidence that the FTA had an impact on liberalized products which have been favoured by the agreements. In other words, for products exported by the United States to Canada, the majority had an increase of their revealed comparative advantage. These products comprise meat products, textile materials, steel, clothing, furniture and furnishings and various other household goods. On the other hand, for the majority of the products liberalized by the FTA and exported to the United States from Canada, there has been an increase in the revealed comparative advantage as shown in Table 4. Thus, we can conclude that Canada and the United States producers have increased their specialization and that the overall trade volumes between the two countries grew in comparison to international trade up to 1994. At this time, however, the volume of trade with other countries has outpaced the growth rate of bilateral trade.

[1] A revealed comparative advantage reflects a specialisation in products or services that a country produces relatively more efficiently than trading partners. This advantage depends on a number of factors such as a country's natural resources endowments, its technology, its economic organisation, and so on.

Table 3. The United States' revealed comparative advantage in the Canadian import market, by commodity group, 1981, 1988 and 1995

Commodity Group	1981	1988	1995
	(1.00=US share of Canadian import market for all commodities)		
Not liberalized by the FTA/NAFTA	1.20	1.09	1.11
Crude food and feed	0.96	0.87	0.83
Other crude materials	1.11	1.15	1.15
Fabricated products	1.21	1.20	1.16
Industrial machinery	1.18	0.95	0.98
Agricultural machinery	1.31	1.09	1.13
Aircraft	1.33	1.01	1.11
Medical and Safety Equipment	1.22	1.19	1.13
Printed materials	1.27	1.30	1.28
Other transactions	1.29	1.21	1.24
Liberalized by the FTA/NAFTA	0.97	0.90	0.95
Meat and dairy products	0.59	0.69	0.88
Fresh fruits and vegetables	0.93	1.11	1.04
Processed food, beverages	0.64	0.58	0.84
Crude materials	1.03	1.20	1.15
Textile materials	0.83	0.71	0.86
Chemicals	1.15	1.09	1.15
Petroleum products	0.84	0.79	0.83
Steel	0.66	0.56	0.86
Basic fabricated metal	1.15	1.13	1.14
Other fabricated materials	1.12	1.02	1.14
Industrial machinery	1.12	0.98	1.06
Transport equipment, excluding autos	0.75	1.02	1.09
Office and telecommunications equipment	1.11	0.94	0.81
Other equipment	1.19	1.12	1.13
Clothing	0.18	0.10	0.23
Furniture and furnishings	0.89	0.77	1.03
Other household goods	0.56	0.53	0.67
Other end products	1.01	0.88	0.94
Crude oil	0.21	0.05	0.01
Automobiles and parts	1.29	1.25	1.20

Source: Schwanen: 1997

Table 4. Canada's revealed comparative advantage in the US import market, by commodity group, 1981, 1988 and 1995

Commodity Group	1981	1988	1995
(1.00=Canadian share of US import market for all commodities)			
Not Liberalized by the FTA/NAFTA	1.83	1.59	1.67
Natural gas	4.69	5.29	4.92
Other energy, excluding crude oil	1.03	0.91	1.74
Other crude products	0.28	0.28	0.36
Lumber	5.32	5.11	4.68
Pulp and newsprint	5.53	5.05	4.71
Fertilizer	3.39	2.45	1.79
Agricultural machinery	2.27	1.33	1.07
Ships, aircraft, and parts	1.71	1.24	1.37
Other end products	0.62	0.46	0.31
Liberalized by the FTA/NAFTA	0.71	0.62	0.74
Meat and dairy products	0.89	1.34	2.10
Fish	1.45	1.19	0.86
Other foods and feeds	0.29	0.58	1.10
Beverages	0.88	0.84	0.82
Other crude materials	1.92	2.28	2.24
Wood-fabricated materials	2.36	2.49	2.63
Paper, excluding newsprint	3.15	2.23	2.84
Textile materials	0.18	0.36	0.69
Chemicals	1.07	0.98	0.77
Chemical products	0.90	1.08	1.54
Iron and steel	1.39	0.93	1.01
Other basic products	1.01	0.96	1.12
Industrial machinery	0.68	0.44	0.61
Office and telecommunications equipment, precision instruments	0.51	0.34	0.36
Other equipment and tools	0.20	0.31	0.93
Other finished goods	0.40	0.33	0.44
Crude oil	0.18	0.63	0.74
Automobiles and parts	1.95	1.81	1.86

Source: Schwanen: 1997

Regarding the impact of NAFTA on Canada's trade with Mexico and despite the fact that an assessment can be only tentative at this point since the agreements are relatively recent and given Mexico faces an economic crisis, Schwanen concludes that both the Canadian exports rate to Mexico and Mexican exports rate to Canada were the same as in the years preceding the NAFTA.

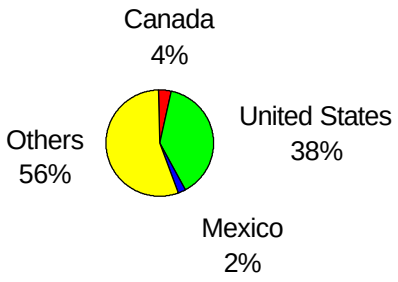
FDI and the Liberalization of Trade

Foreign Direct Investment (FDI) constitutes either a substitute or a complement of trade. In the context of the FTA and NAFTA, it is also important to appraise the impact of trade liberalization on the propensity to attract foreign investment. Once again, the dynamics are rather complex. It is worth mentioning that Canada constitutes the largest single host country to United States' FDI. To illustrate the magnitude of this, let me say that the manufacturing sector in Canada is 50 percent foreign owned (UNCTC: 1990). However, the share of American FDI in Canada has been declining, and there is a fear that American multinationals will transfer their operations to Mexico in order to take advantage of cheaper labour, with the consequence of massive Canadian job losses. Another scenario is that U.S. multinationals will close their Canadian plants given the higher labour costs, taxes, political instability, smaller size of the Canadian market, and so on. As stated by Eden, "(…) the worst case for Canada is to be squeezed at both ends by regional free trade. The FTA causes the higher value-added stages to shift to the United States while the NAFTA causes the lower value-added stages to shift to Mexico" (Eden: 1994, 202).

On the other hand, as for the case of Canadian FDI in the United States, the latter country is much less dependent on foreign investment, but there has been a more aggressive strategy from Canadian firms into the United States lately.

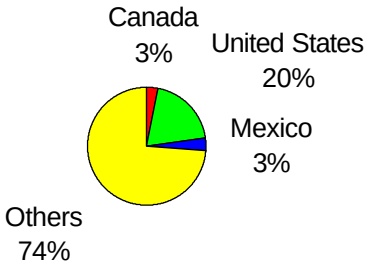
It is also worth examining the general level of the whole North America attractiveness for FDI in the context of the FTA/NAFTA. Contrasting the share of world FDI flows into North America before the FTA and after the NAFTA, it is interesting to note that North America attractiveness for FDI from countries outside the agreement has decreased quite substantially showing the less attractive destination of this continent for FDI. However, it is also worth mentioning that Canada and especially Mexico constitute a larger share within the North American territory of FDI inflows, while the share of the United States decreased substantially. (See figures 1 and 2) (Schwanen: 1997, 18).

Figure 1
Pre-FTA Shares of World FDI Inflows, 1984-88



Source: Economic Council of Canada: 1992

Figure 2
Post-NAFTA Shares of World FDI Inflows, 1994-95



Source: Economic Council of Canada: 1992

In conclusion, the lowering of trade barriers between Mexico, the United States and Canada seem to have increased the volume of trade, but the trends were present before these agreements. On the other hand, NAFTA countries attract a less sizeable share of FDI, and the choice of Canada for American multinationals decreased. Finally, while Mexico is a cheaper location for production than Canada for attracting American FDI, Canada may also lose competitiveness with the United States for higher-value added production.

2.2 An innovation gap in Canada?

The introduction of technological change plays essentially the same role as international trade regarding the dynamics of employment between different types of labour and the distribution of income within a country. It became conventional wisdom to consider technological change as one of the most important determinants of economic growth, whether technological change is originating from foreign or domestic sources. However, the relation between technological change and economic growth is complex. The reasons for this complexity are *a priori* related to the difficulty of measuring knowledge in general and scientific and technological knowledge, in particular. Moreover, the links between productivity gains and technological change are not clear. Although we cannot precisely measure technological change, some indicators can give an approximate picture of the state of innovation in a country.

Recently, the OECD diagnosed an innovation gap in Canada (OECD: 1995). According to them, the Canadian manufacturing sector is lagging behind in terms of innovation and, as competitiveness depends heavily on innovation, the future of Canada appears not as bright as was its past. In this section an attempt to describe the Canadian picture in science and technology will be done in order to appraise the veracity of the OECD's assertion.

The Canadian economic dependence on natural resources has had a tremendous impact on the development and direction of the Canadian technological capability over time, largely because a national technological capability is built incrementally, and what a country has been able to do in the past is a principal determinant of what it can achieve in the future (Lavoie, Finnie: 1996). The future of the Canadian economic situation depends partly on its capacity to invest in the state-of-the-art science and technology activities.

Investment in Research and Development

Comparing Canada with other industrialized countries on the basis of investment expenditures in R&D, reveals that this country does not perform well, and its position has not improved lately. The ratio R&D/GDP of the Canadian economy is the third lowest among the 12 leading countries as depicted in Table 5.

Table 5. Gross expenditure on R and D, as a proportion of GDP

Country	1981	1989
	(Per cent)	
West Germany	2.42	2.88
Switzerland	2.29	2.86
Japan	2.14	2.85
United States	2.45	2.82
Sweden	2.30	2.76
France	1.97	2.32
Netherlands	1.88	2.26
U.K.	2.41	2.20
Austria	1.17	1.40
Canada	**1.21**	**1.33**
Italy	0.87	1.29
Australia	1.01	1.24
Average	1.84	2.18

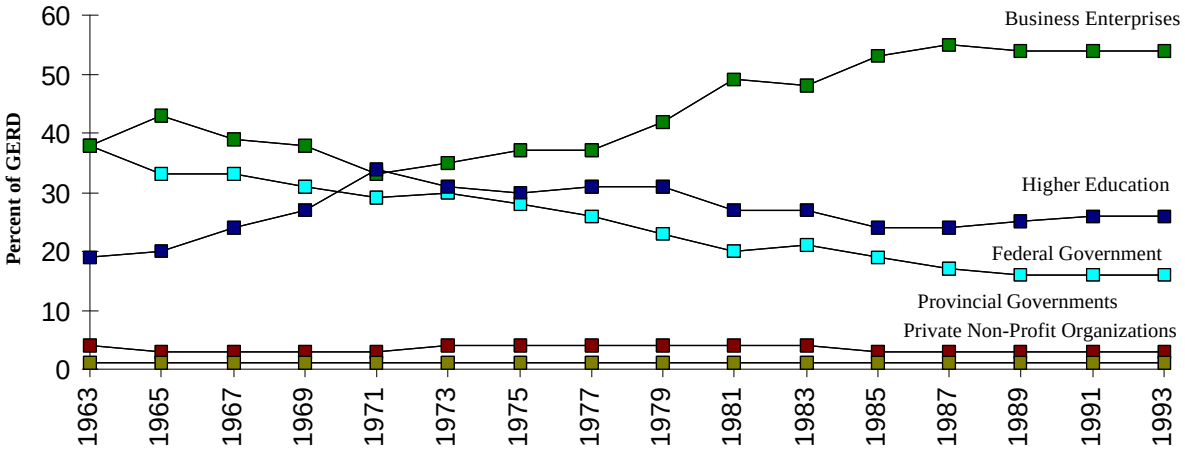
Source: Economic Council of Canada (1992)

Gross Domestic Expenditures on R&D ("GERD") represent a critical determinant of a country's technological development. Furthermore, the proportion of these investments made by private business, as well as their distribution by industrial sector, are important, although limited indicators of an economy's performance[2].

A first striking fact is that R&D investments represent a smaller proportion of GDP in Canada than in most other developed nations. A second important point is that the business share of Canada's expenditures in R&D ("BERD") is also at the lowest rank. After decreasing from 1965 up to 1971, the share grew up to 1987, and then stabilised, and held at 54 percent of GERD in 1993. (The shares of education and government held at approximately 25 and 20 percent, respectively). These trends are illustrated in Figure 3.

[2] R & D is an input indicator and its capacity to measure innovation is therefore limited (OECD: 1992), (Napolitano: 1991). Moreover, whether they be from a public source or a private one, the returns on investment will be different (Mohnen: 1990).

Figure 3
GERD by Performing Sector



Source: Statistics Canada (1993) calalogue 88-202, p. 15

Thus, Canada invests less in R&D than its major competitors, and less of the total investment is by private business. Although a certain level of public investment in R&D can obviously be a good thing, it is generally recognized that the investments of business are critical for two main reasons. First, businesses not investing in R&D is a broad sign that technology is not generally a vibrant activity in the economy. Second, business investments are usually thought to be a more critical element of the general dynamic of technological development[3]. In short, the low level of business investments are both a symptom and a cause of the relative lack of technological development of the nation. On the other hand, foreign firms in Canada finance a substantial amount of R&D as compared to the portion of these firms in other countries (see Table 6).

Table 6. R & D Financed by Foreign Companies

	Foreign Company Financed R&D (as % of total R&D expenditure, 1989)
Belgium	n.a.
France	13.5
FR Germany	3.0
Italy	7.8
Netherlands	4.4
Sweden	2.3
Switzerland	2.0
UK	16.2
EC/Western Europe	8.4
Canada	**18.8**
Japan	0.1
USA	13.7

Source: Patel, Pavitt (1991)

[3] The value of business investments are verified by Mohnen (1990:7) who, after reviewing a large body of literature on empirical studies of R&D and productivity growth, concludes that there exists "a higher rate of return on company-financed vs. publicly-financed R&D […]".

The Use of Advanced Manufacturing Technologies (AMTs) in Canada

These technologies constitute a major determinant of productivity performance and can measure the state of structural transformation of firms and, consequently, of countries. There is a huge range of AMTs, from computer-aided design to robotic assembly plants. Statistics Canada surveyed in 1989 establishments of all sizes in 15 manufacturing groups.

Table 7. Proportion of establishments using AMTs: A comparison Canada and the United States, 1989

	Canada	United States
	(Per cent)	
Transportation equipment	12.0	19.4
Electrical and electronic equipment	15.2	21.5
Instruments and related products	13.1	18.7
Machinery	14.0	18.3
Metal fabricating	9.1	13.2
Average	12.7	18.2

Source: Economic Council of Canada (1992)

Table 7 compares five Canadian and American major industrial groups which account for 40 per cent of manufacturing employment in Canada and 43 per cent in the United States. There is an evident gap. The main difference can be explained by the greater average size of the United States establishments. In fact, AMTs use is largely determined by establishment size as only large firms can cope with the fixed costs involved. Other factors play a role in the inter-country difference such as the higher cost of these equipments in Canada than in the United States. The industry mix and defence contracts can also explain some difference, but still, Canada lags behind the United States which itself lags behind Japan (Economic Council of Canada: 1992).

The existence of an innovation gap, such as diagnosed by the OECD, is therefore supported by the findings of this chapter, that is, the low level of R&D expenditures investment as well as the poor level of AMTs adoption by Canadian firms.

3. A picture of employment change in Canada (1971-1991)

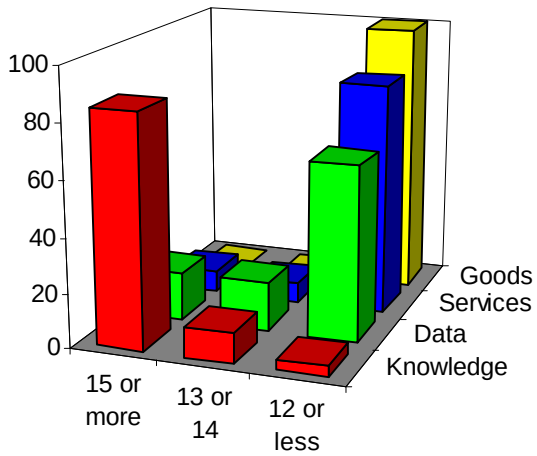
Now that a general picture of trade and innovation has been drawn, the employment trends will be described in order to assess, in a more enlightened context, the relationship which might exist between trade, innovation and employment trends.

3.1 An overall upskilling trend

In this section, an overview of employment changes is presented. Borrowing the seminal classification of Wolff and Baumol[4] (Lavoie, Roy: 1998), we have examined the rate of growth of four categories of occupations over two decades in Canada. These categories have been decided on the basis of the occupations making the core of what has been called the *information economy*. Two groups of occupations – knowledge and data – are considered as being at the core of the information economy and constitute the information category of occupations. Knowledge and data correspond to the skilled group of workers. In other words, these two groups of occupations should become the engine of economy. According to Wolff and Baumol, knowledge workers are those who produce ideas or provide professional advice. Data workers are those who use, transmit or manipulate this information and are mainly in clerical occupations.

Two other categories of occupations which make up the non-information group of occupations - services and goods - take, therefore, a less important role and are expected to be decreasing in relation to knowledge and data occupations. Services workers, such as security guards or babysitters, perform essentially personal services; whereas, good workers, such as machine operators and assemblers, transform materials. While educational requirements for services and goods categories and, to a lesser extent, data occupations, are relatively low, those required to fill a knowledge occupation are much higher (Figure 4).

Figure 4
Educational Attainment Required
(per cent distribution)



[4] For details concerning the methodology and classification of occupations developed by Wolff and Baumol, see Osberg, Wolff and Baumol (1989).

Table 8 shows quite well that the trend towards what has been called the information economy (towards knowledge and data occupations) is taking place in Canada, but the trend towards what has come to be called the *knowledge-based economy* (towards knowledge occupations) becomes more important as an economic phenomenon.

This table depicts a disaggregated picture of employment trends between 1971 and 1991. While total employment was growing at an average rate of 2.4 percent per year, the employment of knowledge workers increased at a rate of 5.8 percent over this period. On the other hand, data and services occupations were growing at a rate above total employment. Finally, the goods category has grown the least with a weak 0.6 percent average rate over the two decades. It is worth noting that the rate of growth of employment was much stronger during the first decade. This is not only true for total employment but for all categories of occupations except for the services category.

On the basis of these data, upskilling appears to be an accurate phenomenon in Canada. However, it is also important to note that upskilling does not mean a single entity of occupations. As shown in Table 8, the knowledge category is not a homogeneous group of occupations. During this period, just above the total knowledge category, the SSHs group was outpacing all other groups of occupations (6.4 percent). While this pattern of growth applied for the overall period (1971-1991), this is the general strength of the growth during the first decade which has given this pattern. Quite interestingly, however, one should note that the SSHs group has been outpaced by the engineering category of occupations[5] during the last half of the last decade (6.0 percent for the latter and 4.8 percent for the former). Another important point worth emphasizing in the knowledge category is that the pure and applied science category of occupations were growing faster during the last decade than during the 1971-1981 decade as opposed to all other categories of occupations. Hence, it is worth noting that even within the knowledge category, occupations have grown unevenly. It is important to keep these findings in mind as we shall come back to this aspect later in the paper when a picture of the career in science and technology graduates will be drawn. In the following section, a disaggregation by industrial sectors is done in order to assess the nature and magnitude of the phenomenon. In other words, we want to know if this is a widespread phenomenon or if it is localized to only a few industrial sectors.

3.2 An industrial picture of employment trends in Canada

Table 9 shows that all industrial groups have been exposed to the upskilling phenomenon. As a whole, it depicts a widespread situation. The most spectacular cases are in agriculture[6] and mining in which increases of knowledge occupations have been mainly at the expense of goods occupations. The upskilling in these natural resources sectors is especially interesting since they have been considered for a long time the spearheads of the Canadian economy, while being regarded as low or medium intensive technology sectors. In the manufacturing sector – both durable and non-durable – increases were also important although not spectacular.

[5] Computer analysts and programmers are included in this category of occupations.

[6] Agriculture includes fishing, trapping, logging and forestry while Mining includes crude petroleum and gas.

Table 8. Employment by type of occupation: 1971-1991

Type of Occupation	Total Employment				Average Annual Rate of Growth			
	1971	1981	1986	1991	1971-1981	1981-1986	1986-1991	1971-1991
				Hybrid Groups Separated				
Knowledge	429000	677000	827000	1038000	4.7%	4.1%	4.7%	4.5%
Pure Sc.	25000	30000	36000	45000	1.9%	4.0%	4.2%	3.0%
Applied Sc.	58000	77000	89000	106000	3.0%	2.9%	3.4%	3.1%
Engineering	120000	196000	245000	329000	5.1%	4.6%	6.1%	5.2%
Social Sc. and Hum.	226000	373000	456000	558000	5.2%	4.1%	4.1%	4.6%
Data	2767000	3702000	3988000	4498000	3.0%	1.5%	2.4%	2.5%
Knowledge/Data	219000	747000	966000	1260000	13.0%	5.3%	5.5%	9.1%
Data/Services	338000	501000	623000	751000	4.0%	4.4%	3.8%	4.1%
Services	1006000	123444000	1484000	1672000	2.1%	3.8%	2.4%	2.6%
Goods	3346000	3805000	3815000	3786000	1.3%	0.1%	-0.2%	0.6%
Total Employment	8104000	10666000	11702000	13006000	2.8%	1.9%	2.1%	2.4%
				Hybrid Groups Included				
Total Knowledge	538000	1050000	1310000	1669000	6.9%	4.5%	5.0%	5.8%
Total Pure Sc.	25000	30000	37000	45000	1.9%	4.0%	4.2%	3.0%
Total Applied Sc.	60000	83000	97000	117000	3.2%	3.3%	3.7%	3.4%
Total Engineering	127000	239000	288000	385000	6.5%	3.8%	6.0%	5.7%
Total S.S.Hs.	325000	698000	888000	1122000	7.9%	4.9%	4.8%	6.4%
Total Data	3045000	4326000	4782000	5504000	3.6%	2.0%	2.9%	3.0%
Total Services	1175000	1485000	1795000	2047000	2.4%	3.9%	2.7%	2.8%
Total Goods	3346000	3805000	3815000	3786000	1.3%	0.1%	-0.2%	0.6%
Total Employment	8104000	10666000	11702000	13005000	2.8%	1.9%	2.1%	2.4%

* Total Knowledge is defined as line 1 + 0.5*line 7
Total Data is defined as line 6 + 0.5*line 7 + 0.5*line 8
Total Services is defined as line 9 + 0.5* line 8
Source: Lavoie, Roy: 1997

Table 9. Proportion of Employment by Occupation and Industry

Industry Group	1971 Type of Occupation				1981 Type of Occupation				1986 Type of Occupation				1991 Type of Occupation			
	K'ledge	Data	Services	Goods	K'ledge	Data	Services	Goods	K'ledge	Data	Services	Goods	K'ledge	Data	Services	Goods
Agriculture	2.2%	3.7%	1.1%	93.0%	4.4%	8.0%	1.1%	86.5%	5.1%	9.4%	1.2%	84.4%	8.2%	13.8%	1.7%	76.3%
Mining	9.3%	16.5%	2.4%	71.8%	13.3%	21.5%	2.3%	63.0%	16.0%	22.4%	1.8%	59.7%	16.5%	22.0%	1.8%	59.7%
Construction	3.2%	9.9%	1.2%	85.7%	7.6%	16.6%	1.5%	74.4%	5.6%	14.3%	0.9%	79.3%	6.8%	15.9%	0.9%	76.4%
Non-Durable Manuf.	5.2%	22.5%	3.0%	66.2%	7.9%	23.5%	2.4%	66.2%	9.3%	24.4%	2.1%	64.2%	11.4%	27.6%	2.2%	58.8%
Durable Manuf.	5.9%	22.2%	2.1%	69.8%	8.1%	21.7%	1.7%	68.4%	9.7%	22.2%	1.5%	66.7%	11.7%	24.4%	1.4%	62.5%
Transportation	5.9%	33.7%	4.3%	56.1%	7.6%	28.6%	2.7%	61.0%	10.2%	33.5%	3.4%	52.9%	11.7%	34.7%	3.3%	50.3%
Trade	2.6%	65.5%	3.0%	28.9%	6.8%	64.2%	2.6%	26.3%	7.6%	65.4%	2.4%	24.6%	8.3%	64.8%	2.4%	24.5%
F.I.R.E.	11.9%	65.5%	6.2%	3.4%	15.2%	79.4%	1.6%	3.8%	16.8%	75.1%	5.3%	2.8%	18.5%	74.6%	4.5%	2.4%
Services	10.1%	42.8%	39.2%	7.8%	11.9%	43.7%	37.4%	6.9%	13.7%	42.9%	36.7%	6.8%	15.1%	43.2%	35.4%	6.4%
Government	10.6%	40.7%	31.8%	17.0%	16.2%	47.7%	21.0%	15.1%	16.9%	43.1%	27.7%	12.3%	18.5%	42.7%	25.7%	13.2%
Total	6.6%	37.6%	14.5%	41.3%	9.8%	40.6%	13.9%	35.7%	11.2%	40.9%	15.3%	32.6%	12.8%	42.3%	15.7%	29.1%

Source: Lavoie, Roy: 1997a

If we compare the composition of employment in the manufacturing – both durable and non-durable – to the entire industrial system such as shown on Figure 5 and 6, the share of goods workers is still largely predominant although decreasing, while, in the entire industrial system, the share of goods occupations has been decreasing rapidly over the whole period and comes second after the growing data group of occupations.

Figure 5
Share of Total Employment by Type of Occupation
(1971-1991)

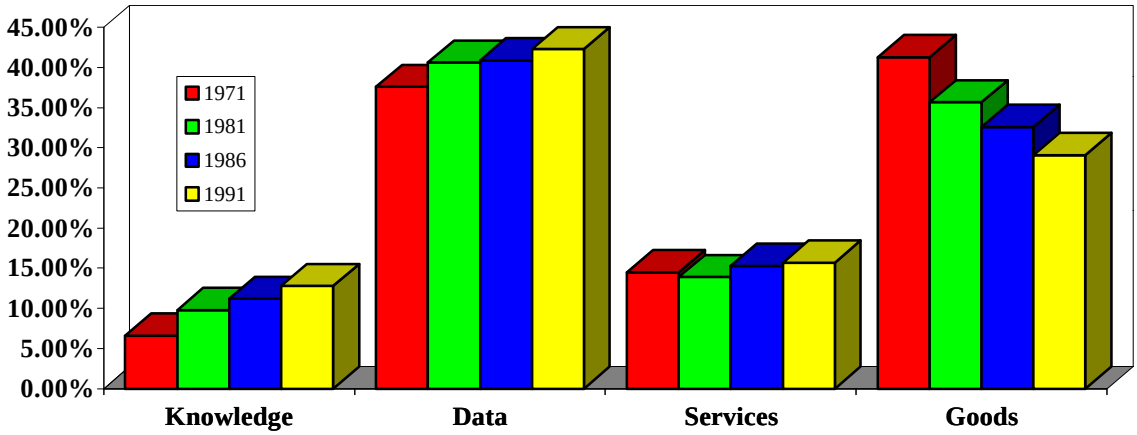
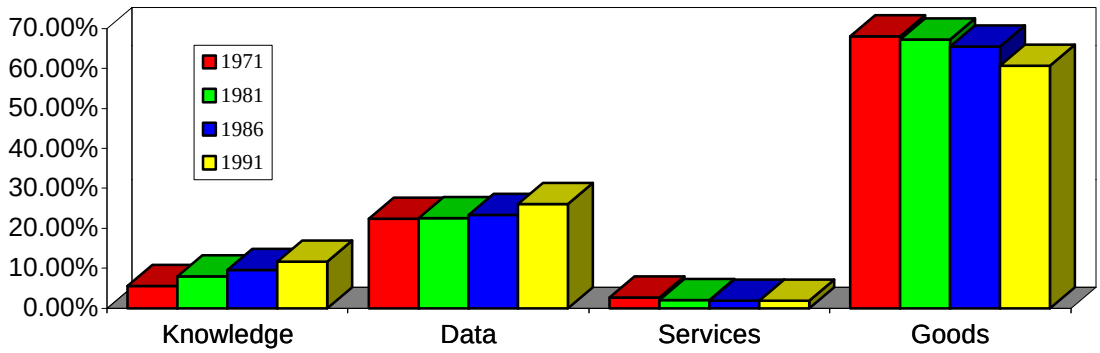


Figure 6
Share of Employment by Type of Occupation in
Manufacturing Industries
(Durable and Nondurable Manufacturing, Construction Excluded)
1971-1991



A Comparison of Manufacturing Versus Services Employment Trends

Table 10 is based on the OECD's occupational classification disaggregated between manufacturing and services sectors. White-Collar occupations – high-skilled and low-skilled – make up by far the largest share of services sectors, and this is increasing over time. However, while the proportion of Blue-Collar – high-skilled and low-skilled – had a small initial proportion of occupations in services, the share of these occupations continued to decrease over time. On the other hand, the composition of occupations is quite different for the manufacturing sector, that is, the Blue-Collar Low-Skilled category of occupations predominates by far on the other groups of occupations, but the share of both categories decreased while both White-Collar categories increased over the period. Another observation worth mentioning is that the upskilling trend in manufacturing occurred earlier, in the 80s, while in the services sector, this trend was fairly even. In the beginning of 80s, Canada was facing a severe recession which probably accelerated the pace of structural change (Gera, Massé: 1996, 59).

Table 10. Occupational distribution of employment in manufacturing and services, 1971-95

	Manufacturing				Services			
Occupational Groups	1971	1981	1991	1995	1971	1981	1991	1995
White-Collar	30.8	31.6	39.6	38.6	74.4	78.8	80.3	81.8
Blue-Collar	69.2	68.4	60.4	61.4	25.6	21.2	19.7	18.2
White-Collar High-Skilled	12.7	15.0	20.4	21.6	33.3	34.3	36.9	38.4
White-Collar Low-Skilled	18.0	16.5	19.2	16.9	41.1	44.4	43.4	43.4
Blue-Collar High-Skilled	17.8	17.1	16.2	15.9	6.6	5.7	4.9	4.1
Blue-Collar Low-Skilled	51.5	51.3	44.1	45.5	18.9	15.6	14.7	14.1

Shares exclude employment in postal services, religious services and public administration
Source: Gera, Massé: 1996

A Shift Towards Innovative Industries

Using another classification of industries, in order to assess the location of the trends of employment, supports the trend towards what is come to be called the knowledge-based economy. The product-differentiated category of industrial sectors, which is essentially composed of specialized suppliers and considered as a driving force in the knowledge-based economy, is, however, slow to increase its rate of employment. Tables 11 and 12 depict well the trend towards science-based industries – led by computers and office equipment, aircraft manufacturing, and pharmaceuticals (Gera, Massé: 1996, 23), a trend which had been especially strong during the 70s, but then slowed down considerably during the 80s. However, these sectors still constitute a small portion of the manufacturing activity of industries in Canada.

Table 11. Distribution by manufacturing employment by sectoral group, 1971-1991

Sector	1971	1981	1986	1991
Resource-Intensive	28.9	28.4	27.8	26.8
Labour-Intensive	24.0	22.1	21.6	20.5
Product Differentiated	12.1	12.6	11.6	12.2
Scale-Intensive	31.1	31.9	33.7	34.7
Science-Based	3.9	5	5.3	5.8
Total	100	100	100	100

Source: Gera, Massé: 1996

Table 12. Average Annual Employment Growth in the Manufacturing Sector by Sectoral Group, 1971-1991

Sector	1971-81	1981-86	1986-91	1981-91	1971-91
Resource-Intensive	1.06	-0.83	-1.57	-1.2	-0.1
Labour-Intensive	0.27	-0.92	-1.86	-1.39	-0.51
Product Differentiated	1.6	-1.98	0.19	-0.9	0.34
Scale-Intensive	1.49	0.67	-0.28	0.19	0.83
Science-Based	4.12	0.58	1.04	0.81	2.24
Total	1.22	-0.43	-0.84	-0.63	0.28

Source: Gera, Massé: 1996

An Analysis of the Manufacturing Employment Decline

What are the reasons behind the "...large drop in manufacturing employment, relative to other sectors of the economy"? (Schwanen: 1997, 20) especially in less innovative manufacturing sectors? As Gault states, "Canada has a service economy. Over two-thirds of gross domestic product (GDP) and three-quarters of employment result from service activity, and close to 60 percent of the measured research and development (R&D) is performed in the service sector" (Gault: 1996, 73). This phenomenon is not new.

To determine the causes of the shift to services is a difficult operation, and to assess the employment loss in the manufacturing sector is still more complicated. In fact, a myriad of interrelated phenomena are involved. We could question, for example, if there has been a "contracting-out" by manufacturing industries resulting in a transfer of employment from the manufacturing sector to services. Specific activities currently carried out in the service industries might have been performed previously in the manufacturing sector, this shift being motivated by "...potential cost savings; the ability to obtain an improved quality of service; and the increasing technical complexity and specialisation of service functions" (O'Farrell: 1995, 527).

3.3 A comparison with the United States

A brief comparison with the employment composition and growth with the United States is worth doing at this point. It shows that both economies are following the same trends. The classification and decomposition model of Wolff and Baumol in their study of the United States, was used in a similar study for Canada (Lavoie, Roy: 1997, 1998).

Figure 7 shows that, although the Canadian economy was less knowledge-based than the United States between 1970 and 1980, both economies became quite similar in the 1990s. It is especially interesting to compare the annual rate of growth of different categories of occupations for

both economies as depicted in Figure 8. It shows clearly that the pace of change of the Canadian employment profile has changed more rapidly during both periods, making these economies quite comparable in terms of employment at the end.

Figure 7 Knowledge and Data Occupations as a Percent of Total Employment (1970-1990)

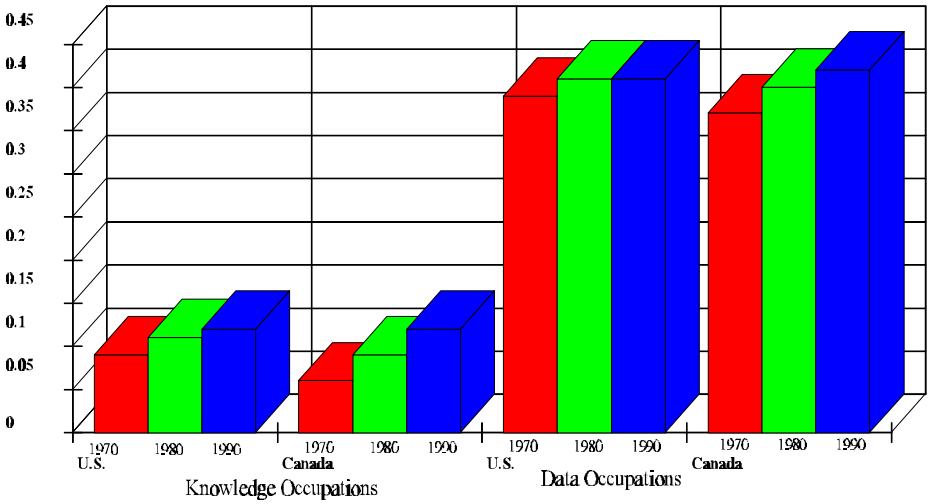
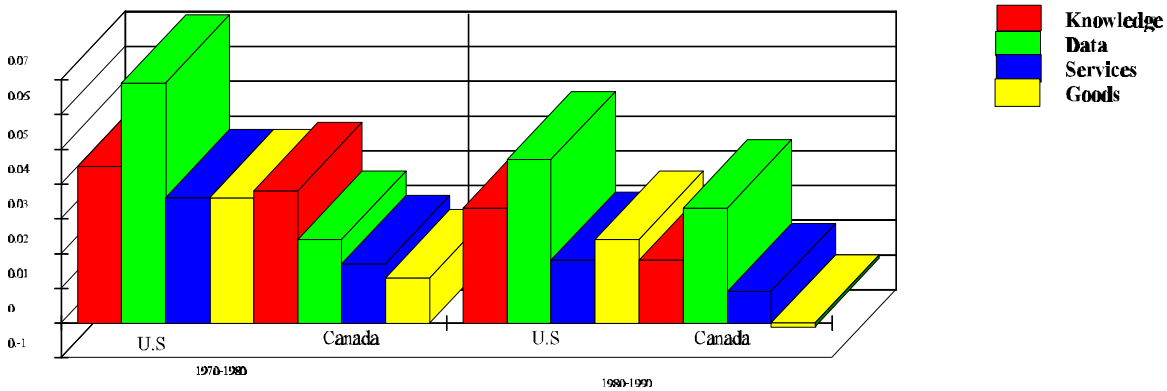


Figure 8 Annual Rate of Growth of Employment by Category: A Comparison U.S., Canada (1970-1990)



4. A picture of industrial outputs change in Canada

According to numerous analysts, knowledge in general and scientific and technological knowledge in particular are the engines leading to economic growth. In fact, this is now conventional wisdom. We can see from Table 13 a trend towards more knowledge-intensive products.

Table 13. Gross output growth in the manufacturing sector by sector orientation, 1971-91

		Sources of Output Growth			
	Growth Rate	Domestic Final Demand	Exports	Import Penetration	Technological Change
1971-81					
Natural Resource Intensive	2.47	1.92	0.97	-0.24	-0.21
Labour-Intensive	2.79	3.46	1.07	-0.86	-0.81
Product-Differentiated	4.57	3.86	2.47	-1.5	-0.37
Scale-Intensive	3.27	2.3	1.97	-0.59	-0.21
Science-Based	9.42	4.99	6.12	-2.11	0.8
1981-86					
Natural Resource-Intensive	0.43	0.07	1.34	-0.67	-0.24
Labour-Intensive	0.86	1.3	1.6	-1.57	-0.49
Product-Differentiated	0.35	-0.28	1.44	-1.48	0.1
Scale-Intensive	4.33	0.48	4.59	-0.79	0
Science-based	7.58	1.42	7.66	-0.7	0.02
1986-91					
Natural Resource-Intensive	0.1	0.54	1.11	-1.29	0
Labour-Intensive	-2.06	0.35	0.57	-2.55	0.47
Product-Differentiated	2.74	2.62	2.76	-2.14	0.34
Scale-Intensive	0.27	0.72	0.71	-0.97	0.09
Science-Based	9.31	2.02	7.76	-1.05	0.48

Source: Gera, Mang: 1997

There has been a substantial increase of manufacturing outputs in science-based industries relative to other categories of industries. Labour-intensive industries, on the reverse, have experienced an important decrease of production over the 1986-91 period[7].

[7] It is especially important to examine this group of industries since "the popular debate focuses on job losses in labor-intensive manufacturing industries and traces them to trade with less industrialised countries" (OECD: 1996).

4.1 Sources of the industrial outputs shift

The domestic demand accounted for the predominant factor leading to a growth of outputs over the 1971-81 period; however, from 1981 exports play an increasingly fundamental role for all industrial sectors. However, it should be emphasized that exports have played a more important role since the beginning of the 1970s in the science-based industries outpacing, therefore, the domestic demand. Conversely, imports penetration has been an important source of negative growth and this is especially true for labour-intensive industries for which exports expansion do not compensate over the 1986-91 period. It is only in the science-based industries that this source has had a decreasing influence over time. We must keep these results in mind for the analytical part of the report.

On the other hand, technological change does not seem to play a substantial role and had even had a negative one especially during the first decade. In the science-based industrial sectors, technological change has played a positive role over the two decades although decreasing during the second decade.

5. An analysis of the impact of trade on employment trends

The changing skill profile of employment, such as evidenced in the third section of the present paper, seems to be explained by a series of interrelated causes which are difficult to disentangle. The main argument is that the increasing competitive pressures faced by unskilled workers in less innovative industries from the international level and the growing adoption of information and communication technologies have imposed this new profile of employment. In the present section, an assessment of trade is undertaken while in the sixth section an analysis of technological change on employment changes will be done.

Popular belief tends to discredit the free trade agreement. The current debate over the Canada-U.S Agreement (FTA), "...is widely seen... as having caused thousands of job losses, hundreds of plant closures" (Eden: 1994). Moreover, the NAFTA adds to these fears since Mexico, being a low-wage country, will induce a competition which will drive down the demand for low-skilled workers in Canada. On the other hand, some informed observers affirm that it is the competition with the United States which is the real challenge for keeping high living standards. In this section, an assessment of international trade will be done with special attention to continental trade.

5.1 The dynamics between trade and employment

The dynamics between trade and employment is a much debated issue in Canada since, in addition to appraising the effects of international trade, those of free trade are hardly predictable.

Impact of International Trade in Canada

While the OECD found a small effect of the net impact of trade in OECD countries, Industry Canada (1996), which followed a similar methodology using a finer industrial disaggregation, provided evidence that "...trade had significant impact on employment growth in Canada over the period 1971-91 (Gera, Massé: 1996, 53). In fact, as shown in Table 14, the net impact has been generally positive over the 1971-81 and 1981-86 periods while slightly negative between 1986-91.

Table 14. Sources of employment growth in various manufacturing groups, 1971-1991

		Sources of Employment Growth (%)				
	Employment Growth Rate (%)	Domestic Final Demand	Exports	Imports	Technolo-gical Change	Productivity
1971-81						
Resource-intensive	1.06	1.98	1.07	-0.39	-0.35	-1.2
Labour-Intensive	0.27	3.5	0.94	-0.99	-0.78	-2.33
Product Differentiated	1.6	3.93	2.62	-1.56	-0.32	-3.18
Scale-Intensive	1.49	2.58	1.78	-0.54	-0.2	-2.01
Science-Based	4.12	5.1	5.77	-2.15	0.83	-4.81
1981-86						
Resource-intensive	-0.83	0.41	1.41	-0.36	0.16	-2.72
Labour-Intensive	-0.92	1.6	1.32	-1.69	-0.31	-1.94
Product Differentiated	-1.98	-0.26	1.58	-1.47	0.14	-2.64
Scale-Intensive	0.67	0.5	3.86	-0.56	-0.01	-3.26
Science-Based	0.58	1.05	5.5	-0.58	0.01	-3.4
1986-91						
Resource-intensive	-1.57	0.59	0.82	-1.51	0.17	-1.23
Labour-Intensive	-1.86	0.17	0.61	-2.51	0.46	0.13
Product Differentiated	0.19	2.54	2.59	-2.16	0.44	-2.76
Scale-Intensive	-0.28	1.07	0.46	-1.16	-0.01	-0.36
Science-Based	1.04	1.96	6.3	-1.24	0.58	-6.46

Source: Gera, Massé: 1996

Gera and Massé offer a disaggregated view of trade in manufacturing which is very useful. The findings reveal that less innovative industries are notably affected by trade, registering job losses, especially between 1986-91. More precisely, the effect on labour-intensive manufacturing industries has been especially negative, particularly because it has not been compensated by a strong positive effect of exports. Conversely, while product differentiated and science-based manufacturing industries have been affected in the same way by imports, the strengths of the exports effect has given a positive net effect of trade. This is an important finding since these industries are at the core of the knowledge-based economy.

As a whole and as a result of the expansion of exports, a growing proportion of jobs has been created in the overall period. Conversely, an important displacement of occupations has taken place due to the increasing import penetration giving, as a whole, a positive net impact of trade and this has taken place in the three intensive sectors – labour, resource and scale-intensive.

5.2 Impact of changing trade patterns on labour market trends in the context of the FTA and NAFTA

Since the implementation of FTA in 1989, there has been a slow-moving growth of employment and of the average real incomes. The increase was mainly experienced by high-skilled workers while low-skilled workers faced a relative decline in wage and employment and the duration of unemployment was increasing. What has been the role of FTA and NAFTA in Canada? Is there some evidence that free trade has had a major impact on job losses and earnings gains?

Looking at Table 1 presented in Section 2, we see an increase of exports to the United States from 1981 to 1991 which was preceded by a decrease from 1971-1981. On the reverse, while imports from the United States were increasing from 1971 to 1981, these were decreasing from 1981 to 1991. Asian NICs and Japan were the only other parts of the world with whom Canada has increased its exports, and Canada increased considerably its imports with Asian NICs even if the basis number was initially quite small. Nonetheless, it is with the United States that Canada does the largest share of trade.

While Mexico is the third partner in NAFTA, some caveats prevent us to assess the impact on Canada's trade. First of all, Mexico faces an economic crisis. Second, the agreement is too young and the NAFTA's provisions regarding Mexico are being implemented more slowly than those of the FTA. The question remains whether we relate the poor employment performance of some manufacturing industries employment to trade and more especially to continental free trade. According to Schwanen (1997, 20) “The decline in manufacturing as a share of total employment became a feature of the economic picture well before the FTA was implemented”.

Dividing industrial sectors into two groups, those sensitive to FTA and the other FTA-nonsensitive[8] such as presented in Table 15, Schwanen shows that if free trade had had an effect on employment or wages, FTA-sensitive industries would have exhibited a worse-than-average performance, which is not the case. In fact, in both categories, employment and wages decline relatively to total employment. The only sectors which perform better are those which have been exposed to continental competition before the FTA, that is, the category "already largely tariff free (Schwanen: 1997, 23). In this category, there are some leading industries like automobile, pulp and paper as well as aerospace industry. The "rapidly expanding exports" group has seen its employment rising relative to total employment, but did not fare as well in terms of average wages. The greatest stability in wages and employment is recorded for the "rapidly expanding exports and imports". Industries belonging to the "rapidly expanding imports" group from the United States has been characterized by a shift in employment trends since the implementation of the agreements. Finally, the worst performing group relatively to employment is the "liberalized but slow trade growth".

[8] Schwanen divided 81 manufacturing sectors into FTA-sensitive industries which gives a number of 46 industries and FTA-nonsensitive industries for a total of 35 industrial sectors. The sensitive ones are those which have been liberalized by the FTA and for which bilateral exports, imports or both have been increasing beyond the average. The nonsensitive sectors to the FTA are those which are either not liberalized or those which are liberalized but did not register a rapid increase in bilateral trade.

Table 15. Relative trends in Canadian manufacturing employment and wages according to industry sensitivity to the FTA, 1983, 1988, 1995

	Share of Manufacturing Employment			Weekly Wages		
Type of Sector	1983	1988	1995	1983	1988	1995
	(percent)			*(total manufacturing=100)*		
FTA-sensitive	56.6	57.1	57.0	92.8	92.5	91.5
Rapidly expanding exports	18.1	18.7	19.7	101.0	102.5	101.6
Rapidly expanding imports	23.8	23.7	22.5	86.6	84.2	82.9
Rapidly expanding exports and imports	14.7	14.7	14.8	92.8	92.9	91.0
FTA-nonsensitive	43.4	42.9	43.0	109.3	110.1	111.3
Already largely tariff free	19.2	19.6	21.2	119.8	120.6	123.2
Still protected	4.3	4.6	5.0	94.9	96.6	93.6
Liberalized, but slow trade growth	20.0	18.7	16.8	102.4	102.4	101.7

Source: Schwanen (1997)

While there is no evidence that the liberalization of continental trade has been responsible for the decline of employment in the manufacturing sector as a share of total employment, international trade, which also includes continental trade, has notably affected the employment profile as was analysed above. To summarize, while imports penetration contributes to depress employment growth in all sectors for all periods, exports had significant impact on employment growth between 1971 and 1991, and this is especially true for science-based industries.

6. An analysis of the impact of technological change on employment trends

As stated by the OECD, "(...) the impact of trade cannot be examined separately from that of technology (...)" (OECD: 1996, 75). While trade flows are determined by the technological sophistication of a country as well as its factor endowments, the level of openness of a country will partly determine its rate of diffusion, adoption and transfer of technology.

6.1 Changing production recipes: A new complexity

In this section, we examine the impact of technological change on employment trends. Using the findings of two studies – Gera, Massé (1996) and Lavoie, Roy (1997, 1998) – an assessment of the role of technological change on employment is undertaken. Both studies use a crude measure of technological change, that is, the change of input/output coefficients[9] which rather represents a change in the production recipes of industries. This certainly includes technological change but is not exclusively related to technological change. There are many advantages of undertaking this approach since it allows us to assess the changing complexity of doing things. However, this complexity is not narrowly related to technology or science but may also be social, environmental, managerial, and so on (Lavoie, Roy: 1997, 1998).

[9] The criticisms of using I/O approach are quite well known and the reader may read Gera, Massé (1996) for a summary.

Using the same data, these two studies are, however, very different given that they use different models of decomposition; therefore, the reader must read carefully the methodology of both. Beyond these differences, there is also the unit of analysis which differs. While Gera and Massé look at sources of employment change by industrial sector, Lavoie and Roy's study looks at sources of changes by occupational category. Despite the differences of models, these studies are quite complementary.

An Industrial Perspective

The results of Gera and Massé's study, which essentially follow the OECD methodology, reveal that technological change or the change of production recipes have contributed to increased employment, especially in the science-based category of industries over the 1971-81 decade, while this factor had a negative effect for the other categories of industries. During the first years of the second decade, however, labour-intensive as well as scale-intensive sectors have also been negatively impacted by the change of production techniques, while other sectors have begun to feel the positive impact of this effect. During 1986-91, the effect has been the most felt across industrial groups, although it has been decreasing for the science-based category of occupations.

We suppose that the technological change effect on employment in the science-based category of industries has resulted in a larger need for these industries to hire knowledge workers or, what is called high-skilled workers. However, this might be also true for all other industrial sectors. According to this study, the so-called technological change effect is less important than other effects brought about by the increase of employment, exports expansion remaining the most powerful one.

A careful look at Table 14 also reveals that the productivity factor has had, by far, the most significant negative impact on employment growth, particularly in the science-based industries which have been especially affected by this factor. While technology is supposed to play a central role on productivity and, thereby, on employment growth, the question of how technological change affects productivity and economic growth is extremely difficult to understand given the substantial variation of industrial sectors and also the technological change and productivity not being a straightforward relationship and, still probably more important, the time lag between the investment in technology and the moment it becomes effective.

Building a story on the basis of these findings and comparing trade effect with that of technological change, one could say that the latter has had a minimally negative effect on all categories of industrial sectors from 1971 to 1986, except for the science-based one for which this effect has been consistently strong. It is interesting to note that this effect has been more negative for the labour-intensive group of industries up to 1986, while it has been quite positive in the next five years, compared with other groups of industrial sectors. The most interesting observation from Table 14 is that, while technological change has been the one affecting most negatively almost all industrial sectors during 1971-86 period, the net impact of trade was generally positive during the same period but became mostly negative between 1986 and 1991, while technological change had a more positive effect during the same period.

Changing the unit of analysis from industrial sector to occupational group, it is interesting to look at the effect of the production recipes transformation, that is, technological change in different categories of occupations. Once again the results of these two studies cannot be compared in terms of the magnitude but can be compared according to the trends which are revealed.

An Occupational Perspective

From an occupational point of view, the causes of some occupations growth or decline have been assessed using Lavoie and Roy's study which implemented a growth accounting decomposition initially suggested by Wolff and Baumol[10]. The model is very useful in determining the broad proximate causes of the employment changes in the economy. The technique decomposes the total change in the proportion of a given group of occupations in total employment over 1971 and 1991 into three components.

These effects have been identified to produce either a decline or an increase of employment. The first one is called the *substitution effect* which occurs within the production technology of domestic firms or industries. This essentially means that, for unchanged levels of industry output and employment, technological change or other factors such as institutional reforms may favour an increase of a given type of occupations. Technology, as a factor of change, is grasped under this effect, but this is not the exclusive factor. For example, it also reflects the nature of the increasing complexity of production. This is this effect which interests us more precisely in this paper. The second effect is attributed to differences of labour productivity growth rates among industries and is called *the productivity lag effect.* It means that industries with a stagnant labour productivity require a growing fraction of total employment. Finally, the third component called the *final output effect* contributes to employment change when, for a given level of worker composition and labour productivity, shifts in the composition of final output of the domestic industry give, in turn, rise to proportional changes in the structure of employment (Lavoie, Roy: 1997, 1998).

Section 3 shows an important increase in the knowledge category of occupations, but this growth differs quite substantially from a sub-category to another. It is interesting and important to disaggregate the category of these highly-skilled workers into different sub-groups to better understand the nature of skills which are the most in demand. We have, therefore, divided this category into four sub-groups – pure science, applied science, engineering and social science and humanities (SSHs). This division allow us to determine the nature of skills in demand in a specific economy and allows us better to understand the relationship between these bodies of knowledge and technological change. An analysis of the causes of employment changes amongst these sub-groups reveal, as will be seen, that if the Canadian economy is moving towards a knowledge-based model, the knowledge is not exclusively technological or scientific. Let us go further in the analysis of the causes of employment change by looking at Table 16.

[10] For a complete description of Wolff and Baumol's approach, the reader is referred to Osberg, Wolff and Baumol (1989). We also refer the reader to Lavoie, Roy: 1998 for the methodology of their decomposition model.

Table 16. Decomposition of the change in employment composition

Type of Occupation		Subst. Effect	Prod.Lag. Effect	Output Effect	Total Change	Subst. Effect	Prod.Lag. Effect	Output Effect	Total Change
			(percentage points)				(distribution: total=1,00)		
Knowledge*	**1971-91**	5.12	1.45	-0.13	**6.45**	0.79	0.23	-0.02	**1.00**
	1971-81	2.13	0.75	-0.06	**2.82**	0.75	0.27	-0.02	**1.00**
	1981-91	2.99	0.70	-0.07	**3.62**	0.83	0.19	-0.02	**1.00**
Pure Sc.	**1971-91**	0.04	0.06	-0.04	**0.06**	0.68	1.03	-0.71	**1.00**
	1971-81	-0.04	0.03	-0.03	**-0.03**	1.20	-1.14	0.94	**1.00**
	1981-91	0.08	0.03	-0.02	**0.09**	0.85	0.32	-0.17	**1.00**
Applied Sc.	**1971-91**	-0.01	0.20	-0.04	**0.14**	-0.09	1.40	-0.31	**1.00**
	1971-81	-0.01	0.13	-0.05	**0.07**	-0.12	1.79	-0.67	**1.00**
	1981-91	0.00	0.07	0.00	**0.07**	-0.06	1.01	0.05	**1.00**
Engineering	**1971-91**	1.56	0.21	0.00	**1.77**	0.88	0.12	0.00	**1.00**
	1971-81	0.74	0.12	0.01	**0.86**	0.85	0.14	0.01	**1.00**
	1981-91	0.82	0.09	-0.01	**0.90**	0.91	0.10	-0.01	**1.00**
Soc. Sc.&Hum.	**1971-91**	3.53	0.98	-0.04	**4.47**	0.79	0.22	-0.01	**1.00**
	1971-81	1.44	0.47	0.01	**1.92**	0.75	0.24	0.01	**1.00**
	1981-91	2.09	0.51	-0.05	**2.55**	0.82	0.20	-0.02	**1.00**
Data	**1971-91**	1.11	4.76	-0.89	**4.98**	0.22	0.96	-0.18	**1.00**
	1971-81	0.62	2.99	-0.74	**2.86**	0.22	1.04	-0.26	**1.00**
	1981-91	0.49	1.77	-0.14	**2.12**	0.23	0.84	-0.07	**1.00**
Services	**1971-91**	-1.60	3.73	-0.65	**1.48**	-1.08	2.52	-0.44	**1.00**
	1971-81	-0.67	2.00	-0.59	**0.73**	-0.92	2.73	-0.81	**1.00**
	1981-91	-0.93	1.73	-0.06	**0.75**	-1.23	2.31	-0.08	**1.00**
Goods	**1971-91**	-4.63	-4.38	-3.90	**-12.91**	0.36	0.34	0.30	**1.00**
	1971-81	-2.08	-2.50	-1.84	**-6.42**	0.32	0.39	0.29	**1.00**
	1981-91	-2.55	-1.87	-2.06	**-6.49**	0.39	0.29	0.32	**1.00**
Total Information**	**1971-91**	6.23	6.21	-1.01	**11.42**	0.55	0.54	-0.09	**1.00**
	1971-81	2.75	3.74	-0.80	**5.69**	0.48	0.66	-0.14	**1.00**
		3.48	2.47	-0.21	**5.74**	0.61	0.43	-0.04	**1.00**

*Knowledge is the sum of Pure Science, Applied Science, Engineering and Social Sciences and Humanities

**Total Information is the sum of Knowledge and Data

Source: Lavoie, Roy (1997)

The substitution effect which is predominant for the whole category of knowledge occupations means that knowledge occupations have substituted other groups of occupations, and this effect has led to an increase of occupations. In other words, changes in production recipes have generally favoured the expertise of the knowledge category of occupations as a whole. It makes up to 79 percent throughout the two decades, and this has been increasing over time.

A careful glance at this category reveals that the substitution effect is quite various amongst sub-groups. While social sciences and humanities and engineering activities[11] are affected relatively in the same manner, the effect of substitution on pure scientists has mainly characterized the second decade and contributed to reduce the demand for these occupations during the first period[12]. For applied science occupations, this effect has contributed to depress their demand during the first decade but has had no effect in the last decade.

The rate of substitution of data occupations is rather weak, meaning that the increasing demand for the specific expertise of these people replacing another type of expertise occurs in less than 23 percent over time. For services occupations, this effect has played a negative role even contributing to decrease their number. This means essentially that these occupations have been substituted for other types of occupations. Finally, the decline of goods occupations has been affected approximately by a third as a result of the substitution effect, although this effect was even stronger throughout the 80s.

An Analysis

There is some important information in these findings, mainly in terms of policy recommendations which should be kept in mind for the last section. First of all, it means not only that the change of production recipes have induced a need to solve problems which are not exclusively scientific or technological, as the knowledge-based economy label would have us believe, but, also, that problems to be solved require an expertise in the control and management of activities since social science and humanities occupations have been strongly affected by this effect. Essentially, this could mean that there has been, during the last two decades, a need to control and manage the new economy in parallel with an increase of the engineering expertise, which has also been substituted for other categories of occupations.

A second important observation is that scientific occupations, especially those of applied science, have not been driven by a scientific complexity, despite the much documented growing interaction between science and technology or, as referred to by others, the growing 'scientification' of technology (Metcalfe: 1995) or 'the rise of science-related technology' (Freeman, Soete: 1997).

One can conclude this section by saying that if technological change, measured crudely by the change of input/output coefficients, had some impact on employment growth, it was mainly for some categories of knowledge occupations (or high skill occupations). In terms of industries, those which have been the most positively affected by the change of production recipes are the science-based industries in the 70s and, later, in the last half of the 80s. In all other categories of industries except the scale-intensive ones, employment has declined as a result of this impact. These findings prompt us to assess the attractiveness of a career in science and technology in Canada. This is done for two

[11] Computer analysts and programmers are included in the engineering category of occupations.

[12] Some scholars have recently presented the importance of building an approach evolving around the economics of science for better understanding the role of science in the stimulation of productivity (Dasgupta, David: 1994, Pavitt: 1991, 1993). Our findings certainly justify this new preoccupation which should allow us to better understand the role of science in the economy in general, and the situation of scientific occupations on the labour market, in particular.

reasons: i) the increasing outflow of Canadian investment in the United States which can drain an important contingent of science and technology graduates and, consequently weaken the science and technology base in Canada; ii) the poor labour market conditions which could also prevent future cohorts of students to enter into a science and technology program given the low attractiveness of previous careers in these specialisations.

6.2 The situation of high-skilled workers in Canada

As will be seen in the last section, a "high-skill path" strategy should be encouraged in Canada; and for success, a career in science and technology must offer attractive outcomes. While there is a trend towards these occupations induced by a myriad of interrelated factors, among which are trade and technological change, Canada must be able to compete against the United States to retain its high-skill workers.

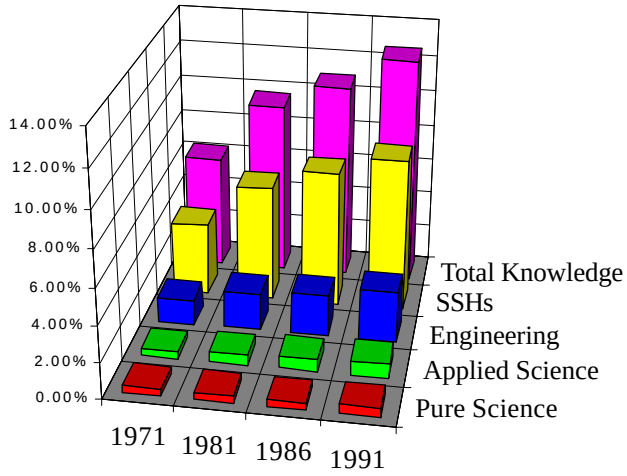
A Variety of Knowledge

As was seen above, there is much evidence that the Canadian economy is becoming increasingly knowledge-based. Fundamentally, this means that there is a trend towards high-skilled employment. However, this category is not homogenous.

The disaggregation of the knowledge category gives another perspective to the decomposition analysis. In this sense, it is worth noting that the different sub-groups do not share the same relationship with technological change. If engineering workers contribute directly to the production and development of technological change, SSHs occupations have another link that is a more indirect one. On the other hand, in an economy where technology appears increasingly science-related (Freeman, Soete: 1997), the relationship between pure science, applied science and technology should be closer than ever.

Figure 9 presents a disaggregation of the knowledge category into four sub-categories. SSHs represents by far the largest and increasing share of the knowledge category, engineering follows but with less than a third of the SSHs share in 1981, 1986 and 1991. The pure science category remains the smallest portion of the knowledge category while applied science, which shared the same size as pure science in 1971, doubled its share in 1991 (Lavoie, Roy: 1997, 1998).

Figure 9
Employment Share of Knowledge Occupations by Sub-Category
(1971-1991)



It is, therefore, interesting to note that if occupations more closely related to technology have been increasing during the last two decades in Canada, the strongest rate of growth has been no less for SSHs occupations which are not directly related to technological change. Therefore, and this is a fundamental point, the complexity generated by technological change, in particular, and probably the increasing globalization, in general, have induced a need to control and manage the new complexity of these economic activities. We have seen that management occupations have, by far, had the strongest rate of growth[13].

The Attractiveness of a Career in Science and Technology

Another important point to consider about the increasing trend towards the knowledge-based economy type are the career opportunities offered to the knowledge workers in Canada. The capacity of the Canadian economy to develop a "high-skill path" throughout the economy will depend heavily on its capacity to attract and retain its highly educated workforce since, as observed above, Canada must compete against the United States to develop and attract investment in higher value-added stages of production.

Recently, in a context where governments are facing important budget deficits, universities and public laboratories have felt very badly the economic situation. Important spending cuts have affected the career prospects of some categories of knowledge workers. While there is an increasing need for knowledge workers and governments continue to encourage young people to pursue these studies, the labour market does not seem to offer attractive careers for these graduates anymore. A growing literature examines this new situation in Canada as well as in the United States[14].

[13] This increase of managerial occupations has been widely documented. See in particular, Colecchia and Papaconstantinou (1996) and the same empirical evidence is presented in Betts and McCurdy (1993) as well as in Picot and Lavallée (1986). Moreover in Lavoie, Finnie: 1997, we found that the only consistent increase of engineers in an occupational ladder evidenced by the NGS is that into management where engineers heve very attractive careers.

[14] See more particularly, Lavoie, Finnie: 1977, 1998; AAAS:1997.

Some worrying facts have been found. Based on the National Graduates Surveys[15], Lavoie and Finnie (1997, 1998) have examined the school-to-work transition of these high-skilled workers during the last decade in Canada in order to assess the quality of their careers. Some observations are worth mentioning:

> The most general finding is that there has been considerable variation in the early careers of science and technology graduates in Canada throughout the last decade. At one end of the spectrum, computer scientists have done very well, reflecting the 'skill bias' of information and communication technologies. Health graduates have also performed very well, while engineers have performed in a solid, although not spectacular, fashion. At the other extreme, pure and, especially, applied scientists have lagged behind, which is not only cause for concern, but is also surprising in a context where science and technology knowledge bases are supposed to be more integrated than ever.
>
> More specifically, pure and applied science graduates generally had higher rates of unemployment, lower earnings levels, reduced rates of job satisfaction, looser job-education skill matches, and less satisfaction with their choice of educational programme than other science and technology graduates, while often performing even worse than the comparison social sciences and humanities groups in these regards. It is only at the Doctorate level that careers in the sciences appear to become interesting and rewarding (Lavoie, Finnie: 1997).

Looking at the industrial distribution trends of these recent graduates entering the labour market, we also found some interesting facts:

> There has been an employment shift of these highly-skilled workers towards the private section of the service industries. Although this sector does not offer the highest salary levels, it gives the highest increases from two years to five years on the labour market. This is consistent for the graduates of all disciplines. The goods industries are particularly competitive in terms of salaries, while primary industries offer quite high earnings after two years on the labour market for most graduates, with other sectors becoming as competitive after five years (Lavoie, Finnie: 1997).

Concluding Remarks

This section was only a short discussion intended to show that it is not sufficient anymore to appreciate the trend towards more highly-skilled occupations in a developed country like Canada. While evidence yields that Canada is becoming increasingly a knowledge economy, important questions arise in terms of how to maintain a quality of career for these workers and to avoid a massive brain drain to the United States or other industrialized countries. As will be seen in the last section, governments have an important role to play to prevent this situation from deteriorating. If the globalized context has been an important factor fostering upskilling trends, national economies will have an important role to play to retain and attract these high-skilled workers.

[15] The National Graduates Surveys (and Follow-Up) databases, developed by Statistics Canada, comprise large, representative, longitudinal surveys of graduates who successfully completed their degrees at Canadian universities and colleges in 1982, 1986, and 1990. These databases focus on the educational experiences and early labour market experience of recent graduates.

7. Policy discussion: encouraging a 'high-skill path' throughout the economy

In a context of high and persistent unemployment rates[16], governments are looking for policies which should, at the same time, reduce this persistent and adverse trend and help the economy to move towards the knowledge-based model of economy. In this concluding chapter, some policy avenues for Canada will be discussed on the basis of the findings of numerous studies reviewed throughout this paper.

As has been seen above, Canada is a small open economy which has always relied on the exploitation of natural resources. Nonetheless, this should not prevent such an economy from being a leading country in terms of competitiveness and high living standards, but Canada will have to develop a more "value-added" economy, especially because a considerable number of substitutes to natural resources exist which are more efficient and often less costly. The implementation of relevant policies should help the country swing in that direction.

A good starting point for the relevant policy discussions is to recognize that Canada must develop a strategy which would allow her forcefully to enter the globalization stream, which means that instead of protecting jobs for low skilled workers and, thereby, having to inevitably deal with the growing inequality of wages between low skilled and high skilled workers, a *high-skilled path*[17] throughout the economy should be encouraged since, as Mishel and Teixeira state, in the case of the United States (which is also relevant to the Canadian economy), "(...) there may not be *too much* upskilling of the job structure, but rather *too little*. Put another way, there may be more of a *potential* for upskilling than *actual* upskilling" (Mishel, Teixeira: 1991, 24). Besides, our findings show that the trend toward skill upgrading has been slowing down during the last decade as compared to the 70s situation. Canada must reinvest the upskilling process.

It is especially worth emphasizing that the globalization process has not been created by governments but rather induced by a dynamic between private actors – which transcend national boundaries – in order to get new opportunities from technological change, which itself led to a reduction of costs and to a fundamentally new international division of tasks. However, in this new economic reality, governments have responsibilities. In searching for answers to how move the Canadian economy to a full employment economy, international trade and technological change *should not be seen as part of problems but as part of solutions*. Amongst others, achieving productivity gains should be a priority and this can be done by fostering competitiveness which, in turn, will force firms to adapt to the new economic reality and new consumer preferences by changing their organisation and adopting new technologies. Before expanding a little more on this aspect, let us summarize the main features of the Canadian labour market as documented in this paper.

- While there has been an upskilling trend in manufacturing in Canada, the pace was much stronger during the 1971-1981 decade. However, a comparison with the American data shows that the pace of change is faster in Canada, but the initial situation was much lower.

- While the number of skilled workers is increasing, this is not an homogeneous group and there is a variety of growth rates within this group reflecting a higher demand for certain types of expertise.

- Careers in science are especially unattractive in Canada as compared to the career of other high-skilled workers.

- The upgrading is, however, a widespread phenomenon, that is, scattered across all industrial sectors.

[16] Canada is a "high unemployment country" in relative terms. The unemployment rate of Canada has been high and well above the OECD average.

[17] This concept has been developed by Mishel and Teixeira (1991) in the context of the United States.

- Contrary to other OECD countries, employment growth relies mostly on exports expansion. In other words, trade is vital for Canadian jobs creation, but what Canada exports also matters.

- Jobs losses have been registered in less innovative sectors especially characterized by imports penetration.

- Productivity has, by far, been the most important negative effect on employment growth. However the intricate links between technological change and productivity would require considerable research to understand its impact on employment growth.

- There has been a trend towards technology-intensive industrial sectors, but the share of these sectors is still very small.

Since the 1980s, the Canadian government has been shifting its "...labour market policies away from job creation programs, regional development strategies, and aggregate demand stimulus towards the supply side of the labour market, notably training" (Leadbeater, Suschnigg: 1997, 1). This strategy has been implemented to reduce long-term unemployment and has contributed to legitimate the "...unemployment insurance system away from "passive" income maintenance to "active" training programs" (Leadbeater, Suschnigg: 1997,1). This type of adjustment policy, where training is the principal focus, is nonetheless limited and questionable in the new global context where numerous regional disparities exist in Canada and where labour market conditions for highly skilled workers are not considerably attractive. Policies should encourage a *high-skill path* throughout the economy, combined with policies oriented towards the acquisition of threshold skills. As was exposed on the basis of Gera and Massé's research, this is the low level of labour productivity which accounted for the most adverse effect in employment growth, even more than imports penetration. As stated by Gunderson.

> The associated productivity improvements results in a workforce that is better equipped to deal with the continuous competitive challenges. Productivity is a key to viable employment growth, and if competitive pressures from trade enhance domestic productivity growth, then that should be regarded as enhancing employability in the long run, rather than being labour displacing (Gunderson: 1997).

There are adjustment consequences on the supply and demand side of the labour market following the displacement of occupations induced by trade or by any other source of change. However, compensation in the short-term for low-skilled workers should not prevent the dynamic adjustment of the labour market to the new reality. As emphasized by Gunderson, (...) if there is one thing we have learned from recent labour market developments, it is that there is not a fixed number of jobs (...) and the labour market is constantly and dynamically adjusting (Gunderson: 1997). However, that is not to say that the free market is working properly where high-skilled workers and, especially, science and technology specialists are concerned. The OECD has been quite clear on this point.

> It is generally recognized that market forces alone cannot in all cases be relied upon to secure an efficient allocation of resources to the development of technology: There are cases of market failure (OECD: 1991, 23).

Therefore, the "high skill path" which we believe to be the right strategy for Canada will require adjustment, not only on the supply side, but on the demand side as well. The focus of the following policy discussion will be divided into three axis: macroeconomic policies, trade and FDI policies and, finally, science and technology policies.

7.1 Macroeconomic policies

Many factors have transformed the Canadian employment situation, but the magnitude of these factors is difficult to assess. While factors such as inadequate training opportunities and freer trade might be a plausible explanation for rising wage inequality and job losses given the duty-free entry of products from low-wage countries, these are not sufficient to explain the trends over just a few years (Schwanen: 1997). Major macroeconomic shocks have taken place during these two decades and their interdependence with other factors such as technological change and international trade is certainly not negligible. For example, the two oil-price shocks with their consequences on inflation and real incomes in the industrialized world are cases in point.

The impact of the present acceleration of the Canadian currency devaluation on Canada's trade flows and, therefore, on employment growth, is one amongst other macroeconomic factors which is worth illustrating in the context of the present study. In some ways, this devaluation is good news given Canada, having a small domestic market, needs to sell abroad and, considering the current value of its currency, has improved its cost position. On the other hand, as Canada is a strong importer of technologies, the cost of the latter has increased and, consequently, firms will not buy or will considerably reduce the purchase of these technologies with adverse consequences for productivity and employment growth.

More generally, macroeconomic policies imply a better cooperation between the federal and provincial government in terms of establishing more open and balanced fiscal and monetary policies which inevitably will influence productivity growth and competitiveness. This aspect of macroeconomic policies is important to keep in mind as they affect trade and competitiveness but would require a deep and complete analysis *per se*, which is impossible to do in this paper.

7.2 Policies towards trade and competitiveness

It is rather difficult to distinguish the impact of trade and technological change from other factors simultaneously affecting the labour market and, more specifically, the upgrading dynamics in Canada. However, in Gera and Massé's study, the findings are clear showing that exports are an important source of employment growth, and this is strikingly true in the science-based industrial sectors. In other words, the Canadian labour force is increasingly dependent on exports for job creation.

According to Mishel and Teixeira (1991), one of the main mistakes to avoid in implementing a competitive strategy is to get a "labor shortage view".

> This means no attention to our trade and competitiveness problems and the need for reorganizing work to achieve a high performance production system. Or, in other words, the labor shortage view leads policymakers to focus only on the problems with education and training and not on the types of jobs created by the economy or how employers structure work (Mishel, Teixeira: 1991, 5).

This is especially worrying in Canada. On the basis of numerous studies whose results have been reviewed in this paper, we have seen that the Canadian employment system is shifting towards high-skilled workers. While the competition from developing countries seems threatening for Canada in terms of employment-displacing effects, a much more considerable threat comes from the competition of the United States, as its main trading partner, and other developed countries in terms of employment cost and quality of high-skilled workers. The danger would be to adopt measures

which could slow down the process of skill upgrading and prevent Canada from competing with the United States and other developed countries in terms of technological change, exchange rate, and so on.

In other words, it is probably not indicated for Canada to specialize in sectors which were traditionally important comparative advantages such as natural resources for the sake of protecting jobs of low-skilled workers. Value-added products should be developed and, as was specified above, the main danger Canada is facing is to produce goods which are not in demand. Trade, as much continental as international, should obviously be encouraged as long as Canada shifts its production towards value-added.

Does the important exports impact on employment found in Gera and Massé's study reflect the recent agreements on continental trade? This is doubtful since the trends were there before the implementation of these agreements.

In terms of imports expansion, it becomes clear that Canada should not attempt to compete against cheaper labour costs countries even if this competition has had relative important adverse effects for low-skilled employment growth, but should rather compete against high-skilled endowed countries. In fact, if low cost countries are a threat for employment performance in Canada in the short-term, the real challenge will be to make Canada competitive with the United States and other industrialized countries in terms of high skills, which is the only way to ensure economic growth, and thus, higher living standards. This implies that instead of raising trade barriers between countries, trade expansion must be fostered but, at the same time, Canada will have to pay special attention to enhancing its technological capability since trade expansion *per se* is certainly not sufficient to develop a "high-skill path"; investments in technological change are fundamental and the Canadian economy seems to lag behind.

Trade and FDI: Fostering Competition

Beyond the complementarity and substitution role of FDI with trade, their presence allows a stronger competition between domestic and foreign firms to respond to the adjustment pressures especially in terms of technological change and associated new skills[18]. Also, as seen above, R&D financed by foreign firms is especially important in Canada (see Table 6). Moreover, the presence of FDI forces firms to adjust to the pressures of the competition induced by globalization. Therefore, opening up continental and external markets should stimulate a more aggressive investment strategy in order to capture potential economies of scale and encourage the "high-skill path".

Besides, the Canadian screening process of foreign investment should take into account the technology content of investments, instead of relying on cultural sovereignty considerations. In other words, FDI is an important way to transfer technology and develop skills as long as foreign investment has a high-technology content (Corvari, Lavoie, Pestieau: 1993). On the other hand, these investments are likely to produce important linkage effects in other sectors of the economy.

7.3 Science and technology policies

One significant factor contributing to the poor Canadian production performance over the past two decades is certainly what has been documented as being the "innovation gap". Technological change is certainly not sufficient to propel the economy into a knowledge-based model but this is a "starting point" to improve productivity whose increase has been especially weak over the last two decades, with an average of only .3 percent per year from 1974 to 1993. Productivity gains are low in Canada, increasingly more compared to any other industrialized countries. While the causes have

[18] There is still considerable controversy about the employment effects of FDI. One important issue is the extent of the substitution of direct investment abroad for domestic investment as well as the impact of FDI on the stimulation of intermediate goods exports and capital goods (Baldwin: 1994, 44).

been extensively studied, there has been no consensus reached. This can reflect the low level of investment in technological change as well as the higher cost of manufacturing technologies than in the United States.

Science and technology policies should, therefore, go hand in hand with trade policies. These policies are strongly complementary as the effects of these two factors are tightly interrelated. Beyond the traditional policy recommendations about the importance of R&D investment, the diffusion of information technologies and so on, there are two important related goals which should be fostered in a context of a "high-skill path" strategy; they are, i) improving the demand conditions of a science and technology career and, thus, 2) increasing the important role of government in the funding of fundamental research.

Encouraging and Stimulating a Science and Technology Career in Canada

The persistence of the Canadian government to control the deficit and restrain expenditure have strongly affected the universities' expansion as well as the level of enrollment of young people. If universities do not recruit new professors, the curricula may be not keeping up with the new industrial reality especially in science and technology (Lavoie, Finnie: 1997).

While it is conventional wisdom to see the new economy oriented to a science base and while technology is, as many analysts describe, increasingly science related, the findings of some of our studies in Canada do not reflect these phenomena. As was mentioned above, other occupations have not replaced science occupations, engineering and management occupations have replaced some others. On the basis of another study (Lavoie, Finnie: 1997), it is revealed that recent science graduates do not have an especially rewarding career and are quite dissatisfied with many aspects of the labour market conditions. Besides, this group of graduates ranks last in terms of satisfaction amongst the whole category of knowledge workers. Nonetheless, the assessment of the science career is probably only the tip of the iceberg, and to follow a "high-skill path", the career in science should not only be encouraged from a strict supply perspective as is occurring presently, but the demand side should be considerably improved by providing favourable labour market conditions. This must go through investing money in fundamental research as will be seen below in order to prevent a massive brain drain to the United States.

Government Support of Fundamental Research

Traditional market failure arguments are still dominating in what concerns the role of government in the fundamental research investment. Sources of market failure can prevent an adequate level of investment in basic research and, thereby, lead to the underevaluation, underemployment and general underutilisation of science and technology graduates. The poor market conditions which are facing some recent graduates in Canada are also closely connected to the situation of governments which try to reduce deficits and, therefore, impose spending cuts especially in fundamental research. In this context, there has been a resurgence against the public funding of basic science[19].

Obviously, to fill the innovation gap in Canada would require more than providing incentives for firms to adopt advanced manufacturing technologies or to invest in research and development or even in fundamental research. Building a strong science and technology capacity also requires better labour market conditions for these high skilled workers. Instead of borrowing a "reactive" strategy to respond to jobs already existing or expected, an "active" strategy aiming at favouring a "high-skill path" for Canada is urgently required.

[19] To know more about this debate, the reader should consult the following studies: (Kelley: 1996, Pavitt: 1997, David: 1997)

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