The Bottom Line

Technology, Trade, and Income Growth

Economic Council
of Canada
1983

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ECONOMIC COUNCIL OF CANADA

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Contents

This report reflects the views of the Members of the Economic Council of Canada, subject to dissents on the part of Messrs. Lortie and Hickey and a comment by Mr. Kaplansky, which has been endorsed by Mrs. Goldenberg and Mr. Dalpé. Dissents and comments appear in full after Chapter 10.

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READER'S NOTE

Throughout this report, financial data pertaining to public agencies and programs are for fiscal years ending March 31st or the nearest year-end date.

The reader should note that various conventional symbols similar to those used by Statistics Canada have been used in the tables:

-- amount too small to be expressed
. . figures not available
. . . figures not appropriate or not applicable
- nil or zero
e estimated figures
x data confidential, to meet the secrecy requirements of the Statistics Act.

Details may not add up to totals because of rounding.

Part A

The Problem

1 Introduction

In the last decade, Canada has encountered ferocious economic problems. Unemployment has soared to levels unprecedented since the Great Depression. Inflation has leapt to heights never before experienced outside wartime. And productivity growth has sunk to a rate so low that it has no historical parallel at all.

At the time of writing, one of these problems is fading: inflation is coming down. The other two persist, however, and they pose a threat to both the level and the future growth of the living standards of Canadians. High unemployment rates have been with us for several years now, and in a report published last year, this Council presented new evidence leading to a clearer understanding of this and other problems related to the labour market.[1] The present report deals with the threat posed by the productivity slowdown with respect to future growth in living standards and with the potential contribution that increased trade can make to such growth.

The fact that we tackle the productivity problem at this time does not mean that we consider it to be more important than unemployment or than other issues, such as ensuring that income distribution is equitable. Indeed we have, in many of our previous reports, dealt with these questions and made recommendations intended to resolve them. Nevertheless, the productivity problem is a very serious one in its own right, and our analysis shows that much could be done to relieve it without unduly prejudicing other important economic objectives.

The Threat to Growth in Living Standards

The decline in the rate of productivity growth in the recent past has been dramatic. Between 1950 and 1973, productivity – measured here quite conventionally as real gross national product per person employed – rose at what was, for Canada, a historically handsome rate of 2.6 per cent annually. But from 1973 to 1981, the average rate of productivity growth was zero. In three of those years, GNP per person employed actually fell. Should productivity growth persist at zero for very long, growth in living standards – that is, in real GNP per capita, or real income – could also become zero or even negative.

Although the full ramifications of long-term zero growth in living standards are not yet known, some of the potential consequences are only too clear. In a world of zero growth, wage and salary gains would, on average, always be eroded by subsequent increases in the general price level. If real wages and salaries rose, they could only do so at the expense of profits and dividends, and only for a short time. Any increase granted to some groups, however desirable, would only lead to a decrease for others. For example, if old-age pensioners needed to rely more on the available public funds or if changing dependency ratios meant that there would be more pensioners around, other groups would perforce get less; if investment rose, then current consumption would have to fall; if more were spent on health care, less would be available to spend on other goods and services; any additional allocations to foreign aid would be at the expense of living standards within the country; and so on. In the past, many desirable redistributional changes could be accommodated, in part or in whole, by the "dividend" that accompanied economic growth. But with no growth in average living standards, this approach would no longer be possible; redistribution of any kind would be much harder to achieve; conflicts between old and young, rich and poor, workers and employers, federal and provincial governments, private and public employees, and many others, would inevitably worsen.

With an average productivity growth of zero over the past eight years, growth in real GNP per capita has dropped to half of its previous postwar average. Thus a cessation of productivity growth need not stop improvement in living standards entirely; nor has the present one done so yet. The main reason why zero productivity growth has only slowed, rather than halted, growth in living standards so far is that the proportion of the population at work has been rising,

under the combined influence of an increasing participation rate and a declining dependency rate. A secondary reason is that Canada has continued to benefit from a growing volume of foreign trade. The productivity slowdown has nevertheless lowered growth in living standards to about half what Canadians have been used to in the past. How long this partial accommodation of the problem can go on through increases in the working proportion of the population and through trade is an open question. With aging of the population expected to occur in the future, it may well be that the average participation rate will eventually begin to contract, even if the proportion of women below retirement age who choose to work should keep on rising. Demographic changes may also eliminate the favourable movement in the dependency ratio. As for trade expansion opportunities, they are inherently limited by the level obtained when trade is free.

In dealing with productivity growth, we must dispose of three important misconceptions. First, the evidence shows that lack of worker effort does not play a significant part in the productivity slowdown and that many other factors are involved. Be they blue- or white-collar, workers cannot be made the scapegoats for this problem. Second, it seems very unlikely – but possible nonetheless – that faulty measurement by statisticians is misleading us into thinking that there is a problem where none exists. Third, the problem is one of vanished *growth*, not of a declining *level*, of productivity. Despite zero growth, the level of productivity is only 3 per cent below its all-time high, reached in 1978.

Real income growth, however, depends on more than productivity growth alone, significant though that may be. Growth in trade also plays an important role. The potential for trade to generate future growth in living standards and the difficulties involved in achieving that objective are also considered in the report. Although some of Canada's past growth in living standards resulted from increasing international specialization and trade, this process could give rise to two important problems that warrant careful examination. First, with a greater commitment to international trading comes the risk of creating an industrial structure that is too heavily biased towards natural resources and in which manufacturing plays too small a role. That could leave Canada vulnerable in the future to changes in resource prices and availability, and it could also yield an undesirable pattern of occupational employment opportunities. Second, adjustment problems usually occur as trade increases. Workers in certain industries may lose their jobs, and firms may have to close down. New jobs and new firms have to be created elsewhere. In the present climate of deep recession, this could be a serious matter.

Policies and Problems

It is one thing to point to the seriousness of the threat to living standard growth; devising remedies that do not have serious side effects is quite another matter. Any increase in productivity means, by definition, that less work is needed to produce the same output. If total output does not rise, some people are thrown out of work. Some believe – erroneously, in our view – that, as a result, a conflict between policies aimed at living standard growth and those designed to achieve full employment may develop. Another difficulty is that policies intended to increase average productivity and average living standards could quite easily change the distribution of income in undesirable ways. These examples show that policies to generate growth in living standards – that is, in average real incomes per capita or per family – must be designed so as not to create negative side effects that would more than offset the benefits to be gained.

Policies that can improve living standards without sacrificing other goals *in any way* are practically impossible to achieve; trade-offs have to be made in most cases. Policies that can improve living standards *without undue cost*, on the other hand, are easier to devise. An in-depth discussion of trade-offs among various economic goals, such as full employment, rapid growth, equitable income distribution, and control of inflation, would be beyond the scope of this report, as our main theme here is to find policies with the potential to raise real income per capita. This Council has discussed goals and policy means many times before, at considerable length. Our general approach is well known. One important point needs to be made, however, concerning fears about the impact of productivity improvement on the availability of jobs.

Improving productivity will necessarily destroy jobs if total output remains unchanged; thus the real question is whether total output will be unchanged. Should it rise, few (if any) jobs will be lost. In the majority of real-life instances of productivity improvement, output rises by roughly the amount needed to avoid job loss. Good evidence to support this proposition comes from historical experience. Productivity levels have more than doubled since the Second World War. If output had remained unchanged, the number of jobs would have been halved. Since total output has more than doubled, employment has risen rather than fallen. Indeed, it has risen a great deal. Other evidence is provided by analysing the process of aggregate demand and job creation itself: an

increase in productivity makes it possible for aggregate demand to rise and stimulate job creation without any acceleration of the inflation rate. An increase in aggregate demand can come about, either through an increase in consumption made possible by the higher wages and profits resulting from productivity improvement, through government policy, or through a combination of both.

Lest we be misunderstood, we must stress that we do not, in Pollyanna fashion, think that productivity improvements never cause job loss. They certainly do, at least for a while – when workers who are displaced seek new jobs, for example – and sometimes the loss is permanent, if the displaced workers have redundant skills and cannot retrain. Therefore, any job loss implications stemming from policies aimed at improving productivity must always be carefully considered in the actual application of such policies. Nevertheless, the weight of the evidence shows that it is possible to improve productivity and, consequently, living standards without unduly prejudicing achievement of the goal of a low unemployment rate.

Reconciling the goal of productivity improvement with other goals is not the only problem encountered in seeking suitable policies for stimulating real income growth. There is also the problem of diagnosing the causes of the productivity slowdown itself. Only some causes are known at present; others are difficult to measure precisely, if not downright mysterious. Before the recent slowdown, work by this Council had explained some of the sources of productivity growth in Canada up until that time, although, even then, a fairly substantial unexplained "residual" remained. A good portion of past productivity growth was shown to have resulted from a combination of physical capital accumulation and improvements in the quality of capital and in the quality of manpower through education and training. A number of other factors played useful supporting roles: growing scale economies, increasing specialization, and the like. Changes in these previously identified growth forces, however, explain only a small part of the present slowdown.

The Scope of Our Report

The difficulty in explaining the slowdown became apparent three years ago, when we began to analyse the productivity problem further by delving more deeply into the microeconomic underpinnings of growth, while continuing our examination of the macroeconomic forces also in play. Our work has now progressed far enough in one area that is a key element in understanding productivity growth – namely, technical advance – to warrant a report at this time, even though a comprehensive treatment of the productivity slowdown as a whole is still beyond reach. At a later time we plan to produce a second report on other aspects of productivity.

Since a lot of Canada's productivity growth used to come from technical advance, measures to restore it or speed it up where it still exists could restore some of the ground lost. Accordingly, we examine closely what might be done in this area. We present a considerable amount of new evidence, much of it in areas that have been badly neglected until now. Although research and development activity is a very important factor, we do not consider it alone, but rather we examine the whole process of technical advance, including that which arises during the normal course of doing business, even without any applied R & D. This also includes the important processes of diffusion and adaptation of new techniques, however they originate. And we cast our net widely across industries, looking at services as well as goods-producing industries and at the nonmarket sector as well as the market sector.

Because trade plays an important role in living standard growth, we have incorporated into this report new material derived from research in that area recently undertaken at the Council. We examine the problems of industrial structure and adjustment that are created by increased trade, as well as additional evidence on the income and efficiency advantages that could derive from greater trade. The objective is to discover whether, in order to compensate for the productivity slowdown, the need for income growth justifies maintaining the present plans to liberalize trade over the next few years, and perhaps even extending them in due time, or whether the resulting problems of a changing industrial structure and the need for workers and firms to adjust are simply too great. Therefore, we focus on recent experience with the repercussions of increased trade and on the lessons to be drawn with respect to the appropriate role of trade as a possible "auxiliary engine" of real income growth in the future.

One important way to raise real living standards should be pointed out here, even though we have not studied it in this report. Moving an economy closer to its full productive capability and decreasing the underemployment of labour and capital equipment will always yield growth in output per person employed. Economic activities are typically more efficient when they are close to, though not at, full capacity than during recessions, when capital equipment is underutilized. Quite clearly, Canada's highly unsatisfactory level of total output at present has reduced the country's productive efficiency. In our Nineteenth Annual Review, we discussed the current

situation in considerable detail and recommended some steps that could contribute to recovery; however, we ruled out strong use of monetary and fiscal policy stimulus at that time because of the risk that such action might spark inflationary pressures anew.[2] Indeed, the limitations of aggregate demand policies in dealing with inflation provide part of the rationale for the type of policies proposed in this report.

Accelerating the pace of technical advance and taking advantage of trading opportunities are not the only ways to cope with the problems posed by the slowdown in productivity and income growth. Note, also, that these two orientations need not be viewed as alternatives to each other. It may well be that technological advances will create both the possibility and the necessity of increased specialization and trade. Other potential areas for policy action aimed at facilitating income growth would include: greater and/or more effective use of human capital formation; modifications to the quantity and quality of physical investment, notably for social purposes; changes in regulation policies; efforts to improve the functioning of the price system; and a more detailed investigation than has been done in this report of how to improve productivity in the public sector. In earlier reports, we examined some of these possibilities with respect to regulation and the financial markets. Other possibilities will be explored in our second report on productivity.

The remainder of our report is set out as follows. In Chapter 2 we examine the facts pertaining to the productivity slowdown in detail, as well as what is known about the sources of growth in per capita income and productivity. We show that technical advance and trade are potentially fruitful areas for the investigation of ways to restore some growth in productivity and hence in living standards.

Part B of the present volume is devoted to technical advance. In Chapter 3 we examine how and why technical advance occurs; in Chapters 4 and 5 we look in detail at the generation, adaptation, and diffusion of new ideas and techniques, new products, and new processes. These chapters provide some background as to what is, or is not, important to the efficient operation of these processes. In Chapter 6 we study closely the actual operation of five important programs that are presently in place to assist technical advance. In Chapter 7 we draw upon the material already examined to make a number of recommendations on how the process of technical advance can be speeded up.

In Part C, we look at policy making in the area of international trade. In Chapters 8 and 9 we discuss how and why policy in this area might affect growth in productivity and real incomes, and we review some of the structural and adjustment problems that might be involved; evidence is presented to assist in deciding what policy approach towards international trade would be the most beneficial at this time, in light of the urgency of the income growth problem. We conclude, in Chapter 10, with recommendations on trade policy.

2 The Search for Solutions

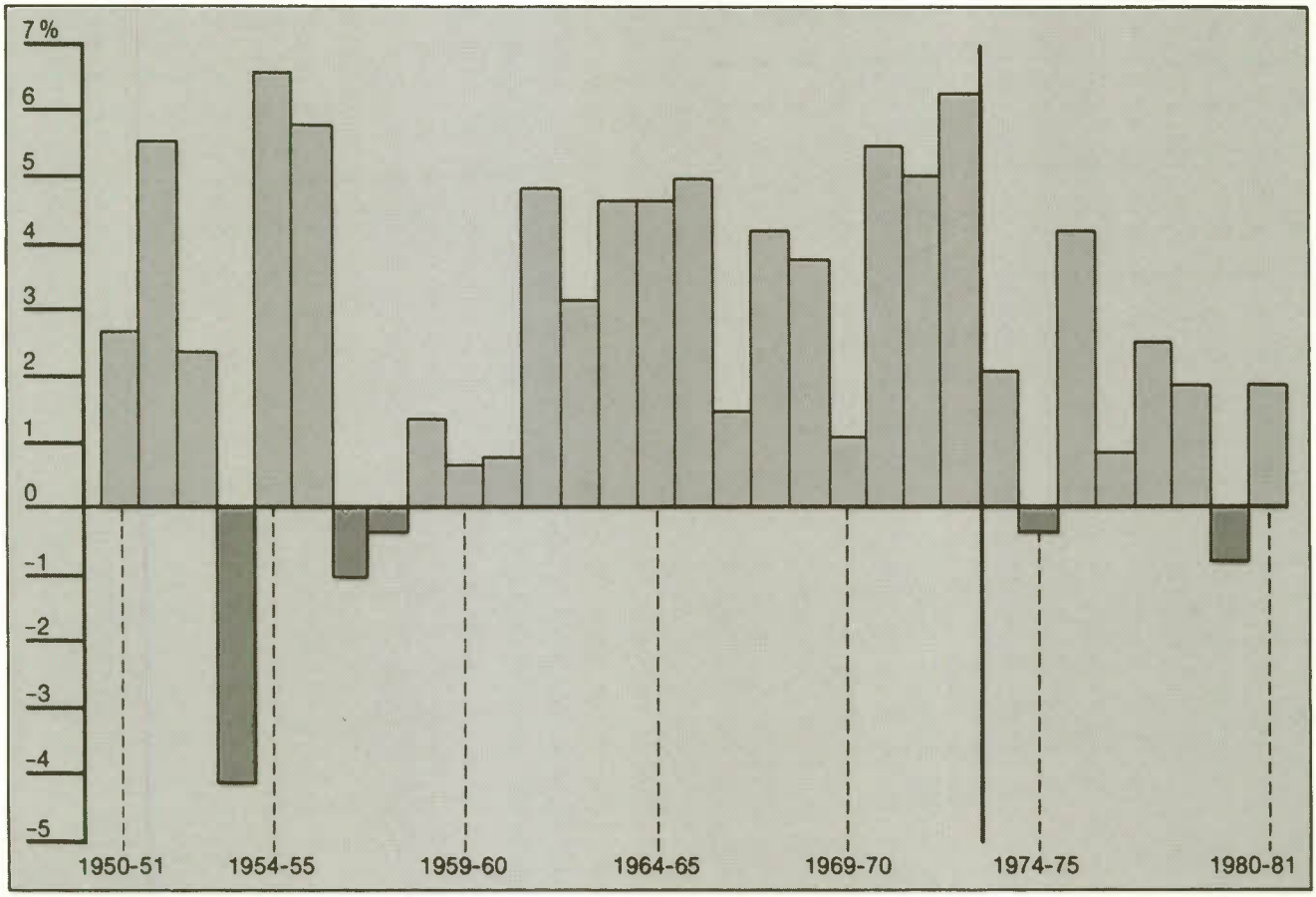
Finding a cure for the current slow growth in living standards is urgent, but it will be far from easy. Because the slowdown in productivity growth is what creates the threat to income growth, it must be investigated in depth. Our analysis of the slowdown, in the pages that follow, contains some of the seeds of the solution. By drawing upon the theory of income growth and combining theoretical considerations with the evidence, we are able to develop an approach to tackle the slowdown problem.

The Facts

Growth in living standards, as measured by the annual rate of increase in constant-dollar GNP per capita, has dropped considerably over the past eight years (Chart 2-1). This is confirmed by comparing the average rate of 1.5 per cent between 1973-74 and 1980-81 with the average of 3.0 per cent recorded from 1950-51 to 1972-73: growth was cut in half between the two periods.

Chart 2-1

Annual Change in Real GNP per Capita, Canada, 1950-51 to 1980-81



SOURCE Estimates by the Economic Council of Canada, based on data from Statistics Canada.

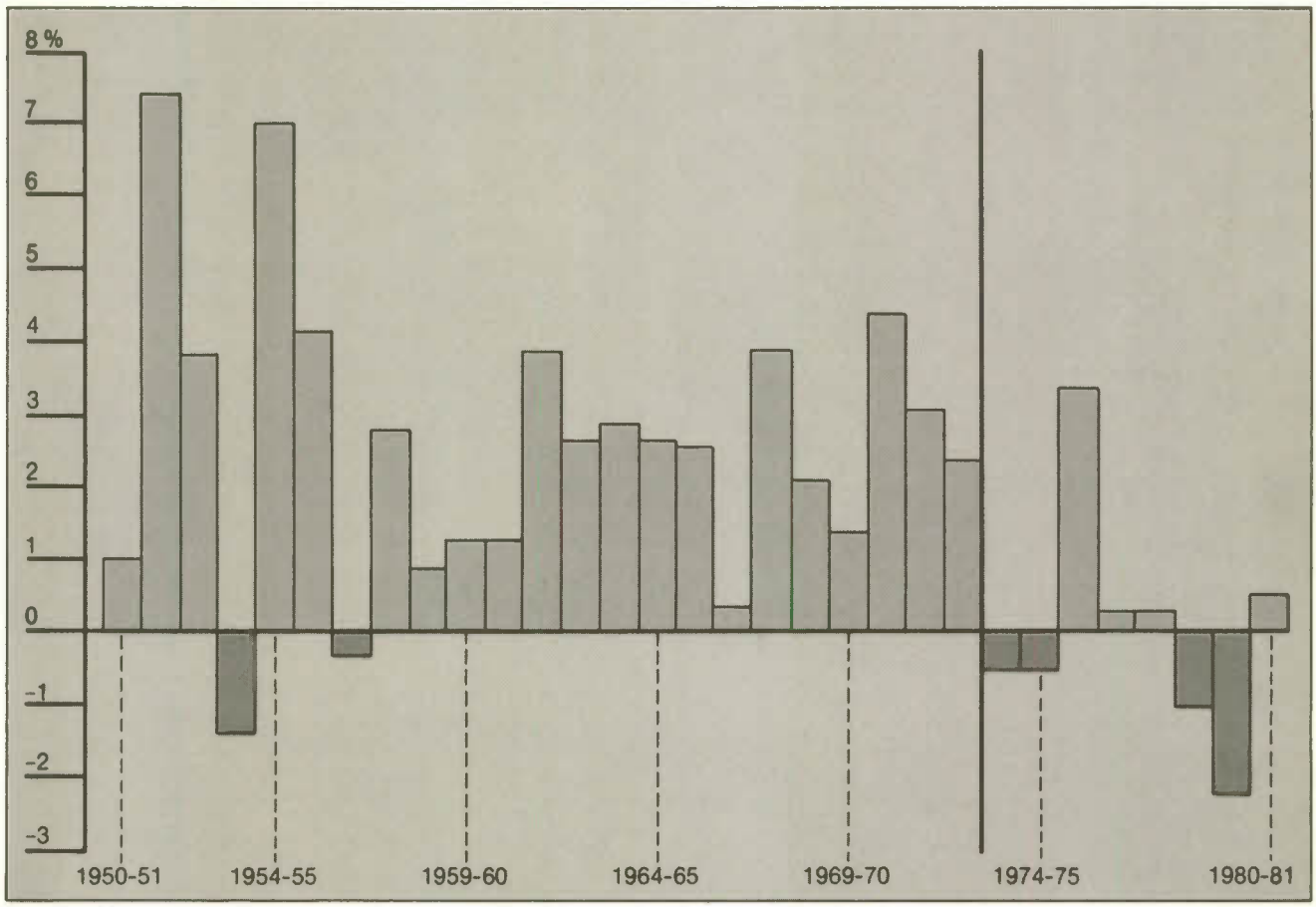
Growth in productivity, as measured by the annual rate of increase in constant-dollar GNP per person employed, fared even worse. After a handsome average of 2.6 per cent from 1950-51 to 1972-73, productivity growth dropped to zero from 1973-74 to 1980-81 (Chart 2-2). There was one good year (1975-76) during the latter period, one very bad year of negative growth (1979-80), and six years of stagnation. The contrast with the previous two decades is startling; then, strong growth was typical, not the exception.

The slowdown has no precedent in the postwar period. The nearest parallel is with the deeply recessionary period from 1956 to 1961, during which growth in living standards was essentially zero (0.04 per cent annually); productivity growth, however, while low by the standards of earlier and later years, was still a respectable 1.2 per cent per annum. The present recessionary period reverses this picture: living standards have advanced somewhat, whereas productivity has remained stationary. For the longer term, the latter problem is probably the more serious, since it seems less likely to be fully resolved by recovery from the current recession.

The productivity slowdown has been pervasive, being evident in most industries. The data for commercial industries, which make up about four-fifths of GNP, permit more accurate and up-to-date measurement than do those for GNP as a whole. In terms of output per person employed, the rate of productivity growth for all commercial industries averaged 3.5 per cent annually from 1960-61 to 1972-73; it then dropped sharply, to only 0.2 per cent from 1973-74 to 1981-82 (Table 2-1). The results in Table 2-1 reveal a pattern that is quite similar to that seen in Chart 2-2. More significantly, they show that the four component industrial classifications exhibited a very similar pattern of productivity behaviour as well. The

Chart 2-2

Annual Change in GNP per Person Employed, Canada, 1950-51 to 1980-81



SOURCE Estimates by the Economic Council of Canada, based on data from Statistics Canada.

productivity growth rate fell to two-fifths of its previous level in agriculture and to less than one-seventh in manufacturing; it was actually negative in services and in "other production" industries.

Table 2-1

Growth in Output per Person Employed,[1] Selected Sectors, Canada, 1961-82

	All commercial industries	Agriculture	Manufacturing	Other production industries	Services
			(Per cent)		
1961-73	3.5	6.4	4.5	3.2	2.0
1973-82	0.2	2.7	0.6	-0.2	-0.1

1 Average annual rates.
SOURCE Statistics Canada, *Aggregate Productivity Measures, 1946-81*, Cat. 14-201 (Ottawa: November 1982), and *Daily Bulletin* (April 11, 1983).

Output per person-hour worked measures more accurately than output per person employed the amount of output produced per unit of labour.[1] The general levels of productivity growth rates provided by this second indicator (Table 2-2) are higher than those seen above, reflecting a decline in the annual number of hours worked per employee and an increase in leisure time, on average, over the same time periods. But a similar pattern of productivity growth prevails, and our perception of the severity and pervasiveness of the problem is reinforced by these figures. A broader historical view of the situation makes this even more evident: Canadian output per person-hour in all commercial industries experienced an average annual growth rate of 3.9 per cent over the whole postwar period (1946-80). Between 1973-74 and 1981-82, however, the average was only 0.9 per cent.

Table 2-2

Growth in Output per Person-Hour Worked,[1] Selected Sectors, Canada, 1961-82

	All commercial industries	Agriculture	Manufacturing	Other production industries	Services
			(Per cent)		
1961-73	4.2	6.9	4.6	3.5	2.8
1973-82	0.9	3.8	1.0	-0.6	0.7

1 Average annual rates.
SOURCE Statistics Canada, *Aggregate Productivity Measures*, and *Daily Bulletin*.

Canada is not alone in facing this problem. It is very important to realize that fact, especially when exploring the possible causes of the slowdown. All of the major OECD nations experienced a significant slowdown in productivity growth over the period 1973-80 (Table 2-3). The U.S. annual growth rate, starting from a much lower figure than Canada's, fell to only 0.5 per cent. Substantial productivity growth persisted in the United Kingdom, West Germany, France, Italy, and Japan, but the rates were only about one-half of what they used to be.

Table 2-3

Growth in Output per Person Employed,[1] Major OECD Countries, 1960-80

	Canada	United States	United Kingdom	West Germany	France	Italy	Japan
				(Per cent)			
1960-73	4.2	2.8	3.6	4.7	5.7	5.7	9.0
1973-80	-0.2	0.5	1.7	2.9	3.2	2.1	4.7

1 Average annual rates.
SOURCE Organisation for Economic Co-operation and Development, *Economic Outlook* (Paris: OECD, December 1982), Table 17.

The slowdown in Canada's productivity growth was more severe than that of any of these countries. Too much should not be made of this finding, however, since the precise estimates of Canada's performance are sensitive to the choice of the base period (pre-1973) and to the revisions in GNP figures. Notwithstanding that fact, the basic message is not sensitive to statistical manipulations: the productivity growth slowdown is drastic and pervasive throughout the OECD.

At a more disaggregated level, each industry's productivity is defined as the gross domestic product at factor cost per person employed in the industry – a definition that is conceptually consistent with that used above (Table 2-1). A comparison of the productivity growth rates for 39 industries between the 1961-73 and 1973-78 periods reveals that the Canadian productivity slowdown, even in its initial stages, was widespread (Table 2-4). Productivity growth actually improved in some industries (such as services to mining and communications) during the 1973-78 period, but 26 industries experienced slower productivity growth. The slowdown was especially severe in agriculture, mining, rubber and plastics, primary metals, metal fabricating, nonmetallic products, transportation and storage, electric power and gas, and wholesale trade, most of which recorded negative growth.

Table 2-4

Traditional Total Labour Productivity Levels and Growth Rates, Selected Industries, Canada, 1961-78

	Output per person employed				
	Level			Growth[1]	
	1961	1973	1978	1961-73	1973-78
	(1971 dollars)			(Per cent)	
Agriculture	2,965	5,752	5,708	5.7	-0.2
Forestry	7,207	11,075	11,735	3.6	1.2
Fishing and hunting	8,351	6,296	7,145	-2.3	2.6
Metal mining	18,416	29,432	21,757	4.0	-5.9
Mineral fuels	24,651	66,706	23,639	8.6	-18.7
Nonmetal mining	10,649	21,644	17,427	6.1	-4.2
Services to mining	15,822	13,615	15,778	-1.2	3.0
Food and beverages	7,425	12,912	13,702	4.7	1.2
Tobacco products	13,168	18,918	21,800	3.1	2.9
Rubber and plastics	6,956	13,558	14,492	5.7	1.3
Leather	4,584	6,288	8,478	2.7	6.2
Textiles	5,226	10,668	13,465	6.1	4.8
Knitting mills	3,835	8,444	13,154	6.8	9.3
Clothing	5,027	6,309	8,452	1.9	6.0
Wood	6,615	8,702	9,923	2.3	2.7
Furniture and fixtures	5,797	8,967	8,944	3.7	-0.1
Paper and allied products	11,342	15,040	15,367	2.4	0.4
Printing and publishing	9,105	11,982	14,123	2.3	3.3
Primary metals	10,568	16,295	14,992	3.7	-1.7
Metal fabricating	7,951	12,784	12,784	4.0	--
Machinery	9,266	12,525	15,955	2.5	5.0
Transportation equipment	7,995	17,328	21,048	6.7	4.0
Electrical products	7,074	13,241	15,532	5.4	3.2
Nonmetallic mineral products	9,640	16,377	16,695	4.5	0.4
Petroleum and coal products	20,618	23,389	20,640	1.1	-2.5
Chemicals	9,363	17,710	20,207	5.5	2.7
Miscellaneous manufacturing	6,659	10,279	11,621	3.7	2.5
Construction	9,416	12,136	11,342	2.1	-1.3
Transportation and storage	7,774	14,649	13,496	5.4	-1.6
Communications	8,818	14,713	22,714	4.4	9.1
Electric power and gas	25,191	40,004	36,978	3.9	-1.6
Wholesale trade	8,579	12,457	11,606	3.2	-1.4
Retail trade	4,939	6,499	6,438	2.3	-0.2
Finance, insurance, and real estate	18,487	18,480	18,596	--	0.1
Education and health	18,006	21,818	20,778	1.6	-1.0
Amusement and recreation	7,120	6,701	9,433	-0.5	7.1
Services to business	11,190	10,981	10,272	-0.2	-1.3
Accommodation and food	8,682	6,772	7,167	-2.0	1.1
Other personal services	6,321	4,387	4,166	-3.0	-1.0

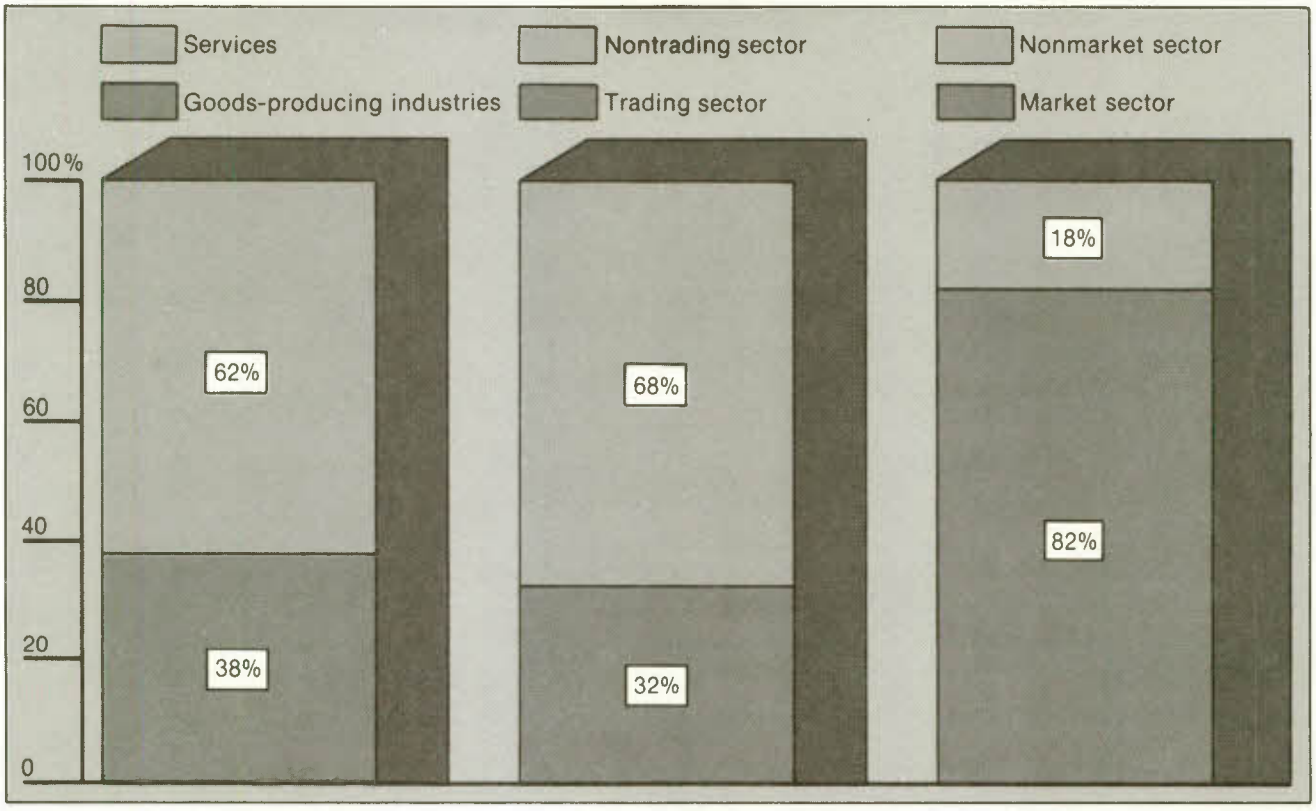
1 Average annual rates.

SOURCE H. H. Postner and L. Wesa, *Canadian Productivity Growth: An Alternative (Input-Output) Analysis*, Economic Council of Canada (forthcoming).

Perhaps the most important lesson to be drawn from the facts about the slowdown is that any solution must range across all industries. It is just as important to restore or speed up productivity growth in industries that supply services as in industries that supply goods, in industries that do not compete with foreign producers as in industries that do, and in industries that are outside the market system as in industries that belong to it. The force of these implications of the data cannot be fully appreciated without some further consideration of the relative importance of various industries in the Canadian economy (Chart 2-3).

Chart 2-3

Three Views of GDP at Factor Cost, Canada, 1980[1]



1 The nontrading sector includes services plus construction; the trading sector comprises the goods-producing industries minus construction. The nonmarket sector includes public administration and defence, education and related services, and health and welfare services.

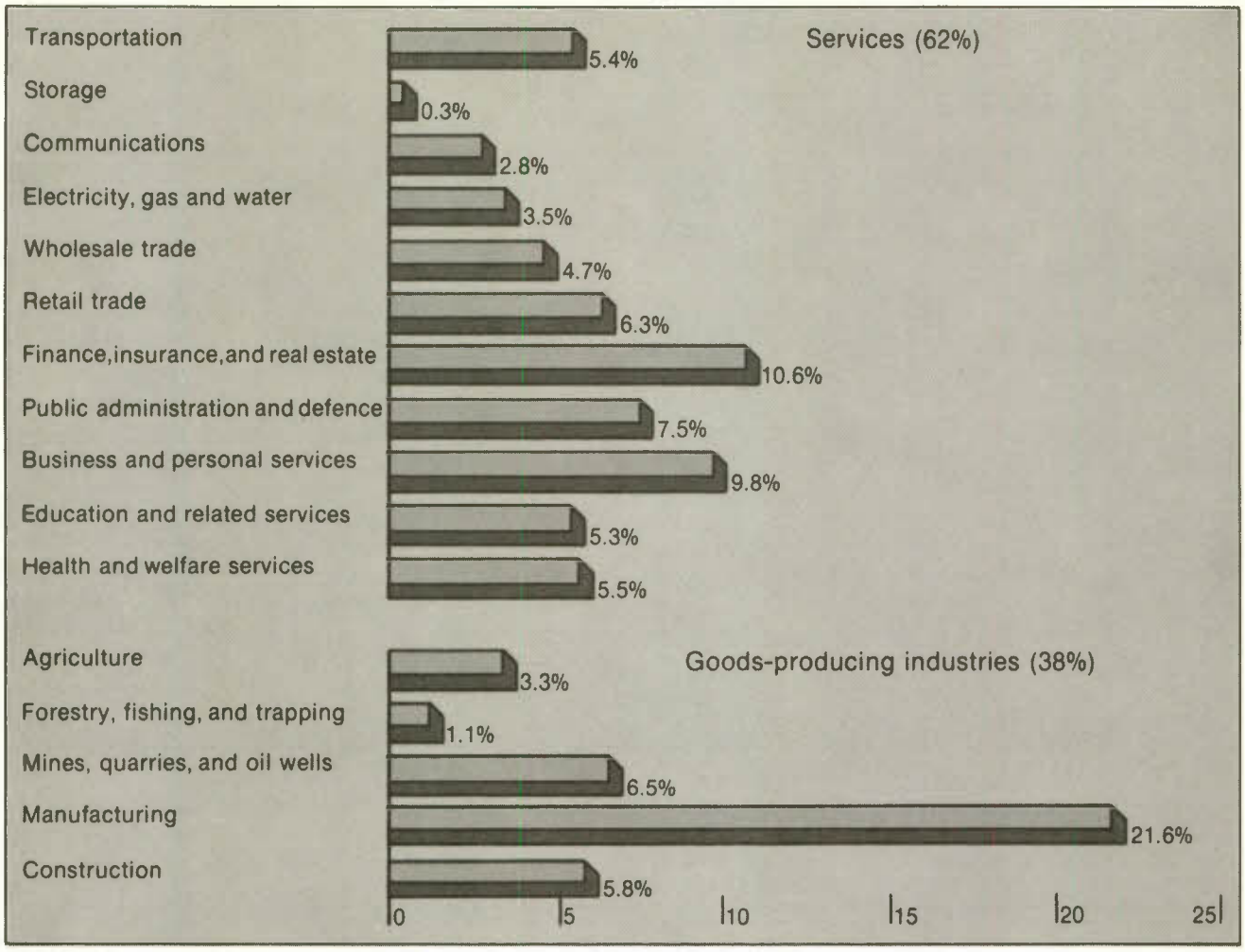
SOURCE Estimates by the Economic Council of Canada, based on data from Statistics Canada.

Industries that provide services – wholesale and retail trade; finance, insurance, and real estate; transport and communications; education; health care; and government administration, among others – are approximately half again as important for the gross domestic product as industries that produce goods (Chart 2-4). To maximize the chances of reversing the productivity slowdown, therefore, one should aim at improving productivity in all of these sectors. To focus entirely on goods production or, even more narrowly, on manufacturing alone would restrict the scope for productivity improvement far too much.

Foreign competition arises not only for exporters but also, whenever imports are significant, for producers supplying the domestic market. Industries facing little or no foreign competition are called nontrading industries. The division into trading and nontrading industries is close to, but not coincidental with, the previous division into goods and service industries. For example, while construction is a goods industry, it does not trade; parts of the finance, insurance, and real estate industry trade in services, but as this is not common the industry is included in the nontrading sector. As the second panel of Chart 2-3 shows, the trading part of the economy is only about one-third of the whole. Thus a focus on improving productivity growth in the trading industries alone – an objective that is often stressed in current discussions of Canada's competitiveness in world markets – would only risk missing very substantial opportunities to improve productivity growth in the nontrading industries, and thus growth in living standards as well.

Chart 2-4

Services and Goods-Producing Industries, as a Proportion of GDP at Factor Cost, 1980



SOURCE Estimates by the Economic Council of Canada, based on data from Statistics Canada.

Governments – the nonmarket sector – are involved in the provision of products and services free or almost free, the cost being met out of taxes. They are heavily involved in deciding how much of these products and services to supply, to whom they should be supplied, and how generously. We have included all of education in the nonmarket sector, despite the existence of some institutions that are partly financed by tuition fees; all of health care, because most services are nearly free to consumers, even though their producers often receive full payment for them; and government administration at the municipal, provincial, and federal levels. The nonmarket sector is large, being almost the same size as all of manufacturing. While we cannot be sure whether productivity growth has slowed down in this sector, because it is not well measured in current statistical practice, we can be sure that improving productivity in the nonmarket sector would contribute to growth in living standards. Ignoring that contribution would seriously constrain efforts to restore growth.

The international nature of the productivity slowdown should warn us against adopting too narrow a perspective in seeking both explanations and remedies. Any explanations that are potentially applicable to several countries are *ipso facto* more plausible than explanations that are Canada-specific. That is

not to say that the latter can never be important; only that the main source (or sources) of the problem seems likely to be the same for several countries. For example, a slowdown in technical change is a more plausible hypothesis for explaining the slowdown than unfavourable movements in natural resource prices. The former is not at all Canada-specific, but the latter is very much so. In seeking ways to improve productivity, therefore, success will be more probable if the focus is on factors with potential application to many countries.

In the same way, approaches that are not specific to any particular industry but are applicable across many industries are more likely to yield successful explanations and remedies. It goes without saying that an examination of industry detail is indispensable, but each industry should be looked at within a common approach rather than on an ad hoc basis.

The Forces of Growth

Growth in living standards can occur in four ways. First, real income per capita rises when an economy moves out of a period of recession into a period of full employment. Because more people who want to work are then able to, and because underutilized plant and equipment are used more fully, total production grows and, with it, production per capita and real income per capita. Second, real income per capita rises when the proportion of the population that is working increases as the result of higher labour force participation rates or of a rise in the proportion of people of working age. In this case, measured living standards rise, but there is some offset in terms of lost leisure and lost production within the home because more people are at work. Third, real per capita income can rise when greater advantage is taken of trading opportunities. The pattern of production is then shifted towards goods and services that can be sold abroad, permitting the purchase of imports. Even without extra trade, real income can rise if world prices for a country's exports rise or if world prices for its imports fall; real income can also decline if the opposite changes occur. Fourth, irrespective of any changes in the three factors mentioned previously, increased efficiency can lead to greater national output. Such an increase in efficiency is what we mean, in this report, by "greater productivity." Efficiency can be measured by output per person employed, although this is not the only possibility. Other indicators will be mentioned below, along with their implications.

The rate of growth of living standards since the Second World War has varied considerably as these four forces have varied in strength. Movements into recession have slowed down or reversed growth in per capita income from time to time, while movements out of recession have speeded it up. Labour force participation and the proportion of the population of working age have changed somewhat less erratically; their general effect has been to raise living standards quite strongly. The third factor – taking greater advantage of trading opportunities – has also made for steady and sustained growth in living standards, although to our knowledge no reliable estimates exist to indicate exactly how strong this influence has been. Finally, improved efficiency was a powerful and fairly steady force for increasing living standards until the early 1970s; since then, that influence has disappeared.

The last few years have been especially traumatic for real-income growth, because only two of the forces favourable to such growth – greater labour force participation and greater trade – have been in play. A protracted recessionary period in the past decade has slowed down growth in living standards, compounding the problem posed by the disappearance of the fourth force, growth in efficiency. The effects on productivity of the worst part of this recessionary period – i.e., the year 1982 and the early months of 1983 – could not be incorporated into the data for this report; however, it seems likely that they would reinforce our conclusions.

Until now, recessions and booms have alternated, so that little or no net contribution has been made by them to the long-run average rate of living standard growth. Because our concern in this report is with long-run trends, we do not examine the effect on living standards of swings in the business cycle. It goes without saying that we do not in any way underestimate the gravity of the current recession; indeed, we expressed our concern in several of our Annual Reviews in recent years. Nor shall we consider the influence of changes in labour force participation and in the proportion of people of working age, because we judge that the scope for significant improvement in growth in living standards by policy-induced alteration of participation or dependency rates is small. Thus our report focuses on the other two forces responsible for variation in the rate of growth of living standards: increasing productivity and increasing trade.

Increasing Productivity

Until the middle of this century, it was a commonly accepted notion among economists that the main driving force behind productivity growth was the accumulation of capital. The industrial revolution was seen by many as the consequence of a permanent upward shift in the proportion of national output that was saved and invested. At the end of the 1950s

some economists attempted to verify this belief by calculating the quantitative importance of capital accumulation for increasing productivity growth. These tests led to a surprising discovery: capital accumulation had accounted for only a very small portion of the observed historical growth in productivity. This result applied to the United States, but it has since been extended to other countries. The estimates suggested that only 10 to 20 per cent of past productivity growth could be accounted for by capital accumulation, with 80 to 90 per cent being an unexplained "residual."

These findings led in the 1960s to a new approach for explaining productivity growth – the "growth-accounting" framework, pioneered in the United States by Denison.[2] The growth-accounting framework uses the simple but fruitful idea that the total national production of goods and services per unit of time (the output) depends on the total quantities of labour and capital used (the inputs), on the quality of the inputs, and on the efficiency with which the inputs are used to produce output. This efficiency is often referred to as "total factor productivity." Production in any individual industry or firm is similarly dependent on inputs, input quality, and total factor productivity, the only difference being that purchases from other industries or other firms, such as materials and energy, which net out at the economywide level, must be included among the inputs for an individual industry or firm.

With output depending on inputs, productivity is readily defined in a general way as "output per unit of input."[3] If annual output is divided by the amount of labour input used each year, the resulting measure is called "labour productivity." Since inputs other than labour contribute to output, the productivity that is defined in terms of labour is, in fact, affected by the availability and quality of these other inputs, as well as by total factor productivity. Thus it is clear that the link between labour productivity and labour effort is weak. Effort is only one of many factors affecting productivity.

The discussion of measurement is important because it permits a fruitful approach to an explanation of labour productivity growth (and its recent cessation) and to an examination of ways to restore some of that growth and to improve growth in living standards.

First, what effect does growth in other inputs have on growth in labour productivity? Here is where the once important capital-accumulation approach comes in. At the national level, capital and land or natural resources are the only other inputs available, unless external borrowing or external aid permits other inputs (materials, for example) to be imported without being paid for by exports. A limited amount of past growth, as noted earlier, can be attributed to capital accumulation. Only a very small part is explained by growth in land or natural resources.

Second, has the quality of the inputs been improving, thus accounting for some of the growth? A lot of past growth can indeed be explained by changes in input quality, but there is no agreement on the precise amount of growth explained by this factor. Not only is it difficult to measure quality improvement, but there are arguments about whether the increased quality of an input (say, a machine) should be considered equivalent to an increase in its quantity. As far as labour is concerned, quality improvement occurs through education (both general and specific), through training, and through on-the-job experience. Much growth has been due to this form of investment in "human capital." Improvements in plant and equipment quality also permit more output to be obtained. At the industry or firm level, improved materials and new materials also play a significant role in raising productivity.

The increases in labour productivity that can be accounted for by greater quantities of complementary inputs (capital, materials, and energy) and by changes in input quality do not explain all of the productivity growth recorded before 1974. First, there still remains an unexplained residual, attributable by definition to changes in total factor productivity. The amount of growth to be explained by this residual is rather large, although estimates vary, depending on esoteric disputes about the measurement of input quality and other matters. It would not be unreasonable to put the amount in the order of half or more of the observed growth to 1974.[4] As a consequence, even in the 1960s and early 1970s, much useful consideration was given to how one might explain the residual – i.e., the increase in total factor productivity. Second, the cessation of productivity growth in Canada in recent years, its near cessation in the United States and the United Kingdom, and its significant slowdown everywhere else turn out to be mostly due to a mysterious drop in the rate of growth of total factor productivity. This has led to even more consideration and hypothesizing, of a potentially useful nature, about how to explain the influence of total factor productivity. In Canada, for example, only about 40 per cent of the slowdown since 1972 can be explained by factors other than the change in total factor productivity – mostly by the occurrence of a protracted recessionary period.[5] The remaining 60 per cent is cessation of growth, as yet unexplained, in total factor productivity. Similar conclusions hold for the United States.

Determinants of
Total Factor Productivity Growth

Thus, if one stays within the growth-accounting framework, an explanation of the slowdown (and remedies for it) must be sought largely through consideration of the underlying determinants of total factor productivity. Other approaches are possible and could be complementary – e.g., the attempt to determine whether better measurement techniques would show that much of the productivity slowdown is illusory or whether undetected changes in input quality are important. Yet it seems likely that changes in total factor productivity, as defined above, will be a key element. Upon what, then, do changes in total factor productivity depend?

Technical Change — Technical change includes new processes, techniques, products, and ways of organizing productive activities, and it is pervasive across all industries. Some of these innovations are made possible by the spending of funds specifically intended for what might be referred to as "applied R & D." Others are the fruit of the ideas of individual inventors. Yet others, and possibly the majority – though the evidence on this point is not conclusive – arise as ideas and incremental advances in the normal day-to-day course of running a business or a public service.

One needs to think only of such innovations as containerization, communications satellites, organ transplants, word processors, and so on to realize that technical advance must be a major source of total factor productivity growth. No one knows its quantitative contribution (is it 20 per cent? 30 per cent? or 60 per cent?), but there can be no doubt about its significance, both in explaining the recent slowdown in total factor productivity growth and in discovering remedies for that slowdown.

Economies of Scale — Another source of total factor productivity growth lies in the increasing advantages to be derived from economies of scale – when trade barriers fall gradually and provide access to larger markets, for example. The term "scale economies" has come to include not only individual-plant economies but also product-specialization economies within the firm, economies of market size, and even economies of scale in research and development and in marketing. The general idea is that "bigger" is "better" and more efficient, since large scale avoids underutilization of the resources required and, at the same time, captures the benefits of a greater division of labour and capital within and among firms.

Most empirical estimates of economies of scale are limited to plant economies in manufacturing industries, which may well be important when new opportunities for international trade are created. A few studies have also suggested that short production runs and excessive crowding of products in a single plant lead to higher costs and that trade liberalization could well reduce the importance of this problem.[6] It must be stressed, however, that economies of scale ultimately depend on technological factors, so that technological changes can completely alter the possibilities for economies of scale and related phenomena. In a series of studies on the effects of the new information technology (merging the computer and communications technologies) undertaken recently by the OECD, an overview of the conclusions indicates that the new technologies are encouraging vertical disintegration of industries and decentralization, leading to fragmented production.[7] Thus it is possible that future-oriented investigations stressing new and innovative technologies may lead to markedly different conclusions on scale effects, relative to the traditional econometric research on historical productivity growth behaviour.

Internal Organization — Productivity performance can also be improved, at least temporarily, by more efficient combinations and organizations of existing labour and physical capital within business firms or within institutions in the nonmarket sector of the economy.

Better industrial relations can have an important effect on the efficiency of the enterprise and thus on total factor productivity. Economic analysis appears to have little to say about the internal organization of firms, but this aspect is intensively analysed in the business administration, organizational, and industrial relations literature.[8] Indeed, the particular structure of large multi-industry enterprises, their ability to anticipate and adjust to changing economic conditions, and their internal human-relations policies can play a large role in determining the actual levels of productivity performance.

Inflation — Some argue that inflation is at least partly responsible for the recent severe slowdown in productivity growth. They contend that a market economy is highly dependent on the information signaled by relative price changes. During periods of high inflation, the information tends to be distorted, creating inefficiencies that can persist even if more resources are devoted to monitoring price and related changes and to interpreting their message. Indeed, the rewards for devoting resources to strictly productive activities tend to be lower, relative to those gained from playing the "inflation game" and deriving profits from financial transactions. And those in

business these days know that inflation is a boon for accounting and legal experts, since shorter planning horizons are the order of the day and everything must be renegotiated more often. Thus it is claimed that inflation directly decreases the efficiency of Canada's market production and exchange system.

An econometric study by the Bank of Canada addressed this issue for the 1963-79 period.[9] The authors concluded that Canadian inflation appears to account for virtually all of the recent productivity growth slowdown, whereas the productivity slowdown explains only a small part of inflation. The feedback relationship between inflation and productivity growth is not spurious; its significance and validity are maintained over and above suspected common causal factors, such as rising energy costs. The study also distinguished between anticipated and unanticipated inflation. While the analysis is impressive, its conclusions must be regarded as highly tentative, because the empirical discussion relates to the whole economy, while the theoretical basis is derived from micro-level considerations. There is, as yet, no quantitative analysis of the various specific economic channels through which accelerated inflation reduces productivity growth. Clearly, further investigation is required.

The Weight of Government — No mention has been made so far, in our discussion of the possible explanations for total productivity growth and for the current slowdown, of the possible effects of high taxes, the structure of the tax system, generous welfare programs, or the role of Crown corporations. Over the past quarter century, taxes have risen and the structure of taxation has changed considerably. Governmental health, education, and welfare expenditures have been extended, and their relationship to personal finances has been altered. Increasing use has been made of Crown corporations by the federal and provincial governments, and the tax treatment and public management of these bodies have changed, as have the circumstances under which they operate.

We believe that these changes have influenced productivity developments in Canada. There are economic analyses and estimates to support this belief, although no consensus has been reached on all of the issues. For example, it is generally agreed that increased taxation of business income has led, through its effect on the size and deployment of saving, to a substantial gap between realized and potential real income. But the measurement of the precise size of this gap is difficult, and the results are tentative.

As for Crown corporations, many economists have drawn attention to the low return on capital earned by most of them and to the consequent reduction in the national productivity of capital. While there is some evidence to support this view, again no comprehensive, reliable measures exist.

In a third area, more than one observer has suggested that increased personal taxes and more-generous welfare programs have inhibited the incentive to work and slowed down growth. The evidence with regard to taxes is rather ambiguous. Research has shown that higher taxes sometimes decrease the time worked and sometimes increase it, with the net effect probably being rather small. In any case, productivity per hour would not be affected, only productivity per person employed; as we have seen, the slowdown shows up with either measure. Similarly, if welfare programs did have an effect, it would be mainly by changing the number of people working or the length of time that they worked; their productivity when actually at work would not be altered significantly. Thus welfare programs might decrease total output but only by decreasing total labour input, not productivity per unit of labour input. There is some evidence that welfare programs have lowered total labour input somewhat. The exact influence of this factor is debatable, and it is significant only if the proposed solution to the productivity problem is radical surgery on the social "safety nets." Neither we nor most others, we suspect, are prepared to contemplate this.

An Alternative Approach

The problem of the slowdown in productivity is so difficult that its resolution may, in the end, require supplementing the growth-accounting framework, which accommodates many of the ideas discussed so far, with other approaches. One approach, favoured by some analysts, could be based on a better measurement of the quality of inputs. Another avenue is provided by input-output analysis. We have used this partly experimental approach, among others, and some of the results are presented here.[10]

The usual measure of labour productivity is industry-oriented; that is, productivity is defined in terms of the gross domestic product (or value-added) per person employed that originates in each industry. The value-added estimate of an industry's real output subtracts all purchased intermediate inputs – such as raw materials, energy, and contracted-out services – from the industry's gross revenue, yielding a net

Table 2-5

Input-Output Total Labour Productivity Levels and Growth Rates, Selected Industries, Canada, 1961-78

	Output per person employed				
	Level			Growth[1]	
	1961	1973	1978	1961-73	1973-78
	(1971 dollars)			(Per cent)	
Agriculture	3,647	6,991	6,981	5.6	--
Forestry	7,794	11,720	11,675	3.5	-0.1
Fishing and hunting	6,992	6,057	6,790	-1.2	2.3
Metal mining	12,463	17,451	14,882	2.8	-3.1
Mineral fuels	14,942	21,777	14,805	3.2	-7.4
Nonmetal mining	9,243	15,233	13,747	4.3	-2.0
Services to mining	10,291	11,908	12,907	1.2	1.6
Food and beverages	5,706	10,105	10,160	4.9	--
Tobacco products	6,906	11,845	12,133	4.6	0.5
Rubber and plastics	7,425	13,096	13,582	4.8	0.7
Leather	5,717	8,691	10,222	3.6	3.3
Textiles	6,255	11,408	12,944	5.1	2.6
Knitting mills	5,342	10,178	12,897	5.5	4.8
Clothing	5,952	8,768	10,447	3.3	3.6
Wood	7,141	10,391	10,919	3.2	1.0
Furniture and fixtures	6,824	10,612	10,703	3.7	0.2
Paper and allied products	8,905	12,742	12,806	3.0	0.1
Printing and publishing	8,829	12,086	13,369	2.7	2.0
Primary metals	9,671	14,609	13,334	3.5	-1.8
Metal fabricating	8,242	13,058	12,826	3.9	-0.4
Machinery	8,877	12,901	14,300	3.2	2.1
Transportation equipment	8,050	14,393	15,167	5.0	1.1
Electrical products	7,791	13,150	14,185	4.5	1.5
Nonmetallic mineral products	8,846	14,342	14,225	4.1	-0.2
Petroleum and coal products	10,331	15,685	14,058	3.5	-2.2
Chemicals	8,541	14,179	14,680	4.3	0.7
Miscellaneous manufacturing	7,516	11,609	12,394	3.7	1.3
Construction	9,174	12,969	12,638	2.9	-0.5
Transportation and storage	7,556	13,279	12,718	4.8	-0.9
Communications	6,791	11,077	15,169	4.2	6.5
Electric power and gas	12,703	18,902	17,790	3.4	-1.2
Wholesale trade	8,630	12,412	12,019	3.1	-0.6
Retail trade	5,713	7,664	7,691	2.5	0.1
Finance, insurance, and real estate	16,818	18,289	18,213	0.7	-0.1
Education and health	13,984	17,792	16,968	2.0	-0.9
Amusement and recreation	8,184	8,456	10,255	0.3	3.9
Services to business	10,498	11,075	10,371	0.5	-1.3
Accommodation and food	7,833	8,201	8,425	0.4	0.5
Other personal services	6,915	5,706	5,377	-1.6	-1.2
International trade	7,788	13,813	13,711	4.9	-0.1

1 Average annual rates.
SOURCE Postner and Wesa, *Canadian Productivity Growth.*

measure of its output. In the calculations, each industry is, in effect, considered a separate entity, and industrial interdependence is ignored. This productivity measure is easy to apply and has two distinct advantages: it yields productivity levels, as well as growth rates, at each point in time; and it can be aggregated in straightforward fashion, since the total net output of all the industries, divided by their total employment, yields the commonly accepted estimate of a nation's aggregate productivity level – namely, GDP per person employed. When two or more levels are calculated for different moments in time, the nation's aggregate productivity growth rate can be obtained.

Economic statisticians have complained that this simple measure of labour productivity is not satisfactory, particularly with respect to individual industries.

They argue that there are other primary factors of production besides labour – namely, physical capital inputs. Moreover, merely subtracting all the intermediate inputs is often arbitrary and may misrepresent the industrial process. Thus other measures of industrial productivity have been advocated; in fact, they were used in our Seventeenth Review. But these other measures do not have the two distinct advantages of the usual measure, and they are somewhat limiting in that the role of international trade and the changes in the terms of trade are neglected – hence the search for an alternative approach to the analysis of Canadian productivity levels and growth rates.

Input-Output Analysis

The input-output approach is one result of this search. To see how it works, consider the example of an automobile manufactured in order to satisfy domestic final demand.[11] If we wish to know the economywide total labour that was required to produce this unit of transportation equipment, we count the labour *directly* required at the final stage of automobile production – that is, the labour embodied in the value-added of the automobile or transportation equipment industry. But this industry purchases a wide variety of intermediate inputs – such as energy, steel, rubber, plastics, electrical products, and business and financial services – from other industries, each of which also employs labour. Thus we must add the *indirect* labour of the other industries whose production of intermediate goods and services was purchased by the automobile industry. Each of these industries also uses intermediate commodities purchased from still other industries – including each other; thus there is even more indirect labour to be included in the production of the original automobile. It was recently reported, for example, that a U.S. subcompact automobile is estimated to require 190 hours of labour (direct and indirect), whereas the Japanese equivalent needs only 100 hours.[12] Calculations like this can yield a productivity measure for any industry that takes into account not only the labour used directly by each industry but also the labour embodied in the materials, equipment, and imports purchased from the other industries.

The results of such calculations are presented in Table 2-5 for the same industries as in Table 2-4, where traditional productivity measures are given. There are considerable similarities and differences between the two sets of figures. The similarities occur when an industry is "almost" vertically integrated, so that intermediate commodity inputs are of little importance, as in the amusement and recreation industry and the wholesale trade industry. The big differences arise when the measured intermediate inputs are significant, as in the mineral fuels, paper and allied products, petroleum and coal, and accommodation and food services industries.

The input-output measurements are particularly sensitive to the productivity slowdown phenomenon. Of the 40 industries displayed in Table 2-5, 35 recorded lower growth rates in the 1973-78 period than in the 1961-73 period (the corresponding figure in Table 2-4 was 26). Productivity stagnation is, therefore, more pervasive across industries when this alternative measure is used.

Three Applications

Three useful applications of the input-output approach can be made immediately. First, it can serve to determine whether the productivity slowdown remains as serious when proper allowance is made for the recent changes in the terms of trade and in capital depreciation rates – an allowance that is not made in the traditional productivity measures. After such allowance is made, we obtain different results. There is an important difference in the early part of the recent slowdown period (Table 2-6). The slowdown was much less between 1966-71 and 1971-76 than traditional measurements would indicate. Instead of being cut in half, the growth rate was lower by only one-quarter. This suggests that more careful measurement might produce a dramatically different view of the seriousness of the productivity decline. There is, however, other evidence to suggest that changes in Canada's terms of trade from 1976 to 1981 did not significantly affect the severity of the (officially measured) productivity slowdown during this most recent period. Thus the

Table 2-6

Growth in Productivity, Using Traditional and Input-Output Measures, Canada, 1961-76

	Growth in output per person employed[1]	
	Traditional measure	Input-output measure
	(Per cent)	
1961-66	3.3	3.3
1966-71	2.8	2.8
1971-76	1.4	2.0

1 Average annual rates.
SOURCE Postner and Wesa, *Canadian Productivity Growth*.

slowdown does not, in the end, appear to be explicable to any significant degree by measurement problems such as those discussed here.

Our second application of the input-output approach concerns the effect of the demand shift to services on the observed aggregate productivity slowdown, given the fact that the productivity levels and growth rates of the service component of output are both lower than those of the other components. Use of the input-output technique permits a direct test of the hypothesis that this factor accounts for a significant portion of the observed slowdown. Table 2-7 shows what the aggregate productivity growth rates would be for the three subperiods if the final-demand weights of services (and other demand components) were held constant at either the 1961, 1966, 1971, or 1976 levels; the last column shows the actual growth rates. If a shift to services had caused the slowdown, the figures in the first column for example, ought not to show a slowdown, or they ought to show a much smaller slowdown than the actual one (last column). Since there is not much difference, one can conclude that services were not responsible. Tests with the weights for 1966, 1971, and 1976 lead to the same conclusion. These figures show that the slowdown, in its initial stages at least, cannot be explained by a shift in demand to services. In fact, the aggregate productivity growth patterns are largely insensitive to the various final-demand weights, even though the latter undergo important shifts over time. One of the most important such changes is the growing role of direct imports in satisfying final demand in Canada. Imports comprised only about 6.3 per cent of total final demand in the year 1961; by 1976 that proportion had risen to 11.7 per cent.

Table 2-7

Aggregate Productivity Growth[1] When Holding Final-Demand Weights Constant at 1961, 1966, 1971, or 1976 Levels, Canada, 1961-76

	1961	1966	1971	1976	Variable weights
			(Per cent)		
1961-66	3.2	3.4	3.3	3.2	3.3
1966-71	2.5	2.6	2.5	2.5	2.8
1971-76	1.8	2.0	1.9	1.9	2.0

1 Average annual rates.
SOURCE Postner and Wesa, *Canadian Productivity Growth*.

The third application involves the question of "correct" productivity measurement – that is, of determining whether a better measurement of productivity, especially in the service sectors, would reveal that the productivity slowdown is, in whole or in part, a "statistical illusion." It is well known that the official output measures of certain service industries, even those in the commercial sector, are not well defined and are subject to considerable improvement. We have been able to obtain an experimental measure of output for the Canadian finance, insurance, and real estate industry.[13] This measure appears to be superior in important respects to the official estimates. It turns out that the output growth rates for the two measures are very similar for 1961-66 and for 1966-71 but that for the 1971-76 period the experimental measure indicates a considerably faster rate of growth. The revision is from −0.7 per cent annually to 3.3 per cent. Because the finance, insurance, and real estate industry is one of the most important in Canada, both in terms of final demand and in terms of its role as a supplier of critical intermediate services to other industries, any productivity improvement in that industry has far-reaching effects. Thus our revised estimates of productivity growth in the finance industry have a startling effect on the measure of aggregate productivity growth. While the official measurement for the finance industry produces an aggregate productivity growth rate for the whole economy of 2.0 per cent for the 1971-76 period, the revised figure is 2.5 per cent, meaning that the productivity growth slowdown (in the initial stages) is much less apparent. Does it mean, however, that the celebrated productivity slowdown is a figment of the statistical imagination? We think not; it is very doubtful whether the severe slowdown in the most recent period (1976-81) could be eliminated by "correct" output measures. Nevertheless, the importance of proper measurement convention is abundantly clear.

Other applications of the input-output approach are possible, including the targeting of productivity improvement measures at industries that have particularly strong linkages to the rest of the economy and where productivity improvements might therefore have a more widespread beneficial effect than elsewhere.

Data Shortcomings

The three applications just described show, we think, that the input-output technique is a fruitful addition to the economist's tool kit for analysing productivity growth. It could be considerably improved, as could productivity analysis generally, if the collection and processing of statistical data could be improved. We experienced considerable difficulty in reaching an adequate understanding of the statistical procedures followed at Statistics Canada for real-

output measurement. It would help considerably if these procedures were fully documented, particularly with respect to durable capital goods and service commodities. More detail is needed on the statistical treatment of quality change, performance and operating characteristics, and the introduction of entirely new products and services. The present documentation is inadequate at a time of pervasive and accelerating computerization of industrial processes and service operations.

Improved statistical services would also be desirable with respect to the rather technical question of reconciling company-based statistical data with establishment-based statistics. Reconciliation difficulties arose when we came to analyse the work (reported upon elsewhere in this report) on the link between R & D expenditures (company-based) and productivity improvement (based on production and employment data from establishment-based statistics). It might be beneficial for producers and users of Canadian statistical data to meet and discuss these problems of data reconciliation. Statistics Canada should be encouraged to bridge the gap between the two sources, either by experimenting with new types of reporting units or by conducting standardized cost-allocation methods.

A Two-Pronged Approach

We can now draw appropriate lessons from the evidence on the income and productivity growth slowdown and from the present state of the theory on these matters, as well as some conclusions about an appropriate way to approach the problem of finding remedies for the slowdown.

Because the slowdown in productivity growth is widespread, spanning all industries and most OECD countries, the need to have the widest perspective possible in the approach to policy remedies is obvious. Remedies must be sought that apply to all industries, with the search directed at ways to improve productivity in the service industries as well as in the goods industries, in the nontrading industries as well as in trading industries, and in the nonmarket industries (including government) as well as in the market industries.

In seeking solutions and proposing remedies, the international character of the slowdown must also be kept in mind. A reasonable test of any proposed approach is whether it would apply not only to Canada, but also to France, Britain, West Germany, Japan, and the United States, for example. Approaches specific to Canada can be used, but they are unlikely to suffice on their own. We do not claim that the productivity problems of other countries should be analysed in Canada; only that the methods used to analyse Canada's problem should, in principle, also be applicable to other countries for the best chance of success.

An important message from the theory is that approaches that focus on explaining total factor productivity growth seem somewhat more promising than those centering on either input quantity or input quality, including the quality of labour. Input quantity and quality cannot be ignored entirely, of course, but in our view the general drift of the analysis over the past few years favours greater emphasis on total factor productivity. The theory also suggests that the explanation of total factor productivity growth itself will require an approach that is more disaggregated by industry than has hitherto been the case. While it may not usually be necessary to go down to the level of the individual firm or plant in seeking explanations of productivity growth, it may be necessary to consider more industry detail than in the past, at the same time bearing in mind the need to explain productivity growth or its slowdown in a large number of very different industries.

The theory can also help to decide where to concentrate research resources, at least initially, when seeking for an explanation of total factor productivity growth. In particular, at the time that we began to focus on productivity analysis, about three years ago, it was quite clear, on the basis of the facts and theory then current, that whatever else was important in total factor productivity growth, technical change was a critical element. A deeper understanding of this phenomenon was viewed as essential to a fuller understanding of productivity growth. Examining the forces underlying technical change is an approach that meets all of the criteria that we have stressed as important in the search for a better understanding of the productivity growth slowdown: technical change is a phenomenon spanning all industries and all countries, and its explanation requires substantial disaggregation. We have devoted a major part of this report to an examination of these issues.

The theory also tells us that growth in living standards depends on trade growth as well as on productivity growth. As we have pointed out, the key social problem lies in the consequences of the productivity growth decline for growth in living standards, not in the decline itself. From that perspective, all policies that enhance real-income growth, whether by promoting productivity growth itself or through other routes, should be considered. Greater trade has contributed to growth in living standards in the past

and will continue to do so in the future under the current GATT arrangements.

There are problems, however, in relying upon this source for future growth in living standards. Protectionist pressures have been growing of late, fueled by the wórst recession since the 1930s, which has generated considerable legitimate concern about high unemployment. There is also concern that the trend towards greater trade may make Canada too dependent on natural resources in the future. In the light of these problems, it cannot be taken for granted that trade should continue to grow, as is presently planned under the GATT arrangements, and therefore that it will contribute to growth in living standards in the future, as it has done in the past. It becomes important, therefore, to consider whether these concerns about freer trade imply that the rate of growth of trade, and hence its contribution to income growth, should be slowed down, left as it is, or even speeded up, in view of the urgency of the income growth problem. These considerations have also been treated extensively in our report.

The theory and facts pertaining to productivity growth and its slowdown make it clear that our investigation of technical change and trade represents only the beginning of what should ultimately be done in the area of income growth analysis. To mention just a few of the possibilities: the effects on productivity of inputs other than labour should be studied; the quality of inputs should be examined; the numerous determinants of total factor productivity other than technical change should be investigated; and some very tricky measurement issues should be examined. All of these issues, and perhaps some others, have a place in a comprehensive treatment of the income and productivity slowdown. We have covered only two of the many important aspects of the problem in this report. We plan to publish, in the near future, another report that will cover some of the other points described here.

Part B

The Role of Technical Advance

3 Technical Advance: An Overview

Technical advance has been identified as a major source of economic growth in modern times. While estimates of its relative importance vary, few would deny that it plays a key role. In the absence of any other source of growth, an apparently modest rate of technical advance of 1 per cent annually, on average, will enable a grandson to become twice as well off as his grandfather, in the same job and with the same degree of effort. An average rate of 2 per cent will make him twice as well off as his father. On the other hand, without technical advance, growth is likely to be very slow – even nonexistent, according to some – leading to a static society akin to that which is commonly perceived to have existed during the Middle Ages.

Obviously, then, it is most important to understand how and why technical advance comes about, in order to adopt a sensible approach towards it. We do not assume that any and all technical advance is necessarily good, because one must look at the costs as well as the benefits. For example, if Canada were able to devise a ball-point pen that would function twice as long as existing ones, but had to spend $100 billion doing so, the investment would not be worthwhile. Similarly, we do not necessarily support all government expenditures that are labeled as helping technical advance, but we do think that some government involvement is necessary.

It is possible to understand fully the policy issues in the area of technical advance only after examining ideas about the process, the evidence of their validity, and what is presently being done in Canada. Even before that, however, it is clear that many important questions exist on which agreement has yet to be reached. Is the total level of R & D spending in Canada too low, too high, or about right? How important is the applied part of R & D spending for technical advance, in comparison with advances in ideas, products, and processes that come up in the normal course of doing business, without R & D?[1] If the level of applied R & D is too low, can or should government policy attempt to do more than it is presently doing? Is it a good idea, for example, to set national targets based on a comparison of Canada's performance with that of other countries? Are there alternative ways of fixing R & D targets, and what are their merits? Does the fact that Canada has more than an average proportion of foreign ownership and control either help or hinder the process of technical advance? What should the policy towards branch plants be, from the point of view of achieving rapid technical advance? Do new technological advances developed elsewhere come into Canada as rapidly as is desirable? If not, can the process be speeded up? Does new technology spread as rapidly as is socially desirable among firms within Canada? If not, can anything be done about that? What about the rate of diffusion of new technology among different regions? Is the allocation of our limited tax resources between policies to increase R & D and policies to speed the diffusion of existing technology properly balanced? Are the guidelines to government departments on why and when to subsidize technical advance, in each of the many existing programs, designed for maximum efficiency in achieving this end? Are tax concessions in favour of R & D well designed? Is patent policy as conducive to technical advance as it could be? What about competition policy? Is sufficient policy attention being paid to technical advance outside the glamorous high-technology manufacturing industries – in the service sector, for example?

While we cannot answer all of these questions in this report, we shall address the more important ones, in the hope that we make a useful contribution to policy making with regard to technical advance.

The Process of Technical Advance

Technical advance can be viewed as the introduction of new ideas, processes, and products, or of improvements to existing practices, processes, and products. Among the major new ideas or processes in the last 100 years, we might mention: assembly-line operation; catalytic cracking; computer programming of machine tools; the supermarket as a form of organization of the retail grocery trade; fast food chains as a form of organization of the restaurant

trade; the basic oxygen process in steel making; the use of containers in transportation; and so on. Among the lesser but still significant idea or process innovations, we might mention: the use of slurry pipelines in transportation; the adoption of self-service in gas stations; the twin-wire process in paper making; the technique of building television sets with replaceable modules; and the use of Ensolite insulation during cold-weather house construction. As examples of major new products, we might mention: the automobile; the telephone; mass-market electricity; the diesel engine; the computer; hybrid corn; and the jet plane; and as examples of minor but still significant new products: cellophane; the ball-point pen; the zipper; the hand-held electronic calculator; radial tires; colour television; sulphanomide drugs; automatic transmissions; sliced and wrapped bread; pneumatic wrenches; and Scotch tape. Technical advance takes place in all sectors, as these examples show – in manufacturing, in the service industries, and in primary production. They also show that, while applied R & D is clearly important in the process of technical advance, much of the latter also consists of improvements that are devised in the normal course of doing business.

The line between new and improved products or processes is sometimes difficult to draw, as is the line between the products and the processes themselves. Is a power wrench a new product, an improved old product, or a new process for installing nuts? Is a colour television a new product or an improved version of the old product? Is the supermarket system a completely new process, or just an improved version of the old corner store? The distinctions nevertheless remain useful, as does the distinction between tall and short people, despite the existence of numerous middle-sized persons.

All new and improved products and processes share the characteristic that they can contribute to the production of more or better goods and services without requiring more labour, capital, or materials. For any given level of effort, they lead to improved living standards.

The bewildering variety of technical changes suggests that it may be difficult to generalize about the causes of technical advance; nevertheless, it is not impossible. To begin with, in the context of a small economy like Canada's, it is helpful, from the policy point of view, to distinguish the three ways in which an advance in technology or a new idea for a better way of doing business can occur.

First, a Canadian firm may be the first in the world to discover a new technology or a new idea and to bring it to commercial application. In the nonmarket sector, an organization in Canada may be the first, worldwide, to devise and put to practical use a new product, process, or organizational technique. In either case, this "first use" may be referred to as the domestic *production* of new technology. A good deal of applied R & D in Canada does result in such production of new technology. An example of this is the Syncrude process for oil extraction from oil sands.

Second, a Canadian firm or organization may adopt a new technology or idea that is already used in Canada by other firms or organizations, thus moving up to "best practice." This is the domestic *diffusion* of new technology. An example of this is the spread of universal product coding from the first supermarket chain to use it in Canada to the other chains in the country.

Third, a firm or organization may be the first in Canada to put to commercial or practical use a new technique or idea that is already used abroad. This will sometimes require adaptation to Canadian conditions, and some of Canada's R & D spending is devoted to that very purpose, as perhaps in the institution of a computerized reservation system in Canadian air transport. Sometimes very little adaptation is needed, as in the case of containerization. To cover both eventualities, we refer to this as the first domestic *adaptation* of new technology from the world pool of technology, though the term is not fully satisfactory. An example of the domestic adaptation of new technology occurred when the first supermarket chain in Canada adopted the universal product coding system, which was already in commercial use in the United States.

This triple distinction is not entirely sharp in all cases, but it is useful. The validity of the policy inferences that we shall draw from it later is little impaired, in our view, by the fact that one could debate at great length about precisely how the borders among the three aspects of technical advance ought to be drawn.

The three ways in which advances in technology can occur are not of equal importance to productivity improvement in Canada. If one examines the examples cited above, one has to conclude that the production of new technology in Canada appears to reflect our relatively small size in the world economy. This is true both for advances of a kind that, regardless of where they are first made, depend on applied R & D work and for advances and ideas that come about in other ways, notably in the large and important service sector. The adaptation of new ideas and technology from the world pool is quantitatively very significant, as is the diffusion of new technology from its first users in Canada to all other potential users.

Production

The development of new products and processes is sometimes sought systematically by firms, individuals, and institutions (governments, universities, and trade associations). The expenditures involved in the search are included as part of applied R & D expenditures. New drugs, better car engines, and cheaper steel-making processes are developments that resulted from systematic searching by firms and that involved R & D expenditures; this also applies to many discoveries made by individual inventors, such as the telephone, the radio, and the airplane. The discoveries of individual inventors are often developed further by firms. Government agencies and universities have also made, and continue to make, systematic searches for technological advances – e.g., in agriculture, where new seeds and new strains of cattle have been developed, and in energy, where ways of achieving controlled nuclear fusion are being investigated.

Sometimes discoveries do not result from a systematic search, but they occur as a by-product of the normal processes of production and marketing. The expenditures in these cases will rarely be counted as R & D by statistical agencies or appear as such in published data. Such advances sometimes derive from ideas developed in the day-to-day process of production and sometimes from ideas that occur to persons or groups not purposely involved in research activity. Examples include the development of better train couplings, the institution of the supermarket, and the concept of containerization.

The distinction between sought-for discoveries and those which occur *en passant* is important. A considerable number of technical innovations seem to fall into the latter class, but most of the developed theory and policy applies only to the former.

Expenditures on applied research and development are, of course, the main variable that would appear to determine sought-for technical advance and the resulting productivity improvements. Yet, somewhat surprisingly, the statistical evidence in favour of a link between R & D and productivity improvement at the industry or economywide level is not strong, and it relates almost exclusively to the U.S. experience. There is better evidence, however, that R & D improves productivity in individual firms. The implied paradox is still a subject of much ongoing research. In Canada, one would expect any link between improvements in industry or economywide productivity and Canadian R & D expenditures to be concealed by the large number of productivity-improving technical changes that originate outside the country and do not result from Canadian R & D. In addition, because technical change resulting from applied R & D is not the only source of productivity improvement, the influence of the R & D is all the harder to detect. Nevertheless, it is worth asking whether evidence of a link exists for Canada, because the presumed existence of such a link is, to a large extent, the premise upon which policy towards applied R & D is based.

Accordingly, a study was undertaken to investigate the relationship between the growth rates of productivity and applied R & D in Canada.[2] This was done for 13 manufacturing industries over the period 1966 to 1976, with both internal and contracted-out R & D being measured for each industry. The input-output method of measuring productivity growth (see Chapter 2) was used in combination with the technique of multiple-regression analysis. The latter enabled us to distinguish the effects of this industrial R & D from the other variables known to influence productivity growth – i.e., changes in the amount of capital equipment of a given type and changes in the scale of operation. The results showed that internal R & D done in any given industry had little effect on its productivity growth but had a favourable influence on productivity growth in the industries that are supplied directly or indirectly by that industry. This means, essentially, that most of the industrial R & D in Canada that has a productivity-raising impact is oriented towards creating new and improved equipment and products for sale to other firms, rather than the development of new production processes that will be used internally by the industry performing the R & D. When interindustry sales and purchases were taken into account, the conclusion emerged that internal R & D growth did influence productivity growth significantly in these 13 industries.

We conclude, partly on the basis of these results and of the U.S. evidence and partly because of the inherent plausibility of the proposition, that increases in applied R & D can stimulate productivity growth in Canada. Whether increases in basic R & D in Canada would also help is not an issue on which we have found any evidence one way or the other. Nonetheless, the weakness of the link between applied R & D and productivity growth – both here and in the United States – is, incidentally, indirect evidence of the possibility that a large amount of technical advance, all over the world, may be achieved through routes other than applied R & D.

The determinants of applied R & D expenditures are also an important issue for policy. The theories on this subject have hypothesized numerous variables, which can be classified according to the locus of their relevance: at the level of the firm, of the industry, or of the whole economy.

At the level of the firm, four variables especially are mentioned frequently. The first of these is the size of firm, as it has been suggested that some minimum size is required to do R & D at all and that R & D becomes more efficient as firms become larger. There is some dispute, however, as to whether size hinders the discovery process beyond a certain point. Some observers consider, for example, that having many small teams rather than a larger bureaucratic arrangement is important for applied R & D to be successful, whether it is targeted at new discoveries or at the adaptation of existing ones. The firm's product diversification has also been suggested as helpful for discovery. Another variable – the nationality of ownership or control of a firm – is often cited as relevant in the Canadian context; it has been argued that foreign-controlled corporations do less R & D in Canada than Canadian-owned firms. The ease with which companies can obtain financing to undertake the risky process of research and development or the almost equally risky process of subsequent marketing has also been considered as a potentially important variable determining the level of research and development.

At the level of the industry, it is recognized that technological opportunity varies among industries. (The argument here may be circular, however: industries that do a lot of R & D may *ipso facto* have many technological opportunities.) The chemical industry, for example, is thought to be better off, in this respect, than industries such as personal services; this difference may explain the differing amounts of R & D and subsequent discoveries by the two industries. Another variable considered to be significant at the industry level is the degree of concentration. In industries with only one or very few firms, there may be less incentive to innovate than in those with more competition. Too much competition could also inhibit technological advance, however, as the firms that make the discoveries initially may be unable to cover their development costs if many other firms imitate them quickly. Patenting can help to forestall pirating, but it is not always feasible. A third variable often suggested is the expected size of the market for an innovation. The reasoning here is that the fixed costs of making the discovery can be spread over a larger number of units sold. Finally, the regulatory climate may also have an influence. Not only may inventive capacity be diverted away from technological advance towards coping with regulations, but there is also a widespread feeling that in a climate of cumbrous regulation the innovative process is stunted.

At the economywide level, a strong and steady growth in total aggregate demand is often cited as a beneficent condition for the invention and development of new products and processes. On the other hand, it is sometimes argued that the need to survive in a recessionary climate can also stimulate innovation. The general tax climate is also considered to be important by some, who maintain that higher profits generate more R & D. Others believe that certain kinds of taxes, notably the capital gains tax, may restrict the genesis and growth of small venturesome firms, which often represent an important source of new technological development. Government tax relief specifically related to R & D, direct R & D subsidies, and purchasing policies favouring research and development form another class of variables that can influence R & D spending. Finally, the size of the base of fundamental knowledge is viewed as an important element of the process of research and development.

This listing is not complete. It includes only those variables about which some degree of evidence beyond mere intellectual plausibility has been collected. Naturally, the varying hypotheses about the determinants of technical change have given rise to conflicting views, and more evidence is needed.

Diffusion

A new process takes time to spread to all the firms that will eventually use it. Similarly, it takes time for all the firms that will eventually make a product to actually produce it.

The diffusion process can be very slow, even when there is no question of letting older types of equipment wear out gradually. It is more often a question of quinquennia and decades than of months and years. The spread of roof trusses throughout Canada, to cite an example from earlier research by the Economic Council, took over 10 years.[3] Lags remain long, even if they are calculated by a less stringent measure than the duration of the period from first to universal use – say, from the time of use by the first 10 per cent of potential users to the time of use by 90 per cent.

Faster diffusion of new technology, if it were possible, would plausibly raise output and real living standards. To illustrate: if technical change occurs at 2 per cent a year, then within five years' time living standards will rise 10 per cent on account of this factor alone. If a fair proportion of this improvement is due to the gradual adoption, over that period, of new ideas, products, and techniques already used by some firms but not by all, an acceleration of that process would cause the 10 per cent improvement in living standards to occur in less than five years' time. It would occur sooner still if the pace of adoption of all the advances that have not yet come into first use

but will do so in the next five years could also be hastened.

There are limits to the improvements that can be achieved in this fashion. The first is determined by the amount of improvement in living standards that could be achieved if all firms always used best-practice ideas and processes and produced the most up-to-date products possible. While the gap between average and best practice can be narrowed – perhaps even almost closed – the speed with which best practice itself advances must, in the last analysis, place an upper limit on the rate of growth of technology and living standards. Speeding up diffusion can, at best, lead to a temporary rise in the rate of growth in living standards, lasting a few years, and thus to a higher level of living standards than would obtain without it. But it cannot lead to a permanent acceleration in the increase of technical advance and living standards. Second, it will not be costless to speed up the diffusion process. When firms seek out what is new and adopt it, that takes time, effort, and money. If governments try to help, that also takes time, effort, and money. If the costs are higher than the benefits, faster diffusion will obviously not yield an improvement in living standards. Third, an innovation may render some kinds of existing capital equipment obsolete, but if that equipment is long-lived, it may pay to continue using it. The replacement of steam engines by diesel engines in locomotives is an example.

Explanation of the diffusion process has been attempted by geographers and economists alike. Geographers have stressed the importance of distance and urban hierarchy.[4] In citing distance, they use an epidemiological approach that likens the spread of an innovation to the spread of a contagious disease. Distance can take many forms: physical distance; physical distance corrected by geographical factors such as mountains, rivers, and so forth; and social and economic distance measured by the probability of concluding social and economic transactions. The main prediction of the epidemiological model of diffusion is that innovations are propagated according to an orderly wavelike pattern that emanates from the centre and moves towards a periphery. The farther an economic agent is from the centre or place of origin of an innovation, the later he is likely to adopt it. An innovation is diffused by imitation, bandwagon effects, or demonstration effects. Its spreading results primarily from a learning process – hence the importance of information flows and personal contacts. When the physical distance is shorter, the communication system better, and the population density higher, the probability of exposure is greater and the spread of the innovation is faster.

In the urban-hierarchy approach, the size of cities is the key to predicting and explaining the diffusion of innovations; geographical or social distance does not intervene explicitly. An urban hierarchy is composed of a large city and a number of smaller centres in the region, distributed in the hierarchy according to their demographic and socio-economic characteristics. Inside each urban hierarchy, the primary city gets the innovations first; from there they filter down to the other levels. Innovations may be risky or uneconomical below a certain threshold of population, or they may require special inputs. They are therefore more likely to be introduced first in cities that have large markets for outputs and/or low supply costs for special inputs. Only later, if the experiments are successful in the larger cities and if the processes involved can be simplified without too much loss in efficiency, will they be brought to smaller centres.

Economists have adopted a different approach, focusing not on distance or urban structure but on variables that, in one way or another, bear on the profitability or riskiness of the innovation. In principle, this approach could involve variables that are similar to those used by geographers, but in practice the stress tends to be rather different. The general idea is that adoption will occur sooner, the more profitable is an innovation at a given level of risk, and the less risky it is at a given level of profit. While profitability certainly serves to explain the speed of diffusion, it does not do so in an especially useful or appealing fashion unless one also examines the variables that underlie that expected profitability; the same applies to riskiness. A large variety of such variables have been hypothesized. Among those which are most commonly used are: the size of the firm; the degree of competition that the firm faces from others in the industry (the level of concentration); the number of firms that have already adopted the innovation; the size of the potential market; the access to risk capital; and the age, education, and other characteristics of the firm's management.

Adaptation

Explanations of the diffusion of new ideas and new technology among firms within an industry or among regions also apply, to some extent, to their diffusion on an international scale. If distance from the point of origin of a new technique affects the timing of its adoption by other firms within the same country, as geographers maintain, this is also true of the distance between the country of origin and other countries. Just as keen competition from early domestic innovators has an effect on the speed of diffusion in the domestic market, so also the keenness of competition from foreign innovators influences the speed of spread into Canada of technical advances that

originate elsewhere. This can be significant not only for the domestic producer facing import competition but also for Canadian exporters, who may find it worthwhile to adopt new ideas and techniques that give their foreign competitors an edge. The analogy with domestic diffusion is, however, of only limited applicability; a number of other elements must be taken into account when examining the rate of adaptation in Canada of new ideas, products, and processes already in commercial or practical use abroad.

The role of multinational corporations is one such element that has been quite extensively investigated. One study has gone so far as to assert that "most people would agree that multinational companies are unquestionably the dominant institutions transferring industrial technologies across national borders."[5] Whether or not one can be as absolute as this statement (this point will be examined in a later chapter), there can be no doubt that multinationals do play a significant role. That role may or may not be indispensable, however, and how vital it is may depend on the nature of the technology to be transferred. The modern theory of the firm suggests that the transfer of technology by multinationals to subsidiaries in other countries may be more efficient for the latest and most advanced, sophisticated, and radical types of new products and processes than it is for those which have been known for some time, are fairly straightforward to produce or introduce, and are not very radical in conception. Thus multinationals may not be an effective transfer mechanism for the more mundane kinds of new technology, which nevertheless play a significant role in improving living standards. In addition, there may be other costs arising from foreign ownership and control, as well as a price in terms of reduced national pride if advanced technology is obtained through this route.

Another difficulty in relying on multinationals for technology transfer is that the proportion of the economy where they are of major importance is quite small. They are very significant in mining and manufacturing, where assets of foreign-controlled corporations represent about three-fifths of the total, but these two sectors account for only about one-quarter of the gross national product.[6] In the rest of the economy, multinationals are much less important. In 1974, aside from mining and manufacturing, the heaviest foreign presence was in wholesale trade, with just over one-quarter of all assets being under foreign control. In all the other market sectors (retail trade, finance, utilities, services, agriculture, forestry, and construction), the fraction was less than one-quarter. There is no foreign control in the nonmarket sectors of health, education, and public administration. Consequently, for about three-quarters of the economy the many technical advances that first come into practical use abroad must enter Canada mainly by means other than the multinationals.

In that part of the market economy where multinationals are not important, present policy relies *de facto* on the self-interest of owners and managers of firms in introducing new ideas and techniques. The desire for profits, growth, or just a competitive edge, and the risk of bankruptcy or takeover if one does not keep up with other firms are all assumed to make businesses seek out, or be receptive to, information from abroad on new products and new processes. Little is known about whether these incentives are sufficient to ensure the speedy and timely adaptation in Canada of new ideas and techniques that originate elsewhere. A further mechanism, whose adequacy is again unknown, is the adoption and adaptation of world technology in Canada through consulting and engineering-design firms.

In the nonmarket segment of the economy, which represents almost 20 per cent of GNP and is thus roughly comparable in size to manufacturing, new processes and products enter by mechanisms whose precise nature has not yet been studied empirically to any great degree. Clearly, entry does not occur through either the multinationals or the self-interest of private business managers.

The fact that a major portion of the economy is not directly exposed to foreign technology advances does not mean that there is no indirect exposure. Many channels of contact exist. Sectors where trade is conducted or multinationals are active, such as manufacturing, will often supply goods to the nontrading sector or purchase goods or services from it. Thus a manufacturer of buses – an industry that trades and has multinationals – is a supplier to the transportation sector and can improve efficiency there, both directly by improving the product and indirectly by transmitting knowledge of how transportation is organized elsewhere. Similarly, a multinational company calling bids for local construction can demand specifications that automatically require national firms to become aware of developments abroad. Another point of entry of foreign ideas and techniques into the nontrading sector is that of human contact through tourism, immigration, international conferences, and so on. An extreme historical case of this is colonialism, which embodied contacts that were a powerful device for international technology transmission. All of this is rather general: the processes of technology transfer in the nontrading sector remain a largely untilled field of economic

analysis, despite their importance for the improvement of living standards.

Finally, mention should be made of institutional arrangements directly designed for transmitting technology across international boundaries. Japan's Ministry of International Trade and Industry, which has for years systematically combed the world in search of new products and processes suitable for adoption by that country's industries, is a well-known example at the government level. Private institutions also exist that perform the same function.

In sum, new ideas, products and processes are diffused internationally, and brought into Canada, by a variety of mechanisms. Some are similar to those which apply to internal diffusion, such as competitiveness among firms in the traded-goods industries; others include multinational corporations, the self-interest of businesses in the nontrading market industries, engineering and consulting firms, human contacts through travel and immigration, and institutions whose mandate includes such diffusion. The theory of what makes international diffusion fast or slow, efficient or inefficient, is not well developed. Extensive work has been done with respect to the limited amount of transmission achieved through multinational corporations. The technology that is transmitted in this manner is a small portion of the total, partly because it is important mostly in mining and manufacturing but not in services and partly because of the role played by new ideas and technical advances that do not involve applied R & D.

The Role of Government

While there is consensus among economists that the process of technical change would be slower without government intervention, none exists as to whether that intervention is already as high as, or higher than, it needs to be or whether it is too low. There are also questions about whether intervention is appropriately or inappropriately designed, whatever its level. "Intervention" here includes not only direct assistance in the form of subsidies and tax concessions in favour of R & D but also other policies that have a strong but indirect influence on technical advance. To illustrate this last point: patent policy, by influencing the profitability of R & D, affects R & D itself; product mandating can change the level of R & D, since it often requires R & D expenditures before world-scale operations become feasible; competition policy, by changing the degree of competition that firms must face, influences the rate of diffusion of new ideas or techniques; policy towards new foreign investment and towards the behaviour of existing branch plants changes the rate of importation of new technology; and policy on market access through trade promotion could increase R & D when that involves R & D-intensive exports. Evidence as to what does or does not influence technical change can help considerably here.

Production

The standard argument for government assistance to R & D, both basic and applied, is that R & D is not profitable enough for private firms to do as much as society's best interests warrant. Firms do some R & D, and for some it is certainly profitable. Yet, if we think momentarily of an economy with no government involvement in the R & D process, examples could easily be found of R & D that would be worth doing but would be unlikely to be done. In wheat farming, for example, no individual farmer is likely to find it profitable to develop new strains of high-yielding wheat on his own; thus there is a need for an external research organization. This body need not be created by government; it could be a farmers' co-operative, or seed suppliers might find it profitable to do the necessary research if new strains could be patented or otherwise protected. Despite these possibilities for private action, one can argue plausibly that research into high-yielding wheat strains is both socially desirable and unlikely to be forthcoming through the market process. A similar argument can be made for much of the agricultural sector. The key characteristics of agriculture that support the case for socially provided R & D are a matter of some dispute, but one can probably include among them the presence of many small producers and the difficulty of patenting discoveries or otherwise protecting them. If so, there may be a case for socially managed R & D in any industry that is characterized by a large number of small firms and by difficulty in patenting or protecting discoveries. Some of the service industries come to mind, such as wholesale trade, and business and personal services, as well as parts of the construction and manufacturing industries.

In industries more traditionally associated with R & D, such as drug manufacturing, transportation, electrical equipment, telecommunications, and so forth, the absence of sufficient profit incentive to produce as many discoveries as are socially worthwhile is not as obvious. After all, much R & D that is done in these industries is profitable. It is possible, however, that not enough is being done, as the following analogy makes plausible. Some private passenger transport companies make enough profit to survive; yet a public transit system, while socially worthwhile, might not be profitable for any privately run firm. Similarly, certain discoveries of new products and processes may be socially worthwhile but might not be privately profitable.

The public-transit analogy rests the case for government assistance to R & D on the inability of private firms to make enough profit on all the R & D that is socially worthwhile rather than on just some of it. In other situations, insufficient R & D is done when individual firms hold back because the rewards of possible success are not considered adequate to offset the costs of possible failure. To some degree, venture-capital firms, conglomerates, and other private risk-spreading arrangements can compensate for this. There is some dispute whether the degree of compensation is sufficient or whether the assumption of some of the risk by government is warranted.

The following simple, but highly illuminating, example will illustrate our thesis. Suppose that there were 100 R & D projects that could be undertaken in totally unrelated fields, each costing $1 million and each with a 50 per cent chance of success. Suppose further that for each successful project, the revenue would be $4 million, thus generating a profit of $3 million; for each unsuccessful project, the $1 million would be lost. If all the projects were undertaken, one would expect about 50 of them to succeed,[7] generating a total profit of $150 million (50 x $3 million). When the $50 million spent on the 50 projects that are expected to fail is subtracted from that amount, there is a net profit of $100 million for all the projects combined. Yet it is quite conceivable that a firm would hesitate to invest $1 million if the 50 per cent chance of a $3 million profit were offset by an equivalent chance of losing its investment. If such risk aversion were widespread, most of the 100 projects could remain untackled, and most of the $100 million gain could remain unrealized. This example illustrates all at once that risk-spreading can be a reason for government to assist the R & D process and that it need not be a reason if firms are not especially reluctant to face risks or if the odds are not good enough, even from society's point of view.

The insufficient private profitability of R & D and its riskiness are standard arguments for government assistance. In this general formulation, these arguments provide little guidance as to how much to assist; whether the current level of assistance in any country is appropriate; how much R & D is a desirable national target or an international obligation; and what kinds of R & D are desirable. A very small country cannot expect to make more than a small fraction of all the discoveries possible; from the point of view of strict national self-interest, it may need to make an even smaller fraction.

For the sake of completeness, we note briefly several other grounds for assisting R & D that are often invoked in the Canadian context. One is that domestic R & D is necessary in order to adapt new technology to Canadian conditions. That is true in many cases; in many others, as a scanning of the examples of new ideas, products, and processes given earlier shows, little or no R & D is needed, and there is greater need for information, investment, and marketing activities. Some argue that R & D activity is necessary to provide opportunities for highly skilled people. Others maintain that R & D is needed to yield exportable products to replace exports of the more traditional manufactures, as they are eroded by tariff reduction and competition from newly industrializing countries, and of raw materials as they become exhausted or fall in price. The evidence bearing on this last hypothesis, which we examine in later chapters, casts doubt on it as a reason for assisting R & D. Finally, R & D may be advocated on grounds of international obligation: any developed country should do enough R & D to contribute its share of technological advances to the world pool.

Diffusion

Although the diffusion of new ideas and techniques is important from a policy point of view in Canada, there is no consensus among economists as to whether a valid case can be made for government assistance. Many argue that the self-interest of firms, either in making profits or in avoiding losses, will ensure that any existing innovation that is socially worthwhile will, in fact, be adopted by private business. It is logically impossible to refute this argument, which we shall not spell out here, if its assumptions are accepted. Some of the necessary assumptions may fail, however, suggesting that some government involvement in the diffusion process may be socially worthwhile.

First, information on the existence of new products or processes may be too costly for individuals or firms to discover as rapidly as is socially desirable. Putting the point another way, the scale economies associated with the provision of information about new products and processes may be such that government intervention is socially worthwhile. Some of the evidence uncovered during our work on the economy of Newfoundland implied that information on new processes and products would have been welcomed by businessmen and would have been fairly simple to provide; moreover, its benefits would probably have exceeded the costs (although no work was done at the time to verify this last, important point).[8] And, certainly, diffusion often seems to be extraordinarily slow.

Second, even for an innovation that is already in use somewhere in Canada, the risks involved in adopting it somewhere else – for example, in smaller urban centres or in industries other than those

presently using it – may deter private entrepreneurs from adopting it as rapidly as is socially desirable. One example is the diffusion of computer technology across the country and across industries, and that of other innovations where international evidence indicates that the risk of rapid adoption is less, from a social point of view, than it might be feared to be by individual business managers.

Third, there is considerable evidence to indicate that there is a large gap between average and best practice in many industries. This gap may be socially desirable – for example, in cases where it is better to let outdated machinery run down than to replace it too soon with more up-to-date machinery. Nevertheless, this difference between average and best practice is often a surprise to businessmen when it is pointed out, as has been done implicitly for many manufacturing industries by the Departments of Industry, Trade and Commerce/Regional and Economic Expansion in circulars containing information on key "industry ratios." Government may also have a role to play in trying to close these gaps.

Fourth, there is little dispute that technology does not diffuse at the socially optimum speed between countries. For that reason, a substantial portion of international aid is devoted to spreading the use of known technology, sometimes with appropriate modifications, to countries that have not yet adopted it. The analogy appears to be valid for Canada. With its 10 provinces, Canada is large enough and distances within the country are great enough that, from the point of view of economic analysis, it can often be regarded as if it were a set of separate countries. New technology does not seem to spread at the most desirable speed between Canadian regions, either in unchanged or in suitably modified form; thus government action on the national scene (akin to international action on the international scene) appears to be appropriate to ensure faster diffusion of new products and processes across the country. The Economic Council has argued this point at some length in earlier publications.[9]

Finally, it cannot be argued that market incentives will ensure the diffusion of new technology at the most socially desirable speed in areas of the economy where the private market does not operate. Those areas account for a substantial proportion of GDP, comparable in size to the whole of manufacturing. Since technical advance does occur in these areas and since a great deal of it originates outside Canada, including the part not based on applied R & D, it is up to nonmarket institutions – most likely governments – to ensure that new products and processes in these areas of the economy are brought into Canada as rapidly as is considered desirable.

In sum, while a cast-iron argument cannot be made against the view that the market will function perfectly in diffusing new technology, the case for some government involvement and assistance in the process seems moderately strong.

Adaptation

On the international scene, as noted in the previous section, there is considerable agreement that new ideas and techniques do not diffuse across international boundaries as rapidly as is deemed desirable. Thus government clearly has a role to play in Canada, just as in Japan and certain other countries, to ensure that the knowledge of new ideas, products, and processes that have been developed elsewhere and are already in commercial or practical use abroad is more widespread domestically than would be the case if the discovery of their existence were left simply to private profit incentives. There is, in other words, an information-spreading role for governments.

Second, the view that international trade is, through one mechanism or another, one of the determinants of the speed with which new technology diffuses across international boundaries implies that government policy towards international trade should take account of this effect. From this point of view, it would appear that the more trade and the more international competition, the better.

Because multinationals play a critical role in the diffusion of new technology across international boundaries, government policy towards these companies can affect the speed with which new technology enters Canada – and hence the level of living standards. No government can avoid having a policy towards multinationals. We are simply signaling here the need to take into account in that policy the potential effects on the entry of new technology.

Multinationals can only play a limited role in international technology transfer, however, because they are unimportant in many industries, especially the nontrading industries. This implies a need to provide a social substitute in these industries – i.e., a need for government involvement in this area, as well as in the other two examined above.

4 The Generation of New Technology

It is important to know whether current levels of R & D spending in Canada are too low or too high, because a good portion of productivity growth is usually considered to be attributable to the R & D-induced domestic production of new technology. Economic growth therefore depends partly on doing the right amount of R & D – neither so little as to forgo the chance of improving living standards nor so much that waste occurs. It is important to know what determines the amount of domestic R & D, for policies to expand or contract it might benefit from an examination of the causal factors that contribute to it.

Like most other goods and services, new technology can be adopted or adapted from the world technology pool, as well as produced domestically. The importation of new products from abroad means that new technology is acquired in tangible form. Intangible (or "disembodied") technology is imported when *know-how* is transferred to Canadian firms from abroad via intracorporate transfer, licensing or other technology transfer agreements, joint-venture arrangements, the contracting of consultants, and so on. Even when new disembodied technology is known and used somewhere in Canada in the form of new and improved products and production techniques, the process of wider adoption or "diffusion" may take considerable time. We devote the next chapter of our report to that process.

Some Evidence on R & D Levels

The research required to determine precisely the appropriate level of R & D has not yet been undertaken in Canada. And, although researchers in other countries have tackled this problem, their results are not very precise and are only indicative. To some extent, this reflects the difficulties involved in measuring the direct and indirect effects of technological advance, which are both quantitative and qualitative in nature. Since an assessment of whether Canadian R & D expenditures are at the right level is, in a strict sense, impossible, we have used four general indicators to determine whether Canadian R & D expenditures are too low or too high: 1) the rates of return to society from R & D *vs.* those realized by the private-sector firms and research centres which do the R & D; 2) a comparison of the national levels of R & D intensity in the major OECD countries; 3) a comparison of the rates of patenting in Canada and abroad; and 4) evidence from the balance of trade and from the employment structure.

Social vs. Private Rates of Return

The benefits stemming from innovation accrue partly to firms and partly to consumers. For firms, the benefit is measured by the sum of the extra annual profits and any wage gains to workers that are attributable to the innovation. Expressed as a percentage of the costs incurred by the firm, this sum yields the *private* rate of return. A further benefit will usually accrue to buyers through lower prices or higher-quality goods. Measuring the size of this benefit to buyers is difficult, but it can be done. The sum of the annual gains to the firm and the value of the annual gains to buyers, when divided by the total cost of the innovation (including any government assistance), is called the innovation's *social* rate of return. The social rate of return is often larger than the private rate, even allowing for a generous risk component in the latter. If this were found to be generally true, it would indicate that too little innovation was being done and that government policy to encourage it might be worthwhile.

Estimates of the social and private rates of return for 17 product and process innovations introduced by U.S. firms of different sizes in several manufacturing industries from the early 1950s to the early 1970s show that the average social rate for these innovations was 56 per cent.[1] The private rates were much lower, the average being 25 per cent before taxes. The fluctuation about that average was enormous, reflecting the large degree of risk associated with innovation. In 30 per cent of the cases, the private return was so low that, in hindsight, no firm would have invested in the innovation; nevertheless, the social rates of return were so high that society as a whole gained considerably. Firms did poorly because

their competitors, through imitation, very quickly eliminated their huge profits. Consumers were better off because the same competition reduced prices on both old and new products.

Other studies have shown that the annual social rate of return per dollar spent on agricultural research in the United States ranged from 35 per cent to 171 per cent and that the return on investment in U.S. poultry research was estimated to be between 20 and 30 per cent annually.[2]

The problem, of course, is to determine whether these U.S. estimates mean much for Canada. Consider, for example, a cost-reducing innovation whose market is all of North America and for which social benefits exceed business profits because competition forces prices to consumers down after a year or two. While the profits will be comparable in size, irrespective of whether the innovation is made in the United States or in Canada – since the market covers all of North America – the aggregate benefits to consumers when the prices eventually fall will be approximately 10 times higher in the United States, simply because there are approximately 10 times as many consumers there. The same reasoning holds when the innovation is a new product (as opposed to a cost-reducing process) that is available throughout North America. It also holds when the markets are local – as in the case of new products or processes in the service sector – provided that the innovations are nevertheless applicable throughout North America. Thus the gap between social and private rates of return is generally likely to be much wider in the United States than in Canada. Consequently, the U.S. evidence that this gap is large in that country does not mean that this is true in Canada as well. As a corollary, government assistance to R & D is much more justifiable in the United States, if the criterion used is a strict measure of the net social costs and benefits to citizens of each nation alone. No doubt there are many instances where, despite the small size of the Canadian population, the social rates of return do exceed the private rates in this country. Moreover, one could argue that Canada should do its share of R & D, as an international economic obligation, even if that meant doing more than strict rate-of-return considerations would suggest. The point that must be clearly understood here is that the customary economic justification for social assistance to R & D is based mostly on evidence that cannot be readily applied to Canadian conditions.

While relevant empirical evidence on social *vs.* private rates of return in Canada is quite rare, some does exist from the area of agriculture, where the costs and benefits of agricultural research, extension, and education in Ontario have been calculated.[3] The benefits were measured by the value of the inputs (land, labour, capital, and livestock feed) that were saved. The ratio of benefits to costs was found to be 37.4:1, with the annual rate of return being 65.7 per cent. Agriculture in Ontario has benefited significantly from research done in other parts of Canada and abroad (primarily in the United States), as Ontario researchers adapt research done in other areas to local conditions. Such spillovers also occur in the opposite direction – that is, from Ontario to other parts of Canada and other countries.

An International Comparison of R & D Intensity

A simpler, less valid but more widely used indication of whether Canadian R & D levels are too low or too high is obtained by comparing them with those of other countries. National R & D intensity is most commonly defined as the ratio of gross expenditures on research and development to gross domestic product GERD/GDP.

Several conditions must hold if such comparisons are to be considered a valid indication of what the "appropriate" level of R & D expenditures in Canada should be. First, it must be assumed that the GERD/GDP ratios of other countries are at "appropriate" levels – neither too low nor too high. We have no way of judging this, except to note that concern has been expressed abroad (particularly in the United States and the United Kingdom) that perhaps an insufficient amount of R & D is being done in those countries.

Second, it must be assumed that what is "appropriate" for the United States, Japan, West Germany, and others is also "appropriate" for Canada. However, the levels and impacts of several important determinants of R & D expenditures vary widely from country to country. For example, some countries devote considerable sums to space and defence research. These sectors have predominantly strategical noneconomic objectives, although there are some economic gains in the form of direct and indirect commercial spin-offs to the nuclear energy, electronic, and aerospace industries, for example. It is not altogether clear whether comparably extensive government support of R & D in countries without large space and defence commitments would have the same impact.

Structural characteristics also have an impact; those economies which are oriented more towards manufacturing than natural resources tend to show higher R & D intensities. Similarly, the GERD/GDP ratio tends to increase with market size; smaller countries, such as Canada and Australia, tend to have lower GERD/GDP ratios than the United States,

Japan, West Germany, France, and others. A variety of other factors that may be important for success in achieving high R & D spending levels, such as access to cheap sources of know-how and the size and nature of the national scientific infrastructure (the number and type of scientists, engineers, specialized research institutions, and so on), all play important roles and all vary internationally. If any or all of these factors matter, the high level of R & D in other countries could be a misleading guide to the proper level for Canada. Therefore, an international comparison of GERD/GDP ratios can be considered as only a very rough means of assessing whether the "appropriate" level of R & D for Canada differs from the actual level.

Compared with other OECD countries, Canada's GERD/GDP ratio ranks low (Table 4-1). Although the ratio declined from 1971 to 1977, Canada's rank remained unchanged, since a number of other countries, notably the larger ones, also showed a decrease in their GERD/GDP ratios. The decreases predominantly reflect rapid GDP growth rather than absolute decreases in R & D spending.

Table 4-1

International Comparison of Research Intensity, 1971 and 1977

	1971		1977	
	GERD/GDP[1]	Rank	GERD/GDP[1]	Rank
	(Per cent)		(Per cent)	
United States	2.68	1	2.39	1
Switzerland	2.33	2	2.29	2
West Germany	2.19	3	2.14	3
The Netherlands	2.17	4	1.99	4
France	1.91	5	1.76	7
United Kingdom	1.90	6	. .	. .
Japan	1.83	7	1.91	5
Sweden	1.48	8	1.87	6
Belgium	1.40	9	1.40	9
Canada	1.35	10	1.07	10
Norway	1.10	11	1.41	8
Austria	0.60	12	. .	. .
Australia	. .	. .	1.00	11

1 Ratio of gross expenditures on research and development (GERD) to gross domestic product (GDP).

SOURCE Data provided by the Science Statistics Centre, Statistics Canada.

A distinguishing characteristic of the OECD estimates is the inclusion in gross expenditures on research and development of estimates of "invisible R & D" – that is, the estimated value of technology benefits accruing to foreign-controlled subsidiaries that do not require explicit payment in the form of royalties or other transfer payments. Consequently, the figures are overstated to the extent that some countries import R & D rather than do it themselves. This bias is most severe in Canada's case because, as a result of the very high level of foreign ownership of Canadian industry, the amount of imported "invisible R & D" is higher than in other major OECD countries.

The Science Statistics Centre estimates that, as a proportion of GDP, gross expenditures on research and development (excluding invisible R & D) in Canada declined from 1.2 per cent in 1970 to 0.9 per cent in 1976.[4] This low and declining performance led the Ministry of State for Science and Technology (MOSST) to propose a goal of 1.5 per cent, to be attained by 1983. This goal was reaffirmed recently, but the target date was extended to 1985.[5] Recently published data show that by 1980, the national GERD/GDP ratio had risen to approximately 1.1 per cent.[6]

Our examination of international GERD/GDP relationships calls into question the validity of statements about underinvestment in R & D that are based upon simple juxtapositions of aggregate ratios for any two or more countries. In order to delve beneath broad and possibly misleading international comparisons of research intensity, a model was constructed to explicitly recognize and measure intercountry variations in the levels of those variables which are held to be the major determinants of R & D expenditures.[7] These variables include factors such as market size, profitability, corporate taxation and the investment climate, foreign ownership, and the levels of government R & D funding, to cite but a few. The role of each of these factors is discussed in detail in the following section. Suffice it to say for now that if the size of these determinants varied across countries, the national GERD/GDP ratios could also be expected to vary; this would not imply that countries below the average should raise their R & D or that countries above the average should lower it. Our work represents only a beginning in respect of the task of more fully understanding why international differences exist, since the analysis is based on a relatively small sample of industries and countries, primarily because international data are far from comprehensive.

The results indicate that, on a broad sectoral basis, the actual level of R & D spending in Canada is far above expectations in the mining sector, about equal to expectations in the agricultural and tertiary sectors, and far below expectations in the manufacturing sector. Overall, the actual degree to which Canada "underinvests" in R & D is less than broad international GERD/GDP comparisons would suggest. The major source of Canada's below-average

GERD/GDP ratio is low R & D spending levels in the manufacturing sector.

Within the manufacturing sector, there is sharp variation across industries in terms of actual and expected R & D intensity. Industry-level analysis shows that, relative to a sample of other OECD countries, R & D spending levels in Canada's pharmaceutical and rubber and plastics industries are much above what would be expected on the basis of firm, industry and economy characteristics. In the paper industry, actual expenditures are slightly greater than expected. In chemicals, nonferrous metals, nonelectrical machinery, and electrical machinery, however, the actual levels of R & D spending are much lower than expected.

Rates of Patenting in Canada and Abroad

Another indicator of the level of national scientific and technological effort is the extent to which residents patent their ideas. A good measure of this is the number of patents granted to residents each year, either per 1,000 population or per 1,000 persons in the labour force. While the data on R & D expenditure levels measure the size of the input into research and development activities, patent data provide a rough indication of the size of the output from formal and informal R & D activity, in the form of new product and process technologies.

Patent statistics are only roughly indicative of national technological output for a number of reasons. First, not all patents are worked, some being held as uncommercialized inventions. Until commercialization – that is, until innovation takes place – there is no real economic impact. Second, many important new technologies are never patented. Third, because the resident population includes the subsidiaries of foreign-based companies and patents granted to these foreign-controlled subsidiaries may be for work done abroad by their parent companies, data pertaining to the patents granted to residents may be inflated. Since Canadian industry has a high degree of foreign control, the patent figures for Canada tend to be inflated more than those for most other countries. Fourth, differences between countries in the criteria used to define what is patentable introduce some bias into international comparisons of rates of patenting. For example, an innovation embodied in a single patent in one country may be recorded as three separate patents in another.

On the basis of the number of patents granted to residents per 1,000 population and per 1,000 persons in the labour force for the period 1976-79, Canada's performance relative to that of other major OECD countries is not significantly better than what is suggested by comparisons based on the GERD/GDP ratios (Table 4-2). Although Canada's rates of patenting, on both the population and labour force

Table 4-2

Number of Patents Granted to Residents per 1,000 Population and per 1,000 Persons in the Labour Force, Major OECD Countries, 1976-79

	1976			1977			1978			1979		
	Total	Per 1,000 population	Per 1,000 in the labour force	Total	Per 1,000 population	Per 1,000 in the labour force	Total	Per 1,000 population	Per 1,000 in the labour force	Total	Per 1,000 population	Per 1,000 in the labour force
United States	44,162	0.21	0.47	41,383	0.19	0.42	40,979	0.19	0.40	30,605	0.14	0.29
The Netherlands	370	0.03	0.07	396	0.03	0.08	432	0.03	0.08	455	0.03	0.09
West Germany	10,395	0.17	0.37	10,815	0.18	0.40	11,581	0.19	0.43	10,895	0.18	0.40
United Kingdom	8,855	0.16	0.34	7,722	0.14	0.29	8,464	0.15	0.32	4,182	0.07	0.16
France	8,420	0.16	0.38	8,361	0.16	0.38	8,083	0.15	0.37	6,846	0.13	0.30
Japan	32,465	0.29	0.60	43,047	0.38	0.79	37,648	0.33	0.68	34,863	0.30	0.62
Sweden	1,888	0.23	0.49	1,960	0.24	0.51	1,699	0.21	0.40	1,514	0.18	0.35
Belgium	1,020	0.10	0.25	1,060	0.11	0.26	975	0.10	0.24	833	0.08	0.20
Canada	1,301	0.06	0.13	1,291	0.06	0.13	1,404	0.06	0.13	1,408	0.06	0.13
Norway	210	0.05	0.14	263	0.07	0.17	201	0.05	0.11	250	0.06	0.13
Denmark	208	0.04	0.09	220	0.04	0.09	243	0.05	0.09	250	0.05	0.10
Finland	291	0.06	0.14	349	0.07	0.16	393	0.08	0.17	394	0.08	0.17
Austria	1,177	0.16	0.36	1,297	0.17	0.40	1,180	0.16	0.36	1,163	0.15	0.36
Australia	910	0.07	0.15	768	0.06	0.13	701	0.05	0.11	467	0.03	0.07

SOURCE Based on patent statistics from the World Intellectual Property Organization, *International Patent Statistics* (Geneva: annually) and on population and labour force statistics from the International Labour Office, *Year Book of Labour Statistics* (Geneva: ILO, annually).

basis, tend to be far below the rates shown by France, West Germany, Japan, and the United States, despite the presence of foreign-controlled subsidiaries, the rates are similar to those shown for Australia, Denmark, Finland, Norway, and the Benelux countries. It appears, therefore, that like the GERD/GDP ratios, the rate of patenting tends to increase with the size of the national economy. In fact, the rates of patenting for the larger countries are two to three times higher than those for the smaller countries. Yet there are exceptions – notably Austria and Sweden. On balance, the patent indicator confirms the evidence provided by the GERD/GDP ratio: Canadian R & D may be on the low side.

The trends in the performance of other countries are also interesting. In recent years, increasing concern has been expressed in the United States about the allegedly declining innovation performance of U.S. industry, compared with that of other major industrialized countries, particularly Japan. From 1976 to 1979, there was a dramatic decrease in the number of patents granted to U.S. residents per 1,000 persons in the labour force and a smaller decrease in the rate per 1,000 population. Similar trends have been noted in the United Kingdom; there, too, concern has been expressed about an observed deterioration in innovation performance. West Germany's performance, on the other hand, has improved somewhat. What is most striking, however, is the consistently superior performance of Japan on both measures.

The Balance of Trade and the Employment Structure

Some have argued vigorously that the high levels of foreign ownership of Canadian industry have resulted directly in the development of a weak manufacturing sector, seriously deficient in its technological capabilities. Two major types of evidence have been used to support this argument: the balance of trade, and the employment structure.

A study of the balance of trade by Britton and Gilmour shows that, for the most part, Canada's balance of payments on the current account was in net deficit throughout the 1950-70 period and that the deficit became increasingly large throughout the 1970s.[8] The major contributors to this deficit were the nonmerchandise trade in "invisibles," particularly the outflows of dividends, profits, interest payments to foreign investors, and payments for managerial and professional inputs and technology; the imports of fully manufactured end products, particularly high-technology goods; and the imports of components and subassemblies. The authors argue that since foreign-controlled firms tend to import large amounts of managerial, professional, and technological services, as well as manufactured goods, there are reduced possibilities for the growth and development of domestic technological and business services and of the producers of industrial inputs embodying new technology.

Britton and Gilmour also argue that Canada lags behind other countries with respect to employment in managerial, administrative, and scientific positions. In 1967 and 1971, for example, Canada ranked low compared with other major OECD countries with regard to the number of R & D personnel per 1,000 population. Our own examination of OECD data shows, however, that as in the case of rates of patenting, Canada falls into a group composed of smaller economies, such as Australia, Italy, Denmark, and Finland.

The major conclusion reached by Britton and Gilmour is that Canadian industry is characterized by truncated management structures, with the highest-ranking positions being located abroad, and that it is dependent upon foreign countries, particularly the United States, for new technology. They maintain that foreign-controlled firms interact less with the host economy than do domestically controlled firms, thus having a negative impact upon the growth and development of other domestic firms. As a result, domestic jobs, R & D, and innovation are displaced.[9]

Beyond this highly aggregated and somewhat circumstantial evidence, what evidence is there that foreign-controlled firms do or do not contribute to technological advance in Canada? Another study analyses 65 technology transfers made by a random selection of U.S.-based firms to their foreign-based subsidiaries during the 1960-78 period.[10] The results show that such transfers hastened awareness of a technology's existence on the part of competitors in the host country and thus hastened imitation as well. The customers and the suppliers of the subsidiary enjoyed cost savings in production and distribution and were the recipients of transfers of know-how; in other words, the technological capabilities of nonsubsidiaries were raised as a result of technology transfers from parent to subsidiary firms. These effects were found to be greater in industries where the subsidiaries of U.S. firms accounted for a large share of the Canadian market than in industries where that share was small. There is also a weaker indication that such effects were stronger in R & D-intensive industries than in industries where firms had relatively small R & D/sales ratios.

Another study of "spillover" benefits found that foreign direct investment promoted greater efficiency, as measured by labour productivity, throughout the Canadian economy by increasing competition levels

in domestic industries, by stimulating the faster adoption of new technology and improved management practices by domestic industry, and by upgrading labour force skills, which were transferred to domestically controlled firms through labour mobility.[11]

The Determinants of R & D Spending

A better understanding of the determinants of R & D spending will permit a more realistic assessment of the potential policy choices for stimulating R & D activity. Drawing upon research abroad, primarily in the United States, and the Canadian evidence available, the major determinants of R & D spending can be divided roughly into three categories, depending on the locus of their impact: firm-level, industry-level, and economy-level (including government) determinants.

Firm-Level Determinants

Firm Size

Early examination of the impact of firm size, commonly measured on the basis of sales, was sparked by the hypothesis put forward in 1950 by Schumpeter that large firms in an industry are more research-intensive than their smaller competitors, since they have more of the incentives and resources to engage in R & D activities.[12] Since firm size is affected by competition policy, the latter can affect innovation and productivity growth; other industrial policies could also influence firm size. Subsequent research has qualified Schumpeter's point of view. Both the rates of patenting and the R & D/sales ratios of firms tend to increase as firm size increases, but only to a point, after which the increases are less than proportionate to sales.

Beyond some magnitude that varies across industries, size is not especially conducive to either R & D output, as measured by patents, or R & D effort, although there are some exceptions of note – for example, the chemical industry.[13] There is also some evidence that small firms conduct their R & D with greater cost-consciousness than large firms and that smallness is not an impediment to the creation of patentable inventions.[14] In fact, smaller firms, and even individuals, are often more productive of inventions, whereas increased bureaucratization in large firms leads, in many cases, to the development of diseconomies of scale in R & D.

The evidence available for Canada points to similar conclusions. One study found no relationship between firm size and R & D spending in the machinery industry and found that R & D/sales ratios in the chemical and electrical industries first increase, and then decrease, with firm size.[15] Other factors, however, such as firm diversification and market share, may play important roles. Evidence from the Economic Council's Survey of Innovation shows a strong tendency for R & D/sales ratios in five sample industries to decrease as firm size increases. Another study, in reporting on the results of a Statistics Canada survey of innovation carried out in 1973, found that small firms and individuals alike contribute substantially to the production of new technology.[16] No single firm size was found to be uniquely conducive to technological progress. Large firms make a strong contribution to large-scale technological change, while small firms are mostly active in areas requiring sophisticated and specialized technological capabilities but relatively small production and marketing resources.

Diversification

Related to the influence of firm size is the degree of firm diversification. Schumpeter theorized that, since R & D is a risky activity, firms active in a variety of fields are generally able to produce and market a greater proportion of R & D output, since they have more opportunity to exploit unexpected research results. Also, the degree of risk faced by diversified firms should be less, since the costs of failure can be spread over a number of activities. The impact of diversification matters, since it can be affected, in principle, by competition, tax, and other policies.

Tests on the effects of diversification have not been conclusive, with the results pointing in several, apparently contradictory, directions.[17] Part of the reason why these results are inconsistent is that the relationship between product diversification and R & D intensity is not straightforward: greater diversification contributes to, and results from, greater R & D activity.

Foreign Control

A third factor having an impact on firm-level R & D expenditures is whether the firm is controlled from abroad. Policy on foreign ownership and control therefore affects the amount and kind of R & D being done. Theoretical and empirical research on the organization of management structures and production activities in multinational corporations addresses, among other issues, the location and organization of R & D activities. Subsidiaries tend to perform less research than their parent companies, since corporate R & D facilities tend to be centralized in the headquarters country. By centralizing R & D activities, economies of scale can be realized up to a point, beyond which increases in the size of the R & D unit can lead to inefficiency. The benefits arising out of

the proximity to large familiar markets also encourage such centralization. The resulting structures of subsidiary firms have been described as truncated, since they do not contain all of the management functions associated with independent firms or, if they do, they do not enjoy autonomy. It is this characteristic that is held by some to be a major contributor to underinvestment in R & D in Canada.

Is there direct evidence that foreign-controlled firms in Canada are not, in fact, as R & D-intensive as their Canadian-controlled counterparts? One of the early studies of this question examined the R & D/sales ratios of a sample of 280 firms in the manufacturing, mining, and petroleum industries in the late 1960s.[18] No evidence was found at that time that foreign-owned firms did less research than comparable Canadian-owned firms, although research by foreign-owned firms was not as extensive or as sophisticated as that of their parent companies.

The relationship between research intensity and foreign ownership depends upon the technological characteristics and progressivity of the industry in question, according to one study.[19] In industries classified as technologically progressive, increased foreign ownership is associated with greater research intensity. Conversely, for industries facing unfavourable technological opportunities, the results suggest that increased foreign ownership is associated with less research intensity. It is increasingly believed that foreign control is widespread in research-intensive industries, not because foreign-controlled firms do more research but because foreign investment tends to be attracted to industries where R & D intensity is high – a reflection of the propensity of multinational companies to exploit technological leads in a number of different national markets. Nevertheless, according to one study, even in the most research-intensive industries, the R & D/sales ratios of Canadian-owned firms tend to exceed those of their foreign-controlled counterparts.[20]

Some argue that most of the R & D performed by foreign-controlled firms is adaptive in nature, oriented towards the modification of existing ideas, methods, and designs to suit the Canadian market. The evidence from our own survey sheds a little more light on the question of the relative share of original and imitative innovations in foreign- and Canadian-controlled firms. High proportions of the innovations of both types of firm in the five sample industries were "world firsts": original innovations represented 59 per cent and 48 per cent, respectively, of the innovations of Canadian and foreign-owned firms. Furthermore, regardless of whether the innovation was original or imitative in nature, the technology was developed using in-house R & D resources for 82 per cent of the innovations of Canadian-controlled firms and for 54 per cent of those of foreign-controlled firms. In some cases, although the innovation may have been a "world first," the technology was acquired from an external source – most often, a foreign-based parent.

For three reasons, such high proportions of original innovations should not be taken as representative of the innovation effort of all firms and industries. First, the five industries surveyed – telecommunications equipment and components, electrical industrial equipment, plastic compounds and synthetic resins, nonferrous smelting and refining, and crude petroleum exploration and production – are more technology- and R & D-intensive than many other industries. Second, the selection of innovations reported upon was made by the respondents themselves, who doubtlessly were somewhat biased towards their own original innovations. The extent of the bias, and hence the magnitude of inflation of the figures pertaining to original innovations, is unknown. Third, the survey contains data on successful innovations only. Innovation attempts that were not successful are not included.

These qualifications, however, do not negate the fact that the relative shares of original and imitative innovations reported in our survey do not differ greatly between the two categories of firms. Although Canadian-controlled firms tend to produce more original innovations and to rely more heavily on in-house R & D resources than foreign-controlled firms, it is clear that the latter are involved in much more than adaptive R & D only.

Table 4-3

Average R&D/Sales Ratio in Canadian- and Foreign-Controlled Firms, by Size of Firm, Canada, 1978

	Canadian-controlled firms		Foreign-controlled firms	
	Number surveyed	R&D/sales ratio	Number surveyed	R&D/sales ratio
		(Per cent)		(Per cent)
Number of employees in the field:				
50 or fewer	34	11.2	13	3.3
100 or fewer	45	10.1	23	4.3
200 or fewer	54	9.1	38	3.7
500 or fewer	60	8.4	54	3.4
More than 500	5	10.3	14	2.0

SOURCE D. P. DeMelto, K. E. McMullen, and R. M. Wills, "Preliminary Report: Innovation and Technological Change in Five Canadian Industries," Economic Council of Canada, Discussion Paper 176, Ottawa, 1980, p. 44.

Thus foreign-controlled firms do spend on R & D in Canada, though not as much, proportionately, as Canadian-owned firms. A comparison of R & D/sales ratios in 1978 shows that the latter, regardless of size, were considerably more R & D-intensive than their foreign-controlled counterparts (Table 4-3). This is in conflict with the conclusions reached in the late 1960s. While this conflict may reflect differences in the samples used, more likely it reflects the fact that a real change has taken place over the last 10 years in the R & D intensities of the two types of firms (Table 4-4). In 1973, the difference between the two types in manufacturing and in all industries was not large. By 1979, however, the R & D/sales ratios of foreign-controlled firms, on average, had dropped considerably below those of domestically controlled firms.

When the composition of innovation costs, averaged for all innovations, is examined, we find that the proportion of expenditures made at the R & D stage is low for foreign-controlled firms, compared with that for Canadian-controlled firms. This difference arises because the former tend more frequently

Table 4-4

Current In-House R&D Expenditures as a Proportion of Sales, Canadian- and Foreign-Controlled Firms, Canada, 1973 and 1979

	1973		1979	
	Canadian-controlled firms	Foreign-controlled firms	Canadian-controlled firms	Foreign-controlled firms
	(Per cent)			
Mines	x	x	0.76	0.75
Gas and oil wells	x	x	1.23	0.84
All mining	0.87	0.63	1.05	0.81
Food, beverages, and tobacco	0.21	0.39	0.16	0.40
Rubber and plastics products	1.31	0.65	1.08	0.73
Textiles	0.41	0.62	1.87	0.58
Wood-based industries	0.25	0.37	0.27	0.25
Primary metals (ferrous)	x	x	x	x
Primary metals (nonferrous)	0.74	1.39	x	x
Metal fabricating	0.77	0.33	0.33	0.37
Business machines	16.92	1.63	7.99	1.33
Other machinery	1.61	1.10	1.08	0.65
Aircraft and parts	5.40	18.05	19.03	5.22
Other transportation equipment	2.54	0.13	2.11	0.22
Other electrical products	1.20	1.36	1.03	1.06
Communications equipment	7.96	4.51	9.73	5.53
Nonmetallic mineral products	0.47	0.36	0.83	0.48
Petroleum products	x	x	0.02	0.39
Drugs and medicines	14.60	3.59	7.51	3.45
Other cheminal products	1.65	0.99	2.59	0.68
Scientific and professional equipment	19.93	0.84	17.72	0.66
Other manufacturing industries	0.47	0.70	0.75	0.22
All manufacturing	0.97	0.91	1.06	0.68
Transportation and other utilities	x	x	0.24	-
Electrical power	0.59	x	0.78	-
Engineering and scientific services	4.39	5.68	7.76	5.84
Other nonmanufacturing industries	x	x	2.41	1.00
All services	0.55	0.53	0.61	2.29
All industries	0.88	0.89	0.92	0.69

SOURCE Data provided by the Science Statistics Centre, Statistics Canada.

to acquire new technology from abroad – usually from parent or affiliated firms – thus requiring less in-house R & D to commercialize that technology. For innovations that are acquired externally, then, only a certain amount of adaptive R & D is undertaken.

Access to Capital

The final firm-level determinant of R & D expenditures to be discussed is the firm's liquidity position and access to capital. These factors can be very much affected by public policy. Many authors argue that only firms generating a substantial cash flow can support a sizable R & D effort, since many firms are unwilling, or unable, to borrow substantial funds to support investment in R & D activities.

Within the firm, R & D is an investment like any other and must compete for funds with other types of expenditures, such as production costs, capital investment, and taxes. Since the risk levels associated with R & D investment are generally higher than those for most other uses of funds, R & D activities are unlikely to be financed by borrowing or issuing new equity; instead, the firm will depend upon profits as a source of funds.[21] For some industries, profitability is a determinant of R & D spending, while for others it is not. This inconsistency may be a reflection of opposing pressures on firms: high profits lead to both greater availability of funds for R & D and greater demand for increased investment in non-R & D activities. Nevertheless, R & D activity does increase both profits and growth.

The role of after-tax profits in determining the level of R & D in foreign- and Canadian-controlled firms has also been examined.[22] In the case of Canadian-owned firms, the level of after-tax profits was found to be an important determinant of R & D expenditures in two out of the three sample industries. In the case of foreign-controlled firms, profit levels were important in only one industry. These results suggest that the condition of the Canadian financial environment is less relevant to an explanation of the variation in R & D spending among foreign-controlled firms than among domestically controlled firms. In other words, the R & D decisions of foreign-controlled firms are not made within a strictly Canadian context but, instead, with reference to the corporation as a whole.

Although our Survey of Innovation contains no data relating directly to firm profitability, some indirect evidence is available with respect to innovation-funding behaviour. Over half of all innovations reported were financed entirely by internal funds. With the exception of the firms employing between 201 and 500 persons, foreign-controlled firms financed a larger proportion of their innovations entirely from internal funds than did Canadian-controlled firms of similar size. Small and medium-sized Canadian-controlled firms not only sought outside funding more frequently, but they also showed a high degree of flexibility in doing so, acquiring funds from a diversified group of financial sources, none of which provided a large proportion of the required investment capital. These firms also cited, most frequently, financial difficulties as a significant problem encountered in innovating.

Industry-Level Determinants

Technological Opportunity

It has been observed that some industries are more research-intensive than others. The degree to which an industry is science-based has been termed "technological opportunity." The industries enjoying greater technological opportunity are those which have a greater scope for exploiting basic scientific knowledge. If policy were to affect the industry mix, it would therefore affect the overall level of R & D.

Differences in technological opportunity are a major factor responsible for interindustry differences in patented output.[23] For example, the electrical and chemical industries exist within a "vigorous scientific climate" and thus have an assured and continuous supply of new, exploitable technical possibilities; the paper, food, and textile industries, on the other hand, face a more limited supply of new technological possibilities.

One study found that the Canadian industries with the greatest technological opportunity are electrical products, chemicals, nonmetallic mineral products, scientific and professional instruments, machinery, fabricated metals, transportation equipment, rubber, and petroleum.[24] Low technological opportunity is available to the food, textile, wood, furniture, paper, and primary metals industries. Industries for which technological opportunity is great tend to be more research-intensive than those with low technological opportunity.

Industry Concentration

The role of industry concentration, which of course is sensitive to competition policy, has been explored extensively as a determinant of R & D. Schumpeter has argued that innovation requires a relatively sizable commitment of resources and is risky; consequently, it requires a sizable return to make it worthwhile. In perfectly competitive industries, imitation by other firms occurs quickly, thus eliminating very high profits and the incentive to innovate. Hence firms in a monopoly position find innovation most profitable and engage in more R & D.[25] At the firm level, this is indeed the case, as the firm introducing a new

product onto the market wishes to profit from being in a short-term, limited monopoly position relative to its competitors with respect to that product.

Empirical findings regarding the role of industry concentration are quite mixed.[26] No relationship was found between variations in market power and the output of patented inventions, and in concentrated industries much R & D appears to be devoted to product differentiation, or pseudo-innovation. Nevertheless, the relationship is complex, since market power tends to coincide with the availability of technological opportunity. For "technology-rich" industries in Canada, increased concentration is associated with reduced research effort, while for "technology-poor" industries increased concentration appears to contribute to greater research effort.

It has been suggested that the complexity of the relationship between concentration and R & D effort arises out of the fact that, beyond the short run, both market structure and R & D activity are affected by factors such as demand and financial market conditions. In markets characterized by rivalry, each firm's R & D effort depends upon the anticipated response of competitors. The stability of market shares in a given industry reflects the extent of that rivalry, one element of which is innovation activity.

Market Size

Of major importance to the level of R & D effort is the expected market size. Because the cost of reproducing knowledge is much lower than the cost of generating it, each firm's private return from R & D depends upon the number of times that knowledge is reproduced – that is, the number of units of output produced.[27] In other words, the overall size of the market determines the volume of the monetary benefits that the production of knowledge generates. Policy can enter the picture in various ways; for example, market size can sometimes be increased by reciprocal agreements with foreign countries to lower trade barriers.

Some authors contend that there is too much emphasis on the role of market demand in stimulating innovation activity.[28] With the exception of pure (or basic) research, R & D activity is oriented towards the tapping of demand, either through the creation of new products or through the more efficient production of existing ones. Although it is a necessary condition, the existence of market demand alone is not sufficient, however; it must occur in an environment where potential technological opportunities exist.

In itself, market size may not be necessarily relevant to an analysis of the industry-level determinants of R & D, since potential market size will vary depending on the share of the market held by the individual firms. Suffice it to say that the existence of a potential market of sufficient size is unquestionably a prerequisite to any applied research and development. Larger industry markets provide more incentives for firms to engage in R & D activities than do smaller markets.

Regulation

A fourth factor having an impact upon industrial R & D spending is the prevailing regulatory climate. Two types of government regulation of industry have an impact on innovation activity in the business sector: health, safety, and environmental regulations; and the regulation of industries such as public utilities, which are subject to price, rate of return, and other controls. Extensive analysis of the impact of regulation on the U.S. pharmaceutical industry has attributed a number of negative effects on research effort to the tightening of safety and efficacy requirements for new product introduction, following amendments to the U.S. Food, Drug and Cosmetics Act in 1962.[29] The negative effects include a decline in the number of new chemical entities, increased cost per chemical entity, a decreased private rate of return to R & D, a faster decline of research productivity in the United States than in the United Kindgom, and a change in location of R & D activities by U.S. firms away from the United States. In the pharmaceutical industry, however, another important factor affecting the increased costs and risks and the decreased output of new chemical entities since 1962 has been the depletion of research opportunities resulting from the heavy exploitation of the basic research available.

Quantification of the impact of government regulation in the health, safety, and environmental fields is therefore complicated, since parallel and unrelated developments in the affected industries tend to obscure direct regulatory impacts. Also, regulation does not necessarily cause a decrease in R & D activity; instead, the direction of some innovation activity may be altered, as in the case of pollution control regulations in the automobile and the smelting and refining industries.[30]

Among regulated industries, railroads have experienced a slowing down and distortion in the pattern of technological change.[31] In the U.S. communications industry, where the Bell System exists as a regulated monopoly, the regulatory impact includes the effects on the changing rate of innovation through time; higher levels of carrier-exclusive technology than is either optimal or necessary; a significant amount and variety of innovation forestalled by independent firms that see no chance of access; and greater control of the market structure through

exploitation of regulatory policy.[32] In general, incentives to innovate are greater under competition than under monopoly if the innovating firms can appropriate the returns.

Economy-Level Determinants

Investment Climate

The relationship between R & D and economic growth works in two directions: increased R & D both contributes to, and results from, economic growth. The investment climate is intimately connected with the expectations of firms with respect to the future growth of the market and can therefore be seen as a national-scale proxy for the expected market size at the industry level. Cost of capital, market demand, and expected rate-of-return considerations all play a role in decisions to invest. Research and development and innovation activity, being more risky than most other investments by firms, are strongly affected by the prevailing national investment climate, although interindustry differences are apparent. It has been found that R & D expenditures often increase in the expansion phase of the business cycle but generally decrease in the contraction phase.

Corporate Tax Levels

The tax burden affects corporate cash flow and thus the amount of internal resources available for R & D activity. As seen previously, the after-tax profitability of firms is one of the factors that determine the level of R & D activity. Therefore, lowering corporate income taxes or increasing depreciation allowances could generate increased R & D effort at the firm level, although whether the benefits would outweigh the tax costs is a matter for detailed analysis.

The Economic Council has undertaken a research program that will attempt to determine the impact of taxation on risk-taking. The structure of personal and business taxation and the impact of changes in this structure on resource allocation are being examined. Research is also being conducted on the effect of tax incentives on business investment. The results of this research will be discussed in a report on productivity, scheduled to be published next year.

Direct Government Financial Support

As the role of government policy and the process of technological advance were discussed in the preceding chapter, only a few comments will be made here. On the supply side, there are two kinds of government participation in the national R & D effort: involvement that has indirect "economic climate" effects, already discussed in terms of the investment climate and the levels of corporate taxation; and policies that are directly and explicitly oriented towards stimulating R & D expenditures.

Within the category of direct government R & D policies are tax-based measures and government grants and subsidies to firms for specific R & D projects. It is reasonable to assume *a priori* that a more favourable tax treatment of R & D expenditures would increase the total volume of the business sector's R & D efforts. In fact, there is good evidence to suggest that Canada already has, by world standards, very favourable tax treatment of R & D expenditures.[33] But, unlike tax incentives, it is much less certain that direct government grants and subsidies in support of business R & D will increase the total amount done, since firms may simply substitute those government funds for private funds that were originally intended for that purpose.

On the basis of a sample of 81 firms in three industries, it was found that Canadian-owned firms in the electrical industry increased the volume of their own funds invested in R & D by more than the amount of the grant, whereas the foreign-controlled firms raised it by less than the amount of the grant.[34] In the chemical and machinery industries, the receipt of a government R & D grant had no effect on the total R & D expenditures of firms. Thus, at the very minimum, R & D grants tend to have the effect of increasing the value of resources devoted to R & D by society (though not necessarily by the private sector) by the amount of the subsidy. Another study, based on a sample of 11 U.S. industries and covering the 1958-75 period, found that the growth of publicly financed stock of R & D had a positive effect on the private R & D stock in total manufacturing and in the durable-goods industries but a negative effect in the nondurable-goods industries.[35]

The Federal Contracting-Out Policy

The level of government funding of R & D in Canada is roughly similar to that in West Germany and Italy but is lower than that in the United States. The proportion of R & D performed in the business sector is much lower in Canada than in all the other OECD countries (except Australia) having a ratio of gross R & D expenditures to GDP of at least 1 per cent (Table 4-5). Having observed that a larger proportion of R & D was performed within the government sector in Canada, the Senate Special Committee on Science Policy (the Lamontagne Committee) recommended in 1972 that industrial involvement in federal R & D activities be encouraged by contracting out projects whenever possible and feasible.[36] The adoption of such a policy was intended to lead to several benefits: the scientific capability and general

Table 4-5

Gross Expenditures on Research and Development by Business and Government, Selected OECD Countries, 1977

	GERD/GDP[1]	Sector performing R&D		Government funding of total GERD	Share of government-financed R&D performed by government
		Business	Government		
		(Per cent)			
United States	2.4	66.8	15.3	51.0	30.0
Switzerland	2.3	75.7	6.8	21.1	32.2
The Netherlands	2.0	51.7	20.8	22.7	91.6
West Germany	2.1	65.0	16.1	44.2	36.4
France	1.8	60.3	22.3	37.7	59.2
Japan	1.9	57.8	12.1	16.2	74.7
Belgium	1.4	67.9	11.4	. .	. .
Canada	1.1	37.3	30.3	45.7	66.3
Italy	1.0	53.6	24.6	47.8	51.1
Norway	1.4	47.1	18.4	33.5	54.5
Finland	1.1	51.9	26.3	30.5	86.2
Australia	1.0	24.8	50.9	54.1	94.0

1 Ratio of gross expenditures on research and development (GERD) to gross domestic product (GDP).

SOURCE A. B. Supapol and D. G. McFetridge, "An Analysis of the Federal Make-or-Buy Policy," Economic Council of Canada, Discussion Paper 217, Ottawa, 1982.

performance of private industry would increase; innovation commercialization would be more likely to occur and with greater ease; more rapid innovation diffusion would occur; and some economic spin-offs from government R & D could be expected.

Later that year, the federal "make or buy" policy was enacted, requiring that all new mission-oriented research and development in the natural sciences be contracted out to Canadian industry.[37] The policy was broadened in 1977 to include existing mission-oriented research and development, wherever possible; science and technology requirements in the human and social science fields of urban, regional, and transportation studies; and unsolicited proposals from private industry.

In examining the impact of this program with respect to contracting out by the federal departments concerned, the Economic Council found that such behaviour has not increased in areas where there are potential benefits but that it has increased where there are few such benefits. No great gains have been made in the amount of federal mission-oriented R & D performed in the private sector. The situation remained the same in 1980 as in 1972: as a source of R & D funds, the federal government is not significantly better or worse than are the governments of other major OECD countries; however, the funds have not been channeled successfully into the private sector.

The reasons for the apparent lack of success of the "make or buy" policy can be identified by examining the behaviour of individual government departments before and after the policy was implemented. Two departments that might have been expected to produce the greatest benefits from contracting out – Communications and Defence – had already engaged in considerable contracting out of R & D prior to the issuance of the "make or buy" directive. Although they, along with Energy, Mines and Resources, remain the most active departments with regard to contracting out to manufacturing firms, the impact of the policy has been negligible, since the gains made in the proportion of R & D performed for them by private industry have only been modest. In the case of the Department of Communications, the policy appears to have been redundant, the department's contracting out activities having reached the saturation point by 1972. The cases of Defence and of Energy, Mines and Resources are more ambiguous. The evidence suggests that the low level of contracting out on the part of the latter may reflect in part a bureaucratic reluctance to comply. To some extent, this may also have been the case for the Department of Defence, although the high costs of contracting out may have played an important role as well.

Although the other departments examined – Health and Welfare, Environment, Agriculture, and Transport – have responded positively to the "make or buy" policy, the potential for them to engage in contracting out is much less than for the departments already discussed. Their response has therefore been relatively modest.

The policy implication arising out of this analysis is that it might be preferable to confine the application of the directive to those departments where contracting out can be expected to produce net benefits. In some situations, departmental R & D requirements might be met more efficiently by conducting in-house R & D – for example, when the objectives are general rather than specific, when the outcome is uncertain, and when specialized facilities are required. Only if an investigation reveals that there is bureaucratic reluctance to comply should there be more vigorous enforcement of the policy.

The result of the "make or buy" policy has been that, in constant dollars, contracting out of R & D to the manufacturing industry has actually declined, while the service sector – mainly R & D consulting firms – has benefited more. It can be argued that this result is not altogether unfavourable and that, in fact, it brings with it some important benefits. Some firms, particularly small ones, do not have sufficient resources to monitor constantly technological developments worldwide – an important source of ideas and information for the conduct of R & D and for the adoption of new technologies. Consulting firms, in the areas of engineering, design, management, and so on, are partially in the business of collecting and integrating such information and could thus fill an important information gap for other firms. Therefore, the fact that some federal departments are making use of the services of these firms in their contracting-out activity can, by aiding their growth, indirectly benefit other firms – provided, of course, that these other firms supplement their in-house R & D with the services of consulting firms.

When letting out a contract, an effort should be made to ensure that technical approaches are not set too early in the process. Federal departments, whenever possible, should define the ends and leave the technical means by which performance standards are met up to the firm (or firms) involved in the project. The practice of setting performance, rather than material, specifications is already being followed in the case of some projects. Wider application of this rule could contribute to promoting the development of R & D and technological expertise in Canadian firms.

Research and Development by Government Itself

Finally, there is an important and direct role to be played by government on a formal basis, both in its own research establishments and in the general support of research in universities, since the size and quality of a nation's underlying "scientific base" have an impact upon R & D in the business sector. By definition, basic research is not directly oriented towards the development of new products and processes; consequently, only very large firms can afford to invest in such research on anything more than a very small scale. For most firms, the major sources of new technological ideas are universities, government research establishments, and, above all, other firms. Also, an awareness of research conducted worldwide, not just domestically, is crucial to the process of national technological advance. A valuable informational role is played by public-sector research institutions.

In 1981, 26 per cent of R & D spending in Canada was performed by the federal and provincial governments in their laboratories and departments; a further 21 per cent was performed by universities. The link between these institutions and industry could perhaps be strengthened in terms of the transfer of both ideas and technological know-how. Firms, particularly the smaller ones, are often unaware of the nature and potential value of public-sector research. Conversely, researchers in government laboratories and in universities are often unaware of the technological needs of industry. Narrowing the gap between public sources of knowledge and private users of that knowledge could bring important benefits.

Besides producing knowledge of technological benefit to the private sector, the universities and government research laboratories fill other important roles. They conduct mission-oriented research of a type not usually performed in the private sector because the costs are high and because the returns cannot be sufficiently appropriated by the firms themselves, accruing instead to society as a whole. Examples are research in the fields of health and the environment. Also of major importance, of course, is the teaching role of universities. Knowledge and skills are passed on to students, who then act as diffusion agents when they are employed in the private sector.

Other Factors Influencing the Generation and Use of New Technology

In the literature on economic development, particularly in Europe, a number of other factors are adduced as important in determining the pace and form of economic development and as relevant for policy. We do not deal with them in this report, but they should be mentioned, and some of their implications should be indicated.

These factors include the agglomeration of activities, the linkages among activities and institutions, the critical masses that generate good synergistic results, and the spatial distribution of technological knowledge and of the production of goods and services.

Some structures are more favourable than others to the development and use of knowledge. Also, certain geographical concentrations of activity appear to be more favourable than others to those objectives.

These considerations have a bearing on the use and location of research parks; on the kinds of activities that are put together; on the design of contracting-out arrangements for research and development; on the location of, and links between, centres devoted to the generation of new technology; and on the places where it is used. While these are important matters, they would take us beyond the research underlying this book. The Council plans to explore these matters in the future and to make the literature on them more readily available.

Conclusion

Four broad indicators have been used to assess whether Canadian R & D expenditures are at their "appropriate" level. On balance, it appears that Canadian R & D spending levels may be too low. It should be stressed, however, that the evidence for this is far from conclusive. It is weak enough that it is crucial to consider individual industries or even projects on their own merits, with a view to discovering in a detailed, careful, and pragmatic way whether more R & D is worthwhile socially in each particular case.

Our interpretation of the rather incomplete evidence on rates of return from R & D is that private rates probably tend to fall below social rates in Canada. If so, this indicator suggests that firms are currently investing less in R & D than is desirable from an overall social perspective, despite current policy action in the form of patent laws and of subsidies and tax incentives for R & D.

At the same time, it is apparent that simple international comparisons at a broad level of aggregation are not very helpful in determining whether current levels of R & D spending in Canada are "appropriate." Disaggregated, industry-level analyses, though complicated by the lack of data, are more enlightening. They do indicate that Canadian R & D is low, though not as low as the aggregate data would imply. Furthermore, disaggregated analyses are fruitful from the point of view of identifying the factors that contribute to either low or high R & D levels, by international standards.

Research conducted to date in Canada and abroad leads to few striking conclusions regarding the impact of the usually hypothesized determinants of R & D on national R & D effort. Firms of all sizes, including independent inventors, contribute to innovation. Although highly diversified firms may spend more on R & D, the output of that R & D activity in terms of new patentable technology tends to be no greater than that of more specialized firms. Similarly, the role played by industry concentration, regulation, and direct government funding of innovations is ambiguous, the impacts being affected by other determinants of R & D, such as technological opportunity. Thus the lesson from these research results is that simple nostrums, such as "push large firms" or "increase the strength of competitive policy" are unlikely to be effective ways to increase R & D. A detailed, individualistic approach is more likely to be fruitful.

A positive role with respect to investment in R & D is played by a favourable liquidity position in the firm and ease of access to capital, a sufficiently large potential market size, a favourable tax structure, and an encouraging investment climate. Research and development in government laboratories and the universities also play a positive role, although the impact of such research is often indirect; the links with R & D and innovation in the private sector could be strengthened.

Finally, our examination of the presence of foreign ownership in Canadian industry leads us to conclude that the evidence presented in this chapter and the next does not support the point of view that the effects of foreign control are only negative. The evidence points to lower R & D intensity, though not necessarily lower technological intensity – the distinction is important – in foreign-controlled firms. By acting partially as an outlet for their parent companies' innovative technologies, foreign-controlled subsidiaries provide a conduit through which new and sophisticated technology that is relatively expensive to develop enters Canada. This point is discussed in greater detail in the next chapter.

5 The Spread of New Technology

The output of the domestic R & D complex consists of two groups of innovations. One group comprises those which are produced by Canadian firms. The other group consists of innovations that imitate technologies being used by firms elsewhere in Canada or abroad. Although both the domestic development of original innovations and the adoption of innovations from the world technology pool are important, the latter is dominant in Canada. According to the National Research Council,

> Canada's total output of technology amounts to less than one percent (1%) of the total world output . . . . It is a matter of considerable urgency that efforts be made to bring the ninety-nine percent (99%) of world technology forcefully and more conveniently to the attention of the possible exploiters, which are mainly to be found in industry.[1]

Canada is not unique in this respect; the world technological system is interdependent, with firms in all countries contributing to, and drawing upon, an international pool of technology. It would be unrealistic to expect that any one country could consistently surpass all others in the innovative application of new and existing knowledge in all fields. An important objective of Canadian policy on technical change, therefore, should be the rapid and efficient introduction into Canada of successful innovative technologies developed abroad and the rapid diffusion of these, as well as of domestically produced innovations of course, throughout Canadian industry.

There is abundant evidence that the diffusion of new technology into Canada and across Canadian regions occurs slowly enough to suggest there may be a need for government involvement. Some examples illustrate this point. Data taken from a special survey of innovations in five industries conducted by the Economic Council show that the average lag for the adoption by Canadian firms of new processes – most of which were developed abroad – was nine years, and for new products it was seven years. In both cases, the median lag was five years; in other words, over 50 per cent of the innovations showed lags of over five years. For example, a process for the continuous processing (as opposed to batch processing) of polystyrene, which was developed in Italy, was first adopted by a Canadian firm seven years later; blast furnace oxygen enrichment, which was in wide use throughout Europe, the United States, and Japan, was first adopted in Canada 22 years after it was first developed abroad; the vacuum casting of uranium was developed in Germany and the United States 31 years before being adopted in Canada; the earliest adoption by a Canadian firm of rubber lining (instead of iron or steel lining) for autogenous grinding mills occurred 18 years after it was developed in Sweden.[2]

There is also a regional dimension. Computers were first introduced into Canada in the early 1950s. Because this is a broad area, the concept of "first adoption" may be defined in various ways, thus making categorical statements about adoption lags impossible. Nevertheless, using a plausible definition of adoption, research done at the Council strongly suggests that Ontario was the first to adopt computers, followed by the Prairie provinces five years later, the Atlantic provinces six years later, and British Columbia eight years later.[3] When the diffusion of shopping centres is measured by the number of centres per 5,000 population, Alberta was the first to adopt this innovation. Ontario followed one year later; and Quebec, Saskatchewan, and Manitoba, four to six years later.[4] In the Atlantic region, the lag was 16 years.

These examples show that complacency about the automaticity or optimality of the diffusion process could be dangerous. Obstacles to the spread of technical change exist, as do slow adopters. Thus there is a role for public policy in assessing whether unnecessary lags exist in the diffusion of new technologies and, if so, in eliminating them.

The Diffusion of Innovations

The decision to adopt an innovation occurs at the level of the individual firm; when, over time, several firms in an industry adopt the innovation, diffusion is said to occur. The characteristics of innovations and

adopters alike change from the earlier to the later stages of the process.

The Process of Diffusion

In the early stage of diffusion of a successful new product technology, purchasers are relatively insensitive to price changes; profits per unit of output are high, as are levels of risk for producers; and product changes are frequent and rapid. Over time, however, purchasers become increasingly sensitive to price, profits per unit of output and risk levels decline, and standardization of product characteristics occurs. The emphasis shifts from unique product characteristics to a reduction in production costs – that is, from product to process innovation.

When the rate of innovation adoption is examined over time, the curve is typically S-shaped (Figure 5-1). Early in the diffusion process, relatively few firms in an industry are willing, or able, to accept the high levels of risk that are involved in adopting an innovation. The level of uncertainty associated with adoption decreases as demand grows and as more firms adopt the innovation. Near the end of the cycle, saturation levels are reached, resulting in a leveling-off of adoption rates. In summary, the willingness to accept relatively higher levels of risk early in the diffusion process is rewarded by higher profits. As the level of uncertainty decreases over time, unit profit levels decrease and competition increases, with more firms learning of, and adopting, the innovation.

From a policy point of view, the encouragement of rapid innovation diffusion so that firms will be early or mid-range, rather than late, adopters can bring several benefits. Consumers are able to gain the advantages of lower prices and better quality at an earlier stage, so that living standards rise sooner than otherwise. Companies can also benefit in several ways, some of which are shown in Figure 5-1. The early adopters of successful product innovations have few competitors, earn high profits, have high skilled-labour intensity, and are in a favourable export position. Mid-range adopters have many of the same characteristics but to a lesser degree. Late adopters, on the other hand, face much greater competition from other domestic producers and from imports. They have high capital and unskilled-labour intensity, and they need long production runs to be more efficient. From a national point of view, therefore, there is greater potential for industrial and income growth when the output of domestic firms includes innovations that are in the early and growth stages of their life cycles.

Technology transfer from firm to firm can occur on either an informal or formal basis. Firm managers may become aware of the existence of a new technology through informal information flows – e.g., through personal contacts, trade journals, trade shows, and industrial espionage. The benefits and feasibility of adopting are then assessed, and a decision is taken about whether to adopt the innovation. If the decision is favourable, in-house research and technological skills are directed towards developing the innovative product or process technology. Alternatively, rather more formal technology transfer agreements can be entered into by the adopting firm. This occurs when the technology to be adopted has already been patented by another firm, when the adopting firm does not possess the in-house skills needed to develop the technology, or when it is cheaper to purchase the know-how from another firm than to develop the technology internally. Formal technology transfer can take several forms, the most common being: parent-subsidiary (intracorporate) transfers that include unwritten arrangements and licensing agreements; licensing arrangements with unaffiliated firms (customers, suppliers, and competitors); joint-venture arrangements; the contracting of consultants; and agreements with universities or government research institutions. Irrespective of whether the technology transfer occurs on an informal or formal basis, the bulk of imitative or adopted technologies originates outside Canada.

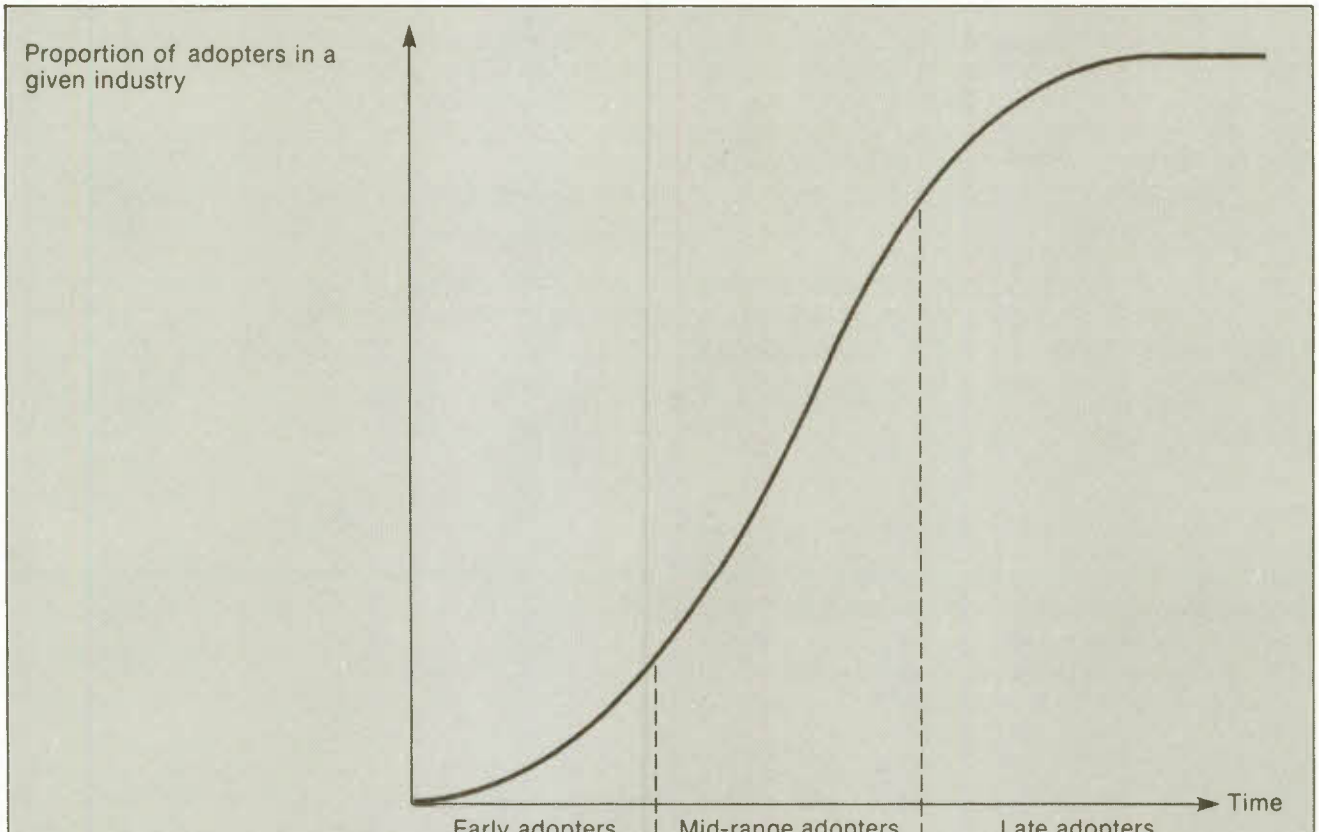
Factors Affecting the Rate of Diffusion

Most of the published research on the factors affecting the diffusion of innovations focuses on what we call the "informal innovation diffusion process," and most of the case studies deal with U.S. manufacturing industries, although the process of innovation diffusion in Canadian manufacturing has also been examined. Although the variety of factors affecting the diffusion process is bewildering, some common threads can be extracted and used to devise potentially useful policies to aid that process.

In an examination of 12 process innovations adopted by firms in four U.S. industries, it was found that as the profitability of each innovation increased and as the size of investment required for adoption decreased, the rate of diffusion increased.[5] Lag rates on innovation adoption also tended to decrease as firm size increased. Another study found that the willingness of firms to adopt an innovation tended to increase with their internally generated funds; in other words, an increased cash flow led to increased investment and hence to more rapid innovation diffusion.[6] Management responses were stressed highly in terms of attitudes to risk and the active search for information. It has also been found that early adopters were younger, more progressive, and

Figure 5-1

Diffusion Path of Innovations and Changes in Their Life Cycle Characteristics over Time



Stages in innovation life cycle

Characteristic	Early stage	Growth	Maturity
Risk	High	Decreasing	Low
Price elasticity	Low	Increasing	High
Unit profit margins	High	Decreasing	Low
Competition	Based on product performance	Increasing standardization	Based on product differentiation and price
Production runs	Short	Lengthening	Mass production
Factors of production	High skilled-labour intensity; low capital intensity	Increasing capital intensity	Unskilled-labour intensity; high capital intensity
Export potential	High	Growing investment abroad	Increasing import competition

SOURCE Based on L. T. Wells, ed., *The Product Life Cycle and International Trade* (Cambridge, Mass.: Harvard University Press, 1972), pp. 3-33.

more willing to undertake risk.[7] Moreover, the probability of innovation adoption was found to be greater for firms investing explicitly in formal R & D activities.[8]

Industry structure has been found to be an important determinant of the rate of innovation diffusion.[9] The presence of many small firms tends to slow the diffusion process because of the difficulties they experience in obtaining information and making use of it. Larger, more specialized firms tend to adopt innovations more quickly than smaller, more diversified firms, since the former benefit more from economies of scale and from "learning by doing." The financial and risk advantages enjoyed by larger firms encourage the faster spread of innovations in industries characterized by significant economies of scale. These advantages are of little significance, however, unless the larger firms are faced with competitive pressure to adopt as a result of the entry, or threat of entry, of new firms into the industry, for example, or of external competition in the form of imports.

The role of access to information has been recognized as important in innovation diffusion analysis, but it has not been dealt with statistically. The often crucial role played by customers for idea generation and sources of information used in technical problem-solving has been stressed.[10] In other studies, equipment suppliers have been found to be important to the innovation diffusion process.[11] Geographical proximity to suppliers offers advantages with respect to ease of servicing and access to technical expertise and equipment improvements, thus spurring innovation diffusion.

It has been argued that greater recognition should be given to the effect of "supply side" factors – that is, the technological characteristics of innovations – on the rate of diffusion.[12] Both product and process innovations are characterized by continuous improvement and modification. As a result, the number of potential users increases over time. Since diffusion rates are commonly measured as the proportion of adopters in an industry at different points in time, growth in the number of potential adopters may imply that the rate of diffusion is slower than is actually the case. A role is also played by what is often referred to as "complementarities," when a given innovation is slow to diffuse because other innovations that would make it possible to relax or by-pass bottlenecks are not available. The learning period required to develop the skills in order to use the innovation varies, depending upon the complexity of the innovation and the extent to which the technology is new and not amenable to the use of skills already available or transferable from other industries. This applies to mechanical skills, facilities, and design or engineering capabilities. In addition, diffusion rates are affected by social, legal, and institutional factors, such as regulation, the availability of labour skills, and licensing and patenting policies.

While the factors affecting the rate of innovation diffusion have been identified through case studies of manufacturing firms, they may well apply to the service, construction, and transportation industries as well; they would certainly apply to the large portions of those industries which are in the private sector and are thus subject to the pressures of competition.

The Formal Transfer of Technology into Canada

Intracorporate vs. Arm's-Length Transfers

Most of the new technology adopted by Canadian firms through innovation imitation or diffusion originates abroad. Besides percolating into Canada informally as part of general information flows, new technological know-how can be transferred formally between firms. Such transfers occur in one of two ways. An intracorporate transfer occurs when the supplier of the technology is related by corporate ownership ties to the firm acquiring the technology. An "arm's-length transfer" occurs when a firm acquires a new technology from another with which it has no ownership ties, such as a supplier, a customer, or a competitor.

With the growth in size and geographical spread of multinational firms, the market for technology has expanded rapidly in the past two decades. While both intracorporate and arm's-length transfers are common, it is good to ask whether one is more efficient than the other at transferring technology to Canada, thus raising real output and incomes. Research into this question is still at an early stage. Much of it focuses upon increasing our understanding of the behaviour of multinational firms – more specifically, of the reasons why they establish foreign branch plants and why they perform some activities themselves but entrust other activities to unrelated firms.

One of the main strengths of very large firms is the production of knowledge and technological know-how. Multinational firms establish subsidiaries in foreign countries for a variety of reasons – for example, to gain access to resources, to compete more effectively with rivals in foreign locations, or to avoid tariff barriers. Because market position can be protected by applying new technology in the form of product and process innovations, technology-oriented multinational firms establish subsidiaries in foreign countries in order to market their products and to provide the means by which their knowledge

advantage can be exploited through production and, at the same time, protected from use by competitors through internalization of the market for technology – that is, by relying heavily upon intracorporate transfers across national frontiers. The R & D function for the corporation as a whole, which is an important source of new technological know-how, is usually centralized near the parent company's head office. Centralization leads to economic and efficiency benefits that arise out of economies of scale, of the potential for research in one area to lead to unexpected benefits in other areas, of the synergism that derives from the interaction of a large group of scientists and other specialists, and so on. As a result, foreign-based subsidiaries tend to conduct less research than their parent companies. Other activities, too, tend to be centralized at the head office, such as financial and investment planning, legal and institutional relations, production planning and co-ordination, large-scale purchasing, and so on. The central co-ordination of these and other activities has been found by very large corporations to be the most efficient way to operate. By conducting business transactions internally, they reduce the risk and uncertainty attendant upon dealing with a large number of unrelated firms.

The multinational firm is not completely self-enclosed, however; arm's-length interactions with unrelated firms are desirable and, at times, necessary. For example, the technology that a multinational wishes to adopt may be patented by another firm, in which case a licence or other formal agreement is necessary. Or the multinational may find it cheaper or quicker to acquire technology from another firm than to develop it internally. Conversely, it may wish to license its own technology to an unrelated firm in order to enter a new market without establishing a foreign branch, or it may simply feel that it is no longer necessary to protect a given technology from use by competitors and may enter into an agreement with them to sell its know-how in order to receive royalties or other payments. Internalization (or intracorporate transfer) occurs when the need to protect the technology from use by competitors is great; when close, long-term interactions are required to effectively transfer information, know-how, and skills; or when there is the potential for unforeseen or unfair gains to be made by one firm at the expense of another.

Given that the reasons for intracorporate technology transfers differ from the reasons for arm's-length transfers, one would expect that the characteristics of the transferred technologies would also differ. Empirical analysis of the two types is especially necessary in the Canadian context, since policies oriented towards foreign investment in Canada must be designed with as full an understanding as possible of the behaviour of large foreign-controlled firms. One key aspect is the nature of the parent-subsidiary relationship with respect to R & D and technology. To this end, the Council analysed data on 1,382 technology transfers by U.S.-based firms during the 1950-78 period, contained in the Multinational Enterprise Project data base at Harvard University. Both intracorporate and arm's-length transfers were considered.

The results of this analysis show that new technologies that represent major departures from the current state of the art and that are expensive to develop are predominantly transferred on an intracorporate basis. Technologies transferred in this way usually have not been subject to many previous transfers – a reflection, partially, of their newness. Also, firms that have not previously been involved to any great extent in the technology transfer process will tend to transfer technology to subsidiary and affiliated firms rather than to unaffiliated firms. Those which are R & D-intensive rely very heavily on intracorporate transfer, since one of the reasons why they establish subsidiaries in foreign locations is to have controlled outlets for their technological know-how.

Why is it that large firms prefer to deal on an intracorporate basis rather than at arm's length? The primary reasons are the risk and uncertainty involved in dealing with any firm over which the transferer has no control and with which there is no common ground, in terms of experience through long-term interaction, shared goals, or similarity in production and operation methods. The situation is similar to that of two strangers with quite different backgrounds and approaches to problems; it is more difficult, in these circumstances, to accomplish a complicated task to the satisfaction of both than it is when two close friends, who are used to collaborating on a variety of problems over many years, work together.

The transfer of know-how and skills from one firm to another is difficult because the use of physical tools such as blueprints, engineering designs, and prototypes cannot conceal the fact that the thing to be transferred is intangible. Particularly for new, hitherto unknown ways of doing things, the difficulties involved are enormous, often requiring a long-term and intensive relationship whereby information and personnel flow between the firm transferring the technology and the recipient. When the firms are related, they share the same goals; thus no gain would be made if, for example, the transfer was left incomplete by the transferring firm. In arm's-length transactions, there is always the possibility that one of the parties involved will make unfair claims in order

to reap benefit for itself. In addition, the firm that has invested heavily in the development of a new technology wants to protect it from revelation to other firms, lest they imitate it at less expense and soon become competitors, thus reducing the innovating firm's rate of return – i.e., its reward for undertaking the risk and expense in the first place.

In general, technologies transferred at arm's length tend to be older and less advanced relative to the state of the art, and to have been the subject of a larger number of prior transfers, than those which have been the object of intracorporate transfers. The problems associated with transferring better-known technology will be less difficult, since the recipient of the technology will already have some of the knowledge and skills in place. The firm transferring the technology will also have had more experience with it and, frequently, will have already been involved in transferring it to affiliated firms; thus it will have learned from past experience how to effect the transfer most efficiently. As a result, the cost to both parties will be less in terms of time and personnel. The transferring firm will feel less need to protect the technology from being used by other firms, since the advantage gained by proprietary knowledge erodes through time as competitors imitate the technology and as new, more advanced technologies are developed. Rather than protect the technology any longer and hold it internally, the transferring firm will gain some further advantage by selling it to other firms. Technologies transferred at arm's length tend, therefore, to be less important to the businesses of the transacting parties than intracorporate transfers. There are, of course, a few exceptions. Some firms (usually small ones) are unable or unwilling to become involved in foreign production, but they do find it advantageous to have a presence abroad. In this case, one alternative is to license another firm that has production facilities in a foreign location.

An analysis of data for the 1945-75 period, also contained in the Multinational Enterprise Project data base, reached parallel conclusions.[13] Multinational firms with high levels of R & D activity showed a high propensity to produce quickly and widely in foreign locations and tended to use subsidiaries rather than independent licensees as the channel for such overseas production. In slightly less than half of the cases where technology-intensive product lines were established in subsidiaries abroad, production was established in Canada before Europe. Despite the fact that Canada and Latin America declined as host countries for U.S.-based subsidiaries relative to Europe, Asia, and Africa, firms continued to use Canada as a very early production site in a high proportion of cases. At the same time, rates of withdrawal by sale or liquidation of subsidiaries have been particularly high for Canada since 1966. Several factors may account for this trend. Through time, many firms have rationalized production, eliminating plants that duplicate the products of other plants or that are in high-cost locations. International trade has opened up somewhat as a result of the GATT negotiations, making foreign production less necessary in some cases. The advantage of producing in Canada in order to gain favourable trade access to the Commonwealth countries is no longer significant. In addition, withdrawal from Canada may reflect, to some extent, a reaction to Canadian attitudes towards foreign investment and to the Foreign Investment Review Agency. It has been argued that access to technology developed by the parent company gives foreign-controlled firms in Canada a competitive edge over domestically controlled firms, as reflected in their larger size, higher productivity, and higher profits, all of which are a natural consequence of efficient organization and operation.[14]

In sum, the foreign-controlled corporation is one of the fastest and most effective channels through which new, sophisticated, and expensive technological know-how is imported into Canada. Although this means that less R & D is done in Canada than might otherwise be the case, it also means that significant technological benefits accrue to Canada. Of course, not all firms and industries operate to the technological benefit of host countries. The drug industry, for example, is frequently cited as an example of a predominantly foreign-controlled industry where relatively little technology transfer into Canada has occurred.[15] Despite this, foreign control of the Canadian drug industry has not had a negative impact on the rate at which new drug products appear on the domestic market, the rate in Canada being similar to that in the United States.

Certainly, the formal importation of technological know-how involves considerable costs in the form of royalties and payments for industrial design, research, and services performed abroad, and so on. On the other hand, it is also certain that Canada cannot produce all new technology domestically and that it must therefore tap into the world technology pool, both formally by entering into intracorporate and arm's-length transfer agreements and informally by generally gathering information about knowledge and technology developments abroad. Within the former category, the technological benefits associated with intracorporate transfers far exceed those associated with arm's-length transfers. Hence, from a policy perspective, any move designed to hamper the technology transfer behaviour of foreign-controlled firms – for example, by forcing them to

deal at arm's length with their subsidiaries – could have negative consequences for technological advance in Canadian industry.

Foreign- and Canadian-Controlled Firms

Evidence from the Economic Council Survey of Innovation shows that the extent and nature of technology transfers to firms in Canada vary greatly, depending upon whether the firms are Canadian- or foreign-owned. The results show that, over the period surveyed, foreign-controlled firms acquired technology from external sources to a much greater extent than Canadian-owned firms. While these transfers were predominantly of the intracorporate variety, transfers from other sources also occurred. Foreign-controlled firms, therefore, are not "tied" exclusively to their parent companies as technology sources. Domestic firms, on the other hand, relied almost exclusively on arm's-length sources when acquiring technology from an external source – predominantly suppliers, research institutions, customers, and consultants.

To a certain extent, these differences are not surprising since, by definition, all foreign-controlled firms in Canada are members of large corporate groups. Many, though not all, of the Canadian-owned firms in the survey were autonomous and thus did not have the option of tapping into centralized corporate technology pools. Nevertheless, one-quarter of these firms were subsidiaries of Canadian-owned corporations, but the parent companies did not act as an important source of technology. Since we do not have any direct evidence, we can only speculate as to why domestically controlled firms did not receive more technology transfers from their parent companies. It may well be, of course, that parent and subsidiary firms operate in different lines of business and that such diversification reduces the potential for intracorporate technology transfer. Technology-intensive firms owned by non-Canadians establish branches abroad in the same or similar lines of business in order to exploit their advantage in technological know-how; this predisposes them to intracorporate technology transfers.

With only a few exceptions, the external sources of technology, ideas, and information for both foreign- and Canadian-owned firms were situated abroad, primarily in the United States. The major sources of information for idea generation and problem solving, as opposed to formal technology, in the case of foreign-controlled firms were parent and affiliated firms. Canadian-owned firms, on the other hand, relied more heavily on arm's-length sources.

An International Perspective

Just how quickly is new technology introduced into Canada, both formally and informally? The evidence on this is fragmentary, but nevertheless instructive. One intercountry comparison, using a case-study approach, examined special presses in the pulp and paper industry, tufting machinery in the textile industry, and numerical control in the tool and die industry.[16] In the latter two cases, Canada lagged behind other countries with respect to the date of initial use. As for the special presses in the pulp and paper industry, while they were initially used at an earlier date in the United States than in Canada, no such lag was evident upon comparing Canada with a sample of European countries. For all three innovations, the rate of diffusion, as measured by the proportion of firms that had adopted them over a given period of time, was slower in Canada.

These differences in the rates of diffusion of the three innovations within each country were attributed to differences in the relative advantages that firms derived from their adoption. Since major manufacturing innovations are characterized by significant economies of scale deriving from large fixed costs and from learning by doing on a large scale, larger firms with long production runs tend to be in a better position than small firms to adopt such innovations. Since a large portion of Canadian industry is characterized by relatively small firm size and short production runs, the rate of diffusion in Canada tends to be slower than abroad. These structural characteristics can be largely attributed to the impact of tariffs. By encouraging the existence of small firms, tariffs in effect impose an indirect cost in the form of slower diffusion speed.

The international diffusion of the basic oxygen process in the steel industry has also been studied extensively.[17] The results show that the United States lagged behind other countries in the adoption of this process primarily because the major U.S. steel producers, being oligopolists, had a vested interest in maintaining the status quo and retaining existing processes despite the cost advantages offered by the new process. Not only did Canada adopt the basic oxygen process before the United States, but the rate of diffusion of new technologies throughout the Canadian steel industry was also higher until the early 1960s. It has been suggested that one reason for this difference is that the use of that process tended to result in greater cost saving at a smaller scale of operation.[18] As the Canadian steel industry consisted of smaller-scale producers than its U.S. counterpart, the new process diffused more rapidly in this country.

Thus it seems that when the scale of a new technology does not match the scale of domestic firms, diffusion rates are slower – a reflection of the fact that additional development work is required to adapt the technology to fit the needs of potential adopters more closely. Some therefore argue that more rapid innovation diffusion in Canada should be encouraged not by promoting large firm size and hence increased concentration, with its negative consequences for competition, but by "freeing the market" and eliminating tariff and nontariff barriers to trade, and by promoting the faster scaling-down of new technology to fit the needs of existing firms.

The Evidence on the Canadian Lag

The current state of the art in innovation diffusion research takes the form of a still rather loose collection of hypotheses rather than a comprehensive model. However, work done at the Council has attempted to move one step further towards the development of a model that will explicitly recognize the complex interactions that occur between the many factors acting upon the diffusion process, by analysing the relatively abundant and unique data contained in the Council's Survey of Innovation data base.[19] Some of the examples of lags uncovered by the survey were mentioned in the introductory paragraphs of this chapter.

Of the 283 innovations reported upon, 111 were imitative in nature; that is, they were first commercialized by other firms, 92 per cent of which were located abroad, primarily in the United States. In half of the cases of imitative innovation, the firms developed the technology using in-house R & D resources; in the other half, the technology was obtained from an external (intracorporate or arm's-length) source. Associated with each imitative innovation is a lag, which is defined as the number of years from the first known date of commercialization to that reported by the imitating firm. While the average lag lasted eight years, half of the innovations showed lags of five years or less, while 27 showed lags of ten years or more.

Before setting out to identify the factors that determine this lag pattern, we developed a scenario about the behaviour of firm managers and about their perception of the risk associated with the adoption of innovative technologies and of its expected profitability. The decision to adopt consists basically of balancing the level of risk perceived for a given innovation with the expected rate of return of that innovation. Risk is a concept that involves uncertainty about future events; it is the chance that the returns expected will not materialize. In order for innovation adoption to occur, the expected rate of return must be high enough to compensate for the perceived level of risk; as the perceived risk increases, so also does the expected rate of return. Because the managers of different firms have different attitudes towards risk, they require varying rates of return before adopting an innovation. As a result, some firms adopt early, while others lag, preferring "safer" investments. The actual decision-making process is complicated by a number of factors that affect both the perceived risk and the expected rate of return.

Our findings show that the length of the lags associated with innovation adoption is strongly affected by risk-related factors. Lags tend to increase with the cost of the innovations relative to firm size, reflecting the higher levels of risk incurred by firms with large-scale investments. On average, in our sample, total innovation adoption costs were equivalent to 19 per cent of the firm's sales in the year in which adoption took place. If this ratio had been higher by 20 per cent, thus raising it to 23 per cent, the average lag length would have lengthened by three months. Similarly, firms took longer to adopt innovations embodied in new products and processes, as opposed to improvements in technologies already used by them. A 20 per cent increase in the proportion of new innovations, which would then have represented 72 per cent instead of 60 per cent of all innovations, would also have resulted in a three-month increase in the average lag length.

Factors pertaining to the perceived rate of return are also important, although their impact is smaller. As the realized pay-back period becomes shorter, lag durations decrease; in other words, when the cost of an innovation can be recouped relatively quickly, firms are willing to adopt it sooner. Also, as the level of government funding of the innovation increases, lag lengths decrease slightly. A rise in the average level of government funding of innovations from 8 per cent to 10 per cent (a 20 per cent increase) would reduce the average lag by about one month. By reducing the cost of adoption to the firm, government subsidization of innovation investment acts somewhat as a spur. The impact of government funding of innovation would likely be greater, were it not for the fact that in many cases firms merely substitute government funds for their own funds.[20] In other words, not all firms increase their spending on innovation adoption by the amount of the government contribution.

There is evidence to suggest that firms that acquire the technology for their innovation from parent or affiliated firms may have a slight edge, in terms of lag duration, over firms that develop the technology internally or acquire it from an outside source. While a 20 per cent increase in the average firm's

R & D/sales ratio (from 4 to 5 per cent) would result in a little less than a half-month decline in the average lag length, a 20 per cent increase in the proportion of intracorporate transfers (from 34 to 41 per cent) would result in a two-month reduction in the average lag length.

In addition to lag durations, the factors determining the cost of the innovation relative to firm size and the use of intracorporate technology transfers were also examined. Higher proportions of financial resources are allocated by firms to innovation adoption when the technologies involved are older – that is, for innovations characterized by relatively longer lags. One explanation might be that, as technologies age and proceed along learning curves through the experiences of earlier adopters, firms that adopt them later regard those technologies as increasingly less risky investments and so adopt them on a larger scale. Similarly, new innovations are perceived as being more risky than improvement-type innovations; as a result, the investment/size ratios of firms are smaller for new innovations. By adopting improved innovations, firms benefit from the experience gained from previous, related methods of operation; hence they are less averse to investing relatively large amounts of capital.

Among the determinants of the use of intracorporate sources of technology, the nature of firm ownership plays an important role. Because a large proportion of Canadian-owned firms are autonomous and have rather limited options as a result, they tend to develop imitative technologies internally. On the other hand, foreign-controlled firms have the option of tapping into intracorporate technology pools. The results show that the age, size, and R & D-intensity characteristics of firms have no notable effect on their choice of sources for technological innovations. Of importance, however, is the cost of innovation adoption relative to the size of the firm. When the investment involved is relatively large, firms tend to rely on intracorporate sources of technology. This behaviour can be interpreted as a way to reduce risk.

The direct impact of foreign control is to cause a decrease in lag duration. Foreign-controlled firms introduced 66 per cent of the imitative innovations. A 20 per cent increase in this ratio, raising it to 79 per cent, would reduce the average lag duration by five months. Conversely, if the proportion of innovations introduced by foreign-controlled firms were reduced by 20 per cent, lowering it to only 53 per cent of the imitative innovations, lag duration would increase by eight months. It is of interest to note that the impact of foreign control on lag duration exceeds in magnitude that of any one of the other variables.

Innovation Adoption in the Service Sector

Thus far, the discussion has focused on the introduction in the Canadian manufacturing sector of technologies developed abroad, one reason being that most of the published studies and of the data available to us relate to this sector only. Nevertheless, there is little argument that productivity growth and technological change have been slower in the service sector. There are two possible reasons why the pattern of technological change differs in those two sectors. First, until very recently, the new technologies designed for use by firms and institutions in the service sector had not been developed with nearly the same frequency as those for the manufacturing sector. In part, this occurred because the service sector is more dependent upon suppliers for new technologies, whereas manufacturing firms are more self-dependent, engaging in research and development that is both internally and market-oriented. Second, the rate of innovation diffusion in the service sector may be slower than in the manufacturing sector. Neither of these explanations applies to Canada only; rather, they reflect the different characteristics of the two sectors in general. Nevertheless, many of the determinants of the speed of innovation diffusion are operative in both sectors. In order to encourage faster growth in living standards, the determinants of the speed of innovation diffusion in all sectors must be identified so that we may better see how to improve the diffusion process.

In recognition of the large size of the service sector in terms of both employment and contribution to gross domestic product, the Economic Council published, two years ago, a study (by Steven Globerman) of the adoption of electronic data processing and related computer applications ("automation" of facilities) in a number of public and private service industries: university libraries, hospitals, grocery retailing and wholesaling, and department and variety stores.[21] Adoption levels in Canada were compared with those in the United States, and the factors contributing to faster or slower automation were identified.

For comparable time periods, adoption levels were higher in the United States for hospital and department store automation. Although a detailed comparison of automation levels in food stores was not possible because of data limitations, for at least one major automation application (scanning equipment), adoption levels were also higher in the United States. Canadian university libraries, on the other hand, appeared to become automated somewhat faster than their U.S. counterparts.

An evaluation of the determinants of these differences suggests that, to some extent, the profitability of automation in the retailing and wholesaling sectors may have been higher in the United States, leading to more rapid adoption in that country. Similarly, the net benefits of adoption in the case of hospitals appeared to be greater in the United States, also leading to faster adoption there. The benefits to hospitals from automation include cost savings and increased efficiency in accounting-related functions such as payroll, patient billing, inventory, pharmacy records, and purchasing. Successful automation has been less widespread in actual medical applications such as diagnostics, patient-monitoring devices, and lab testing.

Globerman argued that in the case of university libraries, the higher adoption levels in Canada at a given point in time reflected greater net benefits here than in the United States. The economic benefits of automation to libraries consisted of savings in requirements for clerical staff; improved record-keeping for circulation, ordering, and cataloguing; and cost savings in actual physical equipment such as typewriters and paper. Globerman also argued, however, that the economies of scale achieved in the earlier stages of automation in the larger Canadian university libraries should have contributed to even faster automation in Canada.

Globerman found that for both hospitals and libraries there was some evidence of organizational slack when there were no strong incentives for increased efficiency or cost saving. Since hospitals and libraries are not profit-oriented, their managers are not subject to the same pressures of competition that exist in the market place. Public sector organizations do, however, compete for publicly distributed funds.

In considering the evidence and interpreting his results, Globerman suggested that policies be designed to increase both the incentive and the ability of public sector organizations to adopt innovations that would increase their operating efficiency. Incentive budgeting, by assuring the service organization that it could retain some percentage of its cost savings in its future budgets, might create a greater incentive to increased efficiency and thus encourage faster diffusion. In addition, the budgetary process should give administrators a reasonable planning horizon. Since planning for, and adopting, innovations usually requires a fairly lengthy transitional period, year-to-year uncertainty in the annual budgeting process is not conducive to the rapid spread of innovative technologies and new organizational structures. In many cases, individual administrators could be allowed greater latitude in making innovation decisions, thus reducing the bureaucratic delay associated with new investments.

Globerman found no clear evidence that larger firm size and economies of scale led to faster adoption of automation in the service industries generally, whether in the public or the private sector. He concluded that "the adverse impact of reduced competition and larger firm size on the propensity to innovate may more than offset any increases in the profitability of adopting innovations characterized by some amount of indivisibility."[22] The policy objective should therefore be to promote more rapid development and diffusion of "scaled-down" technology – an approach that would augment the market forces that lean in that direction anyway.

Further work for the Council has examined the adoption of electronic data processing by the insurance industry.[23] The early pattern of electronic data-processing use in this industry is similar to that found in other industries, in that the earliest application was the automation of basic accounting activities. Over time, new uses emerged. These included improved cash collection procedures, the introduction of new services, and improved customer service.[24]

In large part, the adoption of electronic data processing in the insurance industry, as in other service industries, led to greater increases in the quality and variety of the services offered rather than to decreases in unit costs. While traditional measures of productivity fail to capture quality changes adequately, it should be pointed out that most productivity studies have dealt with the goods-producing sector – one in which the effect of the failure to capture quality changes is arguably less severe than in the service sector.

The pattern of first use of electronic data processing in the Canadian insurance industry is comparable to that in food retailing and in department and variety stores. Adoption in these industries predates adoption by deposit-taking institutions in general and chartered banks in particular, as well as by public institutions such as hospitals and libraries. Preliminary analysis suggests that this pattern of faster adoption by the insurance sector can be explained by the fact that its product is more standardized and that the degree of competition in the insurance industry is greater.

Electronic data processing was first adopted by the U.S. insurance industry in 1954, with adoption by its Canadian counterpart occurring two years later. By 1962, however, the percentage of automated insurance firms was about the same in both countries. In terms of intensity of use, as measured by the number

of computers per firm, the U.S. insurance industry was ahead of its Canadian equivalent until the mid-1960s; thereafter, intensity of use in the two countries converged. In other words, the United States was faster off the mark, but Canada caught up rapidly.

Preliminary analysis suggests that the critical factors explaining the pattern and rate of adoption of electronic data processing in the insurance industry are firm size and standardization of output. The economies of scale associated with the adoption of automation are substantial. As a result, the largest firms in the industry were the first to adopt. As well, life insurance companies (whose policies are more uniform than those of other insurance firms) were quicker to automate than general insurance firms. The impact of size on automation adoption appears to be stronger in the insurance industry than in the grocery retailing and wholesaling industry and in department and variety stores.

By 1969, 88 per cent of the insurance industry was still not automated. This slow rate of diffusion to medium-sized and small firms is striking. It highlights the limited impact of the scaling-down of electronic data processing despite such innovations as time-sharing and the minicomputer. At present, attempts are being made to exploit the possibilities offered by real-time networking, which allows smaller firms to tap into the computer facilities of larger firms. This process is advancing slowly, as communication costs pose a barrier. Other problems are lack of standardization and compatibility in record-keeping and software. The issue of potential market failure in scaling down new technology to fit the needs of firms in *all* sectors is an important one for science policy. It reinforces our conclusion that greater emphasis should be placed on innovation diffusion than has hitherto been done.

The Patent System

Thus far, the discussion has focused upon identification of the factors affecting the speed with which Canadian firms adopt new technology. There is, however, a tool already available that can be used to promote the diffusion of technical information and know-how more effectively, thus increasing the potential for quicker and more-efficient technological advance in Canadian industry. That tool is the patent system; it could be used by establishing a service for the dissemination of the wealth of technical information contained in patent descriptions.

Historically, the patent system was designed as an information-gathering tool. In fourteenth- and fifteenth-century Europe, the main reason for granting inventor's privileges to foreigners was to attract technical knowledge from abroad and to disseminate it throughout the domestic economy. Foreign craftsmen were encouraged to practice their crafts in the host country, protected from competition for limited periods, provided that they employed and trained domestic labour in their special knowledge and skills. This is an early example of the most direct form of importation and diffusion of technology for industrial development purposes. During the nineteenth century, it became generally recognized that written patent descriptions were an important source of technical information; by the end of the century, national patent laws reflected that recognition by requiring that inventions be classified and that patent descriptions and indexes be published, and by providing for free public access thereto.

The explosive growth of technology during the twentieth century, however, has resulted in patent offices applying their resources solely to the legal examination of applications for patents. The informational aspect of patents has been almost completely neglected, and until recently no serious effort was made to ensure that the vast amount of new technical information accumulating in patent files was disseminated. Since the onset of the current worldwide economic slowdown, the rate of patenting has declined, giving patent offices a breathing spell that has enabled them to regain control of their previously huge backlog of unexamined applications. Once again, they are turning their attention to the long-neglected half of their intended function – information dissemination.

Patent files can be regarded as a technical information bank. If they were put to the use suggested here, firms could tap into that information and use it as an aid in technical problem solving and in idea generation, building upon technical ideas that are already patented. Dissemination of patent information would also make it possible to inform potential users of technology as to which firms have expertise in which areas, thus promoting technology transfer, both domestically and internationally. Given an effective patent-information dissemination service, the potential for more rapid and more efficient technological advance in Canadian industry would increase.

There are enormous differences between countries and between patent offices, in terms of both their awareness of the informational value of patents and the steps taken to exploit it. At one end of the spectrum is Japan, with two patent information organizations: the Japan Patent Information Centre, which specializes in computerized patent-information retrieval systems, and the Japan Institute of Invention and Innovation, which is engaged in a variety of

activities directed at educating the public about the patent system and at providing a comprehensive range of patent information services to the public and to industry. Sweden and Australia are about midway in the spectrum. The Information Centre of the Swedish Patent Office performs technical-content searches of patent files and is involved in educational and training activities. Similarly, the Australian Patent Information Service provides an on-demand information service based on worldwide patent literature and engages in educational activities by participating in public seminars and lectures. Patent offices in virtually all the industrially developed countries now have information programs similar in purpose to those in Japan, Sweden, and Australia, although they vary in scope and emphasis. The U.S. government, for example, does not operate a formal patent-information search service; however, technical information is provided to the public through various specialized offices.

Canada occupies a position at the opposite end of the spectrum, where no active dissemination of patent information takes place, in company with the developing countries. That situation is anomalous because, unlike the patent offices of the developing countries, the Canadian Patent Office has ample resources in technical information, as well as the human and physical resources to deliver an information system to those who need it.

Although the Patent Act promotes the disclosure of technical knowledge by requiring that an inventor give a complete technical description of his/her invention in the application, it does not contain effective measures for promoting the dissemination of that technical knowledge. Thus it fails to fulfil what is now viewed increasingly as one of the basic functions of a patent system – namely, promotion of the disclosure and dissemination of technical knowledge in order to encourage innovation.

The strength and specificity of Section 36 of the Patent Act stands in contrast to the weakness and generality of Section 27. Section 36 provides for a full description of the product or process to be patented, so that any person skilled in the art or science to which it pertains can make or use it. It also requires the patent applicant to state those aspects which are new and to which an exclusive right is claimed. Section 27 is vague, stating that the Commissioner of Patents "may" (rather than "shall") cause patent information to be printed for distribution or sale. Thus dissemination of patent information is only discretionary. The teaching value of the patent specification, so clearly provided for by Section 36, cannot be realized without complementary, formally mandated measures aimed at the dissemination of that information.

In Canada, the marketing of patent information has been left to the private sector. Private patent-information services are restricted in scope, however, because profits can be made only through specialization in narrow areas of special interest to large corporations and organizations. These services do not adequately serve small and medium-sized manufacturing companies.

The Canadian Patent Office, were it given the appropriate mandate, could immediately mount a patent information dissemination service aimed especially at small businesses. It could do this in a cost-effective way – even though private companies could not – merely because most of the necessary overhead is already covered by the need to run the patent-granting part of its program. An effective methodology for the dissemination of patent information has already been established through a two-year trial project carried out in 1978-80, which involved the marketing of patent information to small manufacturers and private inventors through provincial research organizations.[25]

The patent system in Canada is underutilized because it is little known outside the patent profession and large corporations. It will remain underutilized, as would a patent information service, unless the Patent Office initiates an educational program to make businessmen and others aware of the variety of uses to which the system can be put, as is already being done in Japan, Sweden, and Australia.

Under Section 10 of the Patent Act, patent specifications are not released from secrecy until the patent itself is issued. If earlier disclosure of recent advances in technology increases the potential for industrial and income growth, then the present system of publishing at date of issue should be changed in favour of earlier publication at a date terminating a fixed period (say 18 months) after the filing date or the priority date of the application (if any), and the Act should be amended accordingly. This practice is being implemented increasingly in many other countries, and it is a requirement of the Patent Cooperation Treaty (which Canada has not yet ratified).

Some might argue that early disclosure could place applicants in an unfavourable position, since their know-how would not yet be protected from imitation by competitors. However, the proportion of applications for patents that are refused is very small. Early disclosure would discourage frivolous applications for patents; furthermore, it would permit the identification at an early stage of what research is under way, thus contributing to a reduction in redundant research.

The question of the size of the fee to be charged for the service cannot be ignored. Basically, there are two considerations that must be taken into account when determining the appropriate user charge. First, for fully efficient use of the service, a fee equal to the incremental cost to the government of providing the service should be charged. Second, the fee could be reduced to below that cost if social benefits additional to the private benefits that businessmen are willing to pay for were identified. Two examples of potential social benefits are: increased effectiveness of government grant and subsidy programs, and informational and educational economies to the public.

In its pilot stage, the patent information dissemination service was found to be highly useful to the administrators of the Enterprise Development Program and the Industrial Research Assistance Program, as well as other government programs involving financial assistance to firms on a project basis. It permitted more effective decision making, because the program officers were able to use patent information to assess the uniqueness and/or originality of proposals and to ascertain whether other firms were involved in similar research; funding of redundant research was thus reduced.

Also included among the potential social benefits are those deriving from the educational aspect of the service. By bringing the patent system as a whole closer to firms, universities, research institutions, and industry associations, the service would contribute to an increased understanding of, and ability to use, the system on the part of the public. The cost to individuals and firms of securing patents and using them as a source of technical information would decrease as users gained experience, thus increasing the effectiveness of the system. Unnecessary and wasteful duplication of research effort would be reduced, while knowledge as to which patents have expired would open the way to new avenues of research and production.

In sum, a patent technical-information service should be government-run, because that would be the only cost-effective means of getting the information to those who need it. But it should not be free, unless noneconomic considerations dominated. If the latter were the case, care would need to be taken to ensure that free service is not overexpanded.

The information required to determine judiciously the proper fee for users of a patent information service is not always obvious nor is it easily quantifiable. The expertise needed to conduct a comprehensive cost/benefit analysis resides not at the Patent Office but at the Treasury Board. If a patent technical-information dissemination program were to be implemented, strict monitoring of costs and careful estimation of benefits should be a condition for its existence, with a formal evaluation of the program by the Treasury Board to occur after a three-year period. At that time, informed decisions could be made about whether the program should continue and what the appropriate user fee should be.

Conclusion

Our general finding is that new technology diffuses slowly into Canada from other countries. It also diffuses slowly from firm to firm and from region to region within the country. By "new technology," we mean new and improved products, processes, and organizational structures. Although there are some exceptions, case studies show that often the process of diffusion of technical change into and throughout Canada occurs more slowly than in other Western developed nations, and not only in the manufacturing sector but in the service sector as well. Substantial benefits could be realized if the diffusion process into and throughout Canada were to be speeded up. We find that scope does exist for policies designed to achieve this.

On a more specific level, we find that the factors affecting the speed with which new technology diffuses are many and that the relationships among them are complex. A particular finding of considerable importance is that one of the fastest and most effective channels for the transfer into the country of new, expensive, state-of-the-art technology and new ideas is the multinational corporation.

Other important findings stem from our analysis of the factors affecting the length of the lag between the first world use of an innovation and its adoption by a Canadian manufacturing firm. Risk and rate-of-return factors play important roles: these include the cost of the innovation; whether it is new or improved; its payback period; the level of government funding; and the nationality of the firm's control.

It is worth highlighting the importance of our new evidence on the diffusion of innovations in the service sector. As was pointed out in Chapter 2, the service industries represented 62 per cent of GDP in 1980. The relative paucity of research on innovation diffusion in this sector represents a large and important gap in our knowledge – one that we have attempted to fill, at least in part. It is quite clear from our work that there are significant lags in the adoption of new technology in Canada's service sector and that slow diffusion within the country after first adoption does occur. Thus it seems likely that there is considerable scope, in this very large part of the economy, for

raising productivity by speeding up technical advance.

Last, there is at our disposal an effective means of strengthening the technology information complex in Canada. By making fuller use of the patent system as a tool for disseminating technical information to private and public sector users, more rapid diffusion of ideas and know-how could be encouraged.

6 Government Assistance to Technical Advance

Government programs designed to foster innovative activity by firms have been introduced in many countries in recent decades. These programs vary widely, ranging from direct government sponsorship of research and development to tax incentives and to subsidy, loan, and loan guarantee programs. The mix of programs has also varied considerably among countries. In Canada, for example, much policy emphasis is placed on tax incentives and on various financial assistance programs offering loan guarantees, loans, and subsidies to firms. The Economic Council has already examined several of these loan guarantee and loan programs.[1] In this chapter, we discuss some of the more important subsidy programs, all of which happen to be operated by the federal government. They include the Enterprise Development Program, the Defence Industry Productivity Program, the Industrial Research Assistance Program, the Program for Industry/Laboratory Projects, and the Technical Information Service.[2]

The Rationale for Government Subsidization of Private R & D

The first question to be addressed is: Why is it sometimes necessary for government to subsidize R & D spending by private firms? Like all other expenditures made by firms, this spending is undertaken to enhance their profits, and many would argue that it is not immediately apparent, therefore, why government support is needed. The short answer to this question is that, without subsidization, certain socially desirable innovation projects might never be undertaken. The reasons why such divergences between the interests of society and those of private firms can arise lie in both the workings of markets that are competitive to any degree and the nature of institutional arrangements pertaining to innovation.

Innovative Activity and Consumers' Surplus

A concept called "economic surplus" is widely recognized as an important feature of economic systems in which production and exchange are carried on largely by means of markets.[3] Some understanding of this concept is important in order to make sound decisions about when and when not to subsidize R & D.

Economic surplus can accrue to buyers or to sellers of a commodity or service. We shall focus here on the more relevant concept of surplus to buyers. In any market that is not dominated by a monopolist who is able to discriminate between his customers, all buyers pay the same price. All purchasers of bread, for example, pay the same price per loaf. Yet many (or all) buyers would be willing – if required to do so – to pay higher prices. As a result, buyers collectively derive unpaid-for benefits. Such benefits are given the label "consumers' surplus" by economists, or sometimes, more clumsily, "inappropriable benefits."

Since buyers collectively obtain such unpaid-for benefits from virtually every commodity or service that they purchase, it may be worthwhile for them to subsidize, through their government, the creation of new or improved commodities or services. The payoff to the subsidy would be a newly created consumers' surplus.

There is a second important reason why government subsidization of R & D may be beneficial. This relates not to new products but to the production processes used in making existing products. It may be socially worthwhile, in appropriate circumstances, for government to subsidize R & D that is aimed at reducing the costs of existing commodities or services. This type of situation often arises when market competition is very keen. In these circumstances, any cost saving from new processes developed by doing R & D is likely to be largely reflected in lower prices to consumers. If the price reduction is expected to be too rapid, however, it may not be profitable for businesses to undertake the R & D needed to bring it about.

We are well aware that much of the R & D leading to successful new commodities and services and to cost reductions is unsubsidized. Even though firms then create unpaid-for benefits for buyers, they can

still charge high enough prices, particularly in the short and medium run, to achieve an adequate private return on their R & D investment. Subsidies are needed only when this does not happen. The problem that certain socially desirable innovative activity may not happen has long been recognized in this country and elsewhere, and it has led to special measures, such as the introduction of patent systems, to alleviate it. Patents allow a period of grace during which firms can charge higher prices, and thus make higher returns, than they will be able to do in the longer term. Although the availability of patent rights goes far to enable innovators to garner the benefits of their creativity, therefore encouraging them in their risky pursuits, it does not completely solve the problem. Patent rights eventually expire. Furthermore, the charging of royalty fees by patentees in exchange for allowing others to utilize their innovations tends to prevent prices from falling sufficiently to ensure socially optimal levels of output of the resulting products.

Social Benefits and Incrementality

Thus the justification for the subsidization of R & D spending by private firms appears to be confined to a specific category of innovation projects. That category consists of those projects which will both cost more than the present value of their expected private benefits and generate a present-value surplus of expected social benefits, after risks have been taken into account. If this surplus is greater than the firm's prospective deficit, it is possible (though not certain) that it will be in society's interest to give the firm a subsidy equal to that deficit, as this will enable the firm to proceed with a socially desirable innovation that would not otherwise be developed. It is important that *both* of the foregoing conditions – a prospective private deficit and greater social surplus – be satisfied. The second one is especially critical; if it is not satisfied, subsidies will be given to projects that should not be undertaken because their prospective costs exceed their prospective benefits, and thus money will be wasted. If the first condition is not satisfied – that is, if prospective private benefits exceed prospective private costs – then it is reasonable to assume that firms can undertake the relevant projects without subsidization.[4] If they are subsidized nonetheless, they receive a windfall gain at the expense of taxpayers. Even though no overall social loss occurs in this case – since income is redistributed from the taxpayers to the firms doing R & D – there is the risk that when government budgets are tight, assistance will thereby be diverted from other R & D projects that do need help.

Strictly speaking, even if the foregoing incrementality conditions are met by a given project, they are not sufficient to ensure that a subsidy is desirable. Other conditions should also be met. The innovative activity in question should be incremental not only to the firm – in the sense that the latter would not undertake the project without the subsidy – but also to the industry to which the firm belongs and to the economy as a whole. In order to be incremental to the industry, the subsidized activity should not preempt or otherwise displace analogous innovative activities carried out by other firms in the industry. Incrementality to the economy is desirable because the subsidy paid to the innovative firm constitutes resources that government has transferred by one means or another from other sectors of the economy. The transfer process itself consumes a considerable amount of resources; this is another cost that the social surplus must be sufficient to offset. If they had not been diverted, these resources would have served the economy in other ways. If the subsidy results in a sufficiently higher level of socially desirable R & D investment in the economy than would otherwise occur, however, it can be said that the activity is incremental to the economy and that the subsidy is warranted.

These various requirements are rather stringent, and it might be considered that even well-conceived and well-administered subsidy programs would have difficulty in meeting them. Consequently, any discussion of the federal subsidy programs mentioned above must go beyond the incrementality requirements; it must also ask whether it is possible to satisfy these requirements in practical terms, and what changes, if any, in the operations of the programs would be needed to accomplish this.

The Enterprise Development Program

This program was introduced in early 1977 by the Department of Industry, Trade and Commerce. It was intended to subsume and rationalize various departmental programs of industrial incentives that had become inappropriate to the more competitive international environment of the 1970s. Some of these programs were narrowly focused.[5] Others, such as the Program for the Advancement of Industrial Technology (PAIT) – one of the most important forerunners of EDP – had broad application.

PAIT was introduced in 1965 (summary data on PAIT subsidies are presented in Tables A-1 and A-2). Its mandate was to support innovative projects undertaken by Canadian manufacturing and processing firms that were deemed likely to enhance Canada's international competitive position, the technological capability of its industrial sector, and the level of industrial employment. Normally, the Program's contribution to approved projects would

equal 50 per cent of their cost. Emphasis was to be placed on projects that were likely to result in products or processes having good sale and profit prospects for the firms involved. Initially, the terms under which the subsidies were awarded provided that the recipient firms would reimburse the government (though not the Program), with interest, should the supported projects become commercially successful. The intention underlying this provision, which converted subsidies into conditional loans, was to prevent recipient firms from gaining an unfair advantage over their competitors; in fact, however, its effect proved to be deleterious to the Program's objectives. Firms found it more advantageous to finance successful projects from commercial sources. Consequently, until this provision was replaced in 1970, the flow of applications for assistance was relatively weak. The new provision, which made the repayment conditions much less onerous, rendered the Program much more attractive to firms and led to a substantial increase in the demand for assistance.

The Program's operations were reviewed internally throughout most of its lifetime. Although the formats of these annual reviews were consistent enough, they tended to inhibit, rather than facilitate, valid judgments about PAIT's economic impact. (Some of the evaluative criteria applied are presented in Table 6-1.) Since this implicit approach to the evaluation of government programs has not been unusual, a brief comment as to its validity is in order.

The sales, capital investment, and employment levels associated with PAIT-supported projects (other than those that failed outright) were viewed as attributable to the Program's subsidies; hence the sales/PAIT subsidy and PAIT subsidy/job ratios. Unfortunately, this apparently plausible reasoning actually provides no insight into the actual impact of the subsidies. It rests implicitly on the assumption that the mere existence of an association between variables – between sales and subsidies, for example – means that a causal relationship also exists between them. This is not necessarily so, since there may be projects that would have been initiated even if they had not been subsidized. In order to establish whether the subsidy was essential to the project, what is needed is evidence along the lines outlined earlier – that is, evidence pertaining to the incrementality of a project to both the firm and the industry. To put the issue in any other terms is to leave the most critical questions unanswered. Moreover, indicators such as sales ratios are not really appropriate measures of the benefits produced by the projects.[6] These should be expressed in terms of private benefits (profits) and of social benefits not appropriated by firms.

EDP was intended to improve upon the performance of its various predecessors in a number of important respects. At least some of those earlier programs had been thought to be unduly oriented, in effect if not in intent, towards large firms. It was also felt that there had been an excessive concentration of subsidy awards to firms in central Canada. Consequently, and to better assess the commercial prospects of proposed projects, the EDP decision-making structure has, from the outset, provided for significant participation by private sector representatives. These are drawn from all provinces, especially when applications for assistance from smaller firms are under consideration.

The Program has two basic aspects. One of these (the one that concerns us here) consists of paying subsidies (called "contributions") to firms undertaking approved innovative projects (figures on EDP project approvals are provided in Tables A-3 to A-6). The other consists of providing "adjustment" assistance to firms in the form of either insured or direct

Table 6-1

Program for the Advancement of Industrial Technology: Internal Evaluation Criteria, 1973-75

	Number of projects	PAIT subsidies	Estimated sales[1]	Capital investment	Employment increase[2]
			($ Millions)		
Successful projects	192	36.6	2,033	43	4,054
Unsuccessful projects	227	22.8	...	...	...
Total, 1974/75	419	59.4	2,033	43	4,054
Total, 1973/74	342	49.4	1,496	77	4,426
			(Per cent)		
Change	22.5	20.2	35.9	...	...

1 The estimated sales/PAIT subsidy ratio in 1974/75 was 34:1.
2 Each additional job created by the PAIT subsidy cost $14,652.
SOURCE Based on data from the Department of Industry, Trade and Commerce.

loans. The objective of EDP subsidies is to enhance the international competitiveness and productivity performance of Canada's secondary industry, and their formal focus is mainly on small and medium-sized firms. Subsidies to small firms may represent up to 75 per cent of project costs, while subsidies to larger firms may account for 50 per cent.

Although its formal orientation towards small and medium-sized firms may be questioned, there is no evidence that large firms have been discriminated against in practice. In effect, EDP's objective is fully consistent with our criteria for the subsidization of innovative activity by firms. This consistency is reinforced by the fact that EDP administrators were required from the outset to ensure that subsidies were awarded only to projects that would not otherwise be undertaken by the recipient firms.

The primary device for accomplishing this objective was the "significant burden" criterion, which was incorporated into the Program's terms of reference.[7] Because of its central importance, the appropriateness of this concept warrants closer study. As implemented, the "significant burden" criterion requires that applicant firms be classified by size, and projects by degree of risk. Then two tests are applied. One stipulates an approximate ratio between the project's total cost and the firm's tangible net worth, while the other stipulates approximate ratios between the project's annual cost and the firm's cash flows for the current and recent years.[8]

Although these tests, and the "significant burden" criterion underlying them, may have a legitimate place in the administration of a subsidy program, they cannot be regarded as satisfactory in terms of the particular purpose for which they have been used – that of ensuring a project's incrementality. They consist of certain estimates of the proportions of the applicant firm's resources that are likely to be tied up in the project. As such, they may be taken to represent some measure (albeit an ambiguous one) of the firm's capacity to finance the project autonomously. But they are not adequate indicators of whether the firm would proceed with the project if it were not subsidized. Thus while the burden that a given project is likely to place upon a firm's own resources may constitute an indicator of the risk to the firm, it is an insufficient measure of the project's inherent riskiness. At the same time, it may also provide an insight into the extent to which outside funding will be required. This insight, together with other financial information, is pertinent to the firm's financial capability to see the project through its various phases. But it does not necessarily follow that a project characterized by a smaller ratio to the firm's internal resources is more likely to be initiated than one with a larger ratio.

What determines a project's relative likelihood of being undertaken is the relationship between its expected benefits and costs to the firm. The question of its burden upon the firm's resources is secondary. Financial markets exist, and once a project is considered to be potentially profitable, whether independently or because of government assistance, they should be able to provide financing. The markets may not always be efficient, in which case remedial action by government may be called for; in such cases, however, the payment of subsidies (as opposed to loans, for example) is unlikely to be appropriate. As suggested above, the subsidization of a private project is most appropriate when it is needed to offset an excess of private costs over private benefits, in circumstances that enable society to gain net benefits. The "significant burden" criterion is of little help in distinguishing those projects which merit subsidies on such grounds from those which do not.

EDP subsidies are administered rather differently than were those granted under PAIT and other preceding programs. For example, EDP is much less characterized by a tendency to measure its impact in terms of indicators whose relevance is difficult to establish or ambiguous. Nevertheless, the essential concept of benefits not appropriable by the innovative firm does not have a place in the EDP information system nor, apparently, in the perspective of those who ultimately judge applications for subsidies.[9] In addition, the necessary projections of the benefits and costs specifically expected to accrue to the firm from the subsidized project are not always performed explicitly. They often tend to become submerged in broader projections of the firm's future operations and financial position.[10] While these broader projections are certainly relevant to the question of the firm's future viability, they cannot serve as a substitute for the project-specific projections that alone can indicate whether the project really needs subsidization. Project-specific projections, when accompanied by projections of the project's future flow of social benefits, are indispensable to a rational judgment about the desirability and the extent of a subsidy. The fact that neither of these types of projections forms an integral part of the EDP decision-making process raises questions about how worthwhile the subsidies it has awarded so far have been.

It may also be the case that the present terms of reference of EDP's credit functions are unduly restrictive, thus leading firms to apply for a subsidy rather than a loan or a loan guarantee. The Program's loan guarantee and lending functions are

essentially confined to situations in which firms are in need of credit, having exhausted all other sources, to enable them to adapt to the pressures of foreign competition. There is evidence to suggest that some of EDP's subsidy awards may have been influenced, at least in part, by such liquidity problems. For example, in the case of one project that was subsidized to the tune of about $1 million, the applicant firm indicated that it needed government assistance because of losses incurred on operations unrelated to the project and because it was in the process of expanding still other operations, also unrelated to the project. In such circumstances, a subsidy is probably an inefficient form of assistance. It might be preferable to modify the Program's terms of reference in order to broaden the criteria for its last-resort, credit-granting functions.

Without doubt, the estimation of the social benefits that a subsidized project, if it is successful, is likely to generate in the future is a more difficult exercise; it is not an impossible one, however. Enough estimates of the inappropriable benefits actually generated by previous innovations exist to demonstrate that reasonably reliable estimates could be calculated for future projects (see Appendix B). Professionals in the Department of Industry, Trade and Commerce have expert knowledge of the technological and economic characteristics of the industries that comprise Canada's industrial sector. If they were given a mandate emphasizing the desirability of such projections, they could, in conjunction with applicant firms, make them reliably. Other federal departments and agencies, as well as various provincial governments, also operate broadly analogous project-specific subsidy programs. They face a similar exigency, which tends to be similarly unmet. Thus co-operation among all the groups of professionals concerned could be very productive.

Another area in which EDP's administrative structure might be improved is the monitoring of the results of subsidized projects. No matter how well administered a subsidy program may be or how closely its administrators may adhere to appropriate criteria (such as those proposed here), the actual social and private returns earned by specific projects will only rarely conform exactly to expectations. It is therefore highly desirable that the decision-making processes of subsidy programs benefit from actual experience. If the actual returns happened, on average, to differ markedly and consistently from the projected figures, this would indicate that these processes needed improvement. There exists in EDP only the embryo of a system designed to track the actual, as opposed to the expected, results of subsidized projects and to compare one with the other. Because the Program is still a relatively recent creation, the great majority of EDP-supported projects are still in their development phase. The breathing space thus provided should be utilized to develop a monitoring system.

As suggested above, subsidized projects should be incremental, not only to the firm but also to the industry to which the firm belongs; and the subsidy should increase the level of socially desirable R & D investment in the economy as a whole. Of these two additional requirements, the first is much the less difficult. If program administrators are reasonably successful in confining subsidies to projects that are socially desirable but financially unattractive to the firms contemplating them, the only danger is that a subsidy will enable the recipient firm to carry out a project that another, more efficient firm in the same industry was either already undertaking or about to undertake. Though this danger exists, its magnitude will usually be minor, since there will seldom be more than a few firms pursuing precisely the same innovation at the same time. It could be minimized by effective use of the knowledge of the innovative activities carried out in most Canadian industries that the professionals who provide technical support to subsidy programs already possess or could readily acquire.

The social-desirability requirement should not only be met prospectively, it should also be confirmed retrospectively. The immediate question is: To what extent have recipient firms been induced by their subsidies to increase their overall level of R & D spending? Because the existing knowledge of the factors that govern innovative spending by firms is incomplete, this is a difficult question to answer with any confidence. Economists have given the problem some attention, however, and a significant and growing body of relevant literature has emerged. This work could be utilized by subsidy program administrators to produce rough estimates of the impact of their subsidies upon the R & D spending behaviour of recipient firms. At the same time, work could be undertaken to develop more-comprehensive analytical methods. Here, too, interprogram co-operation would have obvious and immediate advantages for everyone.

The overriding retrospective question, however, relates to the extent to which the benefits, both social and private, actually generated by subsidized projects have conformed to the expectations entertained when the subsidies were awarded. Recall that, for a subsidy to be both warranted and well calculated, two conditions should be met, on average over all subsidized projects. The discounted value of the project's social benefits should exceed the sum of

the subsidy and the cost of delivering it, and the discounted value of the project's costs should exceed that of its private benefits by the amount of the subsidy. Even if, on occasion, these correct criteria could be applied only roughly, that would still be preferable to a more precise application of wrong criteria. While it is possible to perform regular (preferably annual) evaluations of EDP's impact upon the R & D spending of the subsidized firms and of the costs of the Program, the related evaluation of the outcomes of the subsidized projects is a more complicated exercise. This is because those outcomes cannot be ascertained until many years have elapsed. On the other hand, if the Program's decision-making mechanisms and procedures remain fairly stable over the years, the outcomes of completed, previously subsidized projects can, once they have been ascertained, shed much useful light on the soundness of current estimation procedures. One might begin with the larger elements of the programs and with those where data are most readily obtainable, in order to gain experience, especially about the quality of the results and the costs of the work. The application of this approach might well provide general examples that could be applied in other contexts.

The Defence Industry Productivity Program

This program was inaugurated in 1959, with the signing of an agreement between Canada and the United States on the sharing of defence production. Canada entered into this agreement because developments in the military sphere during the postwar period had made it abundantly clear that countries with relatively small military establishments, such as Canada, could not hope to be self-sufficient in meeting their needs for ever more costly and sophisticated equipment. In subsequent years, Canada concluded analogous agreements with various other allied countries. The Program has been administered in recent years by the Department of Industry, Trade and Commerce. Its overall objective, which has remained essentially unchanged throughout its existence, was formulated recently as follows:

> The objective of the DIP Program is to develop and sustain the technological capability of the Canadian defence industry for the purpose of generating economically viable defence exports and related civil exports arising from that capability:
>
> (a) by supporting selected development projects;
>
> (b) by paying one half of the cost of acquisition of new advanced equipment required for plant modernization; and
>
> (c) by supporting the establishment of production capability and qualified sources for production of component parts and materials.
>
> In keeping with the Department's roles of promoting export sales and viable industrial growth and efficiency, DIP Program resources are directed to projects that serve the objectives of international defence development and production sharing arrangements and, in addition, to projects that support industry sector strategic objectives and maximize the potential economic return on the resources employed.[11]

Some 70 per cent of DIPP outlays have been made in support of development projects (figures on DIPP expenditures are presented in Tables A-7 and A-8). During recent years (and perhaps earlier), the eligibility criteria that were applied to proposed projects have stipulated that:

> (a) The company proposing the project must be established in Canada and must substantially undertake the project in Canada.
>
> (b) The project must be compatible with the structure, resources and future potential of the company and its approved corporate strategy.
>
> (c) The project must be directly related to defence export markets and/or related civil export markets which employ technology important to Canada's national defence.
>
> (d) There must be attractive market opportunities in defence export markets and related civil export markets for the resultant product and reasonable prospects that the company can successfully market the resultant product. To determine the adequacy of the potential market, minimum ratios of expected sales to Program support are expected to be adhered to although other factors will also be taken into consideration. Examples are Canadian defence requirements, industrial development goals and objectives, incremental profits available to firms, etc.
>
> Where an immediate market is apparent, the applicable ratio of sales to Program support should be 10 to 20 times of the Crown investment. The Canadian content of the expected product sales is the determining factor in the application of this ratio. Where the Canadian content is less than 50%, the ratio should approach 20 to 1: where the Canadian content is greater than 50% the ratio may approach 10 to 1.
>
> Where the market is in the future, projects should be evaluated by means of a technological forecast of the demand for the product coupled wherever possible with documented evidence of the market. In this connection it is important to establish that access to the export market will be possible when the product is ready for sale.
>
> (e) The project must demonstrate the potential for generating an acceptable incremental return on the investment required to be made by the company and Government. This return would normally take into account such factors as incremental export sales,

import replacement, employment, profit, capacity utilization, etc.[12]

The motivation behind the numerous project-specific DIPP subsidies – usually representing 50 per cent of project costs and subject to various repayment provisions – that have been awarded over the past two decades has certainly been the desire to facilitate projects that would not otherwise have been initiated. Unfortunately, the criteria cited above are not well specified for achieving that end. Their emphasis is clearly upon projects that promise to be successful from the standpoint of the firm but admittedly, not overly so – hence the repayment provisions. Even by that standard, however, they are not optimally focused. It is not the prospective sales/subsidy ratios that matter (though they may be indicative) but the prospective returns on investment in the project. The major defect in the criteria is the absence of an explicit requirement that program administrators confine subsidies to incremental projects and that they apply tests designed to conform with such a restriction.

The primary objective of the Program is to foster, mainly through subsidies, exports by the Canadian defence production industry of defence-related products and their civil counterparts. While the subsidization of exports is questionable on general grounds – because of the danger that such subsidies could result in gratuitous net benefits to foreigners and in net costs to Canadians – there are some well recognized exceptions to this principle, one of them involving national defence.

Although this fact imparts a basic validity to the primary objective of the Program, the same cannot be said of its mandate to focus upon specific innovation projects. In other words, the justification that we have used for subsidizing a specific project – namely, that the project offer the prospect of serving society's interests rather than those of the innovating firm – cannot readily be extended to those cases where the project's ultimate output will be mainly consumed abroad. Since it is the Canadian taxpayers who pay the subsidy, they must be able to reap at least commensurate social benefits for the subsidy to be regarded as warranted. If the project's output is mostly exported, the only social benefits that Canadians can receive will come from the increased imports that ultimately result from such exports. These social benefits will usually exist in some measure, because import markets tend, like most markets, to be non-monopolistic; whether they will suffice to justify the subsidy is another question. When trade takes place between two countries – i.e., when exported commodities are in effect exchanged for imported ones – consumers in both countries are expected to benefit. Otherwise, there would be little incentive for trade to occur. Beyond that, however, it is difficult to generalize. There is certainly no reason to expect that the total benefits will be divided equally between the two national groups of consumers: in general, this will not be the case. Nor does there exist any generalized answer to questions about which group will benefit more and by how much. There are simply too many factors involved in the process, chief among them being the terms of trade – namely, the physical rates of exchange between Canada's imports and exports.

Thus the administrators of any innovation subsidy program, such as DIPP, that entails the funding of specific export-oriented projects will find it nearly impossible to make a realistic prior estimate of the social benefits that would ultimately accrue to Canadians from a given project. Yet, without such a prior estimate they cannot rationally decide whether, or to what extent, the project warrants subsidization. It would therefore be better if the project ceased to be their focal point.[13]

As was just suggested, a number of situations can exist where the payment of an export subsidy is in society's interests. One such situation is the so-called "infant industry" case. Here, the object of the subsidy is to preserve a given industry that is experiencing the transitory difficulties associated with being new but that will, in the foreseeable future, be capable of standing on its own feet. Another such situation may also arise in certain types of "competing subsidy" cases, where the object is to assist Canadian firms in resisting socially destructive encroachments into their markets by foreign competitors who are subsidized by their home governments. A third such situation (the one that concerns us here) arises in the case of industries and firms deemed essential to national security – an area in which defence production is, by definition, of central importance. In all of these cases, the focal point of the government assistance is the firm itself rather than any specific project that it might undertake. The primary aim is to enable the firm to continue in the same general line of business. The magnitude of the necessary subsidy should be determined by the gap between the average rate of return that the firm, or its relevant component, actually earns and that which it could earn in some other area of activity. Thus DIPP's social value could generally be enhanced by switching its focus more towards firms, and less towards projects, than at present.

Of course, firms that play a vital role in the defence production field are not the only types of essential institutions that need subsidies when their private returns are inadequate: certain other institutions, such as hospitals and universities, also need them.

Subsidies, like other government expenditures, are financed mainly by taxes. In a democratic society it may be assumed that, in the final analysis, taxpayers make a retrospective judgment, by voting, about the appropriateness of subsidies to hospitals and universities in general and also that they are competent to do so. The taxpayers-voters are also the consumers, in a palpable sense, of the services of these institutions. Within limits, they are in a position to judge the adequacy of both the quantity and quality of their services. They can therefore be depended upon to make a sound, though broad, judgment about the appropriateness of government contributions to the cost of operating them.

Matters are a great deal more complicated when the subsidized institutions are firms engaged in defence production. Briefly, one problem is that the taxpayers-voters do not consume national defence services in quite the same way as they consume health or educational services. More important, however, not only do they not possess as much information about defence services, but often they cannot be allowed to possess it, in their own interests, except in terms that are far too vague to be useful in determining whether subsidies to specific firms and industries are warranted. Consequently, some body that is intermediate between the program administration and the subsidized firms is necessary – one that could be entrusted with the sensitive technical information usually involved in defence production decisions and that would also tend to regard itself as the protector of the taxpayers' interests. A possibility might be an advisory committee or board, adequately endowed with supporting resources, composed of distinguished private individuals and responsible to Parliament. These persons would, of course, be appointed by the government, but the selection process could easily be made on a multipartisan basis. Although the analogy is imperfect, the introduction of this sort of additional component into the administration of DIPP is comparable to the participation of appropriate individuals from the private sector in the EDP's decision-making process.

Unlike EDP, whose history is still too short to provide much information on how the projects subsidized under its aegis have generally turned out, the outcomes of many DIPP-supported projects are known. A high proportion of DIPP subsidies have been concentrated in a small number of large projects, and in an even smaller number of firms. Thus the experience represented by these projects permits insights of wide relevance, not only to the overall results of DIPP subsidies but also to the decision making that preceded and accompanied them.

In examining the project files pertaining to these large projects, it was found that a common feature of most of the DIPP subsidies is that they were frequently awarded without projections having been made of the revenues that the firm could expect to receive from the future sales of the new product (if the project succeeded), or of the costs that it would need to incur to earn those revenues. In other words, the returns that the firm could realistically expect to earn from the completed project were usually not estimated. The absence of such estimates would have made it very difficult to decide whether the subsidy was essential to ensure that the project would proceed, or to ascertain with any precision the amount of subsidy that was required. Perhaps the most crucial omission was the failure to consider the social benefits that the projects could be expected to generate for Canada. As a result, even if the subsidies were essential to the pursuit of the projects, it is very difficult to know whether the expected social benefits were adequate to justify them. These problems all arise essentially because the most central questions were never clearly raised. These, once again, are: Why does this project require a subsidy? Are the firm's prospective, risk-adjusted returns inadequate? If so, by what amount? How much is the project likely to generate in the way of social benefits to Canada? Do these benefits offset the costs of the subsidy?

Admittedly, it is difficult to answer these questions when a project is export-oriented, but that is an entirely separate problem. Its intractability constitutes grounds for shifting the Program's focus from the project to the firm, but it cannot justify decisions to award subsidies (often in large sums) based on incomplete and possibly misconceived economic grounds. It is this, more than the fact that several of these large projects failed in the end to generate significant economic benefits (even in the form of revenues to the firms involved), that must be regarded with particular concern.

There have been cases where firms have received fairly numerous DIPP subsidies – which amounted to large sums in the aggregate – after an inadequate analysis of the economic prospects of the projects involved. This suggests that the subsidies may have been implicitly directed more towards the recipient firm than towards the individual projects. Such a focus of the subsidization effort would have been entirely appropriate, as was suggested above. Its justification would be that it enabled the subsidized firm to continue certain kinds of activities that, although relatively unprofitable to the firm, were in Canada's interests. Ideally, proper judgment of this by program administrators would have required a

clear picture of the reasons why these activities were deemed essential and why they were insufficiently profitable for the firm, as well as of the extent of that unprofitability. Such information was seldom compiled, because the ground rules under which officials operated did not require it to be. More specifically, and referring only to the purely economic considerations, it was not usually ascertained what average returns the recipient firm could reasonably expect to earn, unsubsidized, from the desired areas of activity. Nor was it ascertained what returns the same resources and facilities might have earned in alternative areas of activity. There was, therefore, no coherent way in which program administrators could determine prospectively, nor is it possible for anyone to say retrospectively, whether (and to what extent) the subsidies were desirable. The operating rules of DIPP did not require that the necessary questions be raised; in the event, they seldom were.

The fundamental reason why the most important questions were generally not raised was probably that DIPP's administration was never explicitly enjoined, in the Program's terms of reference and administrative directives (as, for example, the EDP's administration had been enjoined) to restrict its support to desirable activities that would not otherwise occur. This prevented the evolution of decision-making machinery animated by a clear and coherent sense of its mandate and endowed with the administrative instruments appropriate to the fulfilment of that mandate. Consider, for example, the Program's eligibility criteria, cited above. As was suggested there, allowing the decision to hinge on "attractive market opportunities" for the proposed project's product and then laying down sales/support ratios conditioned by "Canadian content" could only obscure and divert attention from the real questions: Does the project need and deserve a subsidy? If so, to what extent? It is not surprising, therefore, that the various information systems that served the Program's decision making over the past two decades tended to be fragmentary and ill-focused. Substantial improvement in these systems has taken place in recent years, but the underlying rationale for subsidies has remained inappropriately formulated, in operational terms. Had this not been the case, the Program administrators might have been forced to shift their focus from the project to the firm, because of the practical difficulties in assessing the social benefits attributable to individual export-oriented projects. Hence, as long as this basic deficiency remains unrectified, the Program is unlikely to serve its legitimate and important purposes in the most efficient manner.

The Industrial Research Assistance Program

This program has been administered, since its inception in 1962, by the National Research Council of Canada. It has always been a much smaller program than DIPP, EDP, or most of the latter's predecessors (see Tables A-9 and A-10 for figures on IRAP expenditures). The Program finances, usually to the extent of 50 per cent of a project's cost, the salaries of research workers hired by firms for R & D projects. Its objectives and methods have been described as follows:

> The objective of the program is to increase the calibre and scope of industrial research in Canada in situations where it leads to high business effectiveness with economic and/or social benefit to Canada.
>
> This objective will be pursued by providing financial support for approved research workers engaged in approved industrial research projects of high technical merit showing prospects for a high return and with good business plans for achieving success. Such project should:
>
> a) be aimed at innovative products or processes realistic to the company and of significant need or benefit for the economic and/or social life of Canada, and might particularly
>
> b) relate to research which, in relation to the company's resources, is an unusually high risk, expensive, or longer range area, but where the potential benefits nevertheless appear large and/or
>
> c) be designed to increase Canada's competitiveness in world trade in realistic situations by strengthening a necessary technological base in a company's present field or in an appropriate new field, and/or
>
> d) encourage participation by government and university scientists in industrial activities, and/or
>
> e) assist the attainment of the objectives of the Canadian Government's industrial strategy as it may be formulated from time to time.[14]

Although there are certain ambiguities in the foregoing objectives and criteria, it is possible to reconcile them with the conditions that should be met for innovation subsidies to firms to be justified. Projects that are unusually risky might well generate insufficient private benefits to enable firms to proceed with them. And if such projects also have the potential to generate adequate social benefits, the subsidization of the shortfall in private benefits would be warranted. It is therefore important to know whether the Program has ever actually operated in reasonable conformity with these possibilities. There are a number of reasons to suggest that it may not have been.

Some of the difficulties originate in the Program's delivery system and in the terms under which its

subsidies are awarded. The projects that are supported usually last two to three years. The subsidies, however, are paid only on an annual basis and relate to the project's budgeted costs for the following year. Each year, a review is conducted of the technical progress made on the project during the previous year. That review underpins that year's decision about the following year's subsidy. This decision-making horizon is too restrictive, in our view, to permit a completely sound and systematic evaluation of the project's ultimate economic prospects.

More seriously, the systematic evaluation of prospective projects, necessary before making a proper judgment about whether subsidies are either necessary or warranted, is inadequately provided for in the Program's present delivery system. Such an evaluation is severely inhibited at the outset by the kind of economic data that applicants are required to supply about the project. These data are usually confined to the firm's sales, its R & D expenditures, and any other government support that has been received; and they usually pertain to the current year, the preceding year, and the forthcoming year. As to the project under consideration, data are obtained, for the current year, pertaining to various projections of its costs. In most cases, projections are also made of the sales or cost savings to be expected from the project. It frequently happens, however, that projections of the total cost of the overall project or of its ultimate product are not made. In other words, the expected private returns from the project are not calculated, nor are its expected social benefits. Thus an objective, empirical basis for judgment about whether subsidies are either necessary or warranted does not exist in the normal workings of the Program.

The underlying problem in this instance is that when the critical decisions are made, projects are not viewed in terms of their future benefits and costs. The view appears to be held that projections of the "indirect" benefits of subsidized innovations – involving their wider economic effects – are too difficult for program administrators to undertake and that the task is best left for recipient firms to perform internally.[15] This may have led to the attempt to express IRAP's benefits in terms of the sales deriving from successful subsidized projects, of the numbers of jobs associated with these projects, and of the investments undertaken by firms in implementing them. This, in turn, has led to the conclusion that the federal tax revenues generated by these sales and investments have greatly exceeded the Program's costs and that the Program must therefore be regarded as correspondingly successful.

Such a conclusion cannot be established satisfactorily on the basis of these measurements. Although they may be of secondary interest as indicators of the existence of links between the subsidies and other economic variables, these measurements do not demonstrate that these links are causal in nature. Projects that did not deserve a subsidy, because their prospective profitability to firms was such that the latter would have initiated them without the subsidy, were at least as likely to be characterized by high levels of sales, employment, capital formation, and tax revenues as projects for which subsidization was essential. Thus it is clear that such measurements tell us little about the difference that a given subsidy has made; and, on the basis of the evidence available, it is hard to know whether, or to what extent, IRAP subsidies have generated desirable research activity that would not otherwise have taken place. As a consequence, it is equally difficult to know what relationship the overall benefits from the subsidized projects bear to the Program's costs.

In the past, therefore, the information upon which IRAP administrators based their decisions was not conducive to making a distinction between projects that warranted subsidization and those which did not. Nor is this situation likely to change in the future, unless appropriate changes are instituted. The IRAP case differs from that of the programs examined above. There is evidence that the EDP and DIPP delivery and information systems are evolving towards tighter assessment of the merits of subsidies. In the first case, there has been from the outset an explicit mandate to support only those projects deemed incremental to the applicant firm; in the other, the practice is gradually moving in that direction. At least some of the IRAP administrators, however, believe that they are not in a position to assess independently the overall economic impact of the projects proposed. They may be right, but if it were really only the applicant firms that could make such assessments objectively, innovation subsidy programs would become very hard to justify under present political standards, which require accountability in the spending of taxpayers' money.[16] Fortunately, that is not the case. There exist numerous examples in the modern economy where objective judgments of this kind are made routinely outside of the firm – by lenders, shareholders, creditors, and the like. The IRAP administrators, in our opinion, could do as well.

We believe that the current practice of viewing proposed projects one year at a time can, and should, be modified. The outlook should be a much longer one, covering all the years during which the products of successful projects will generate sales revenues and incur production costs. Such an approach has its difficulties, especially where longer-

term projects are concerned. However, firms make such projections every day in their investment decisions, the vast majority of which do not involve government support; so do the various constituents of capital markets. Since IRAP's formal objective is quite explicit – to foster innovations that are "realistic to the company and of significant need or benefit to the economic and/or social life of Canada" – the necessary analysis of proposed projects is, in fact, already a requirement. Each applicant firm could be required to submit the information needed for proper projections as a condition of application. These projections could be reviewed by program administrators to discover whether, or to what extent, a subsidy is necessary for the firm to undertake the project. The administrators could then make the crucial additional calculation, in consultation with the applicant firm, of the social benefits expected to result from the project. This would permit a judgment about whether these benefits are likely to justify the subsidy.

It has been suggested to us that many R & D projects, especially the more worthwhile ones, could be stifled at birth by the kind of rigorous cost-benefit approach that we are advocating here. The reason is that considerable amounts of time and research expenditures are needed even to acquire enough information to know whether an idea or a project stands a chance of becoming viable. The information needed to assess an R & D project is, in other words, a product of the R & D process itself. Without the courage to risk a considerable amount of money early on and with little more than the hunch of a good research administrator to go on, much that could be truly pathbreaking may never see the light of day. Minor advances in the known state of the art, valuable but dull, would become the order of the day. By and large, the projects accepted by IRAP in the past avoided this trap, and some significant breakthroughs were made. Partly as a result of this and partly as a result of other factors, the Program has been well received by the industries it serves.

We would not be inclined to advocate changes that might damage IRAP's success in making future breakthroughs, but we would add that a true breakthrough must be shown to be economically worthwhile. In our view, the proper response to the dilemma described above is *not* to abandon the attempt to apply the cost-benefit approach altogether. Rather, for those kinds of projects where money *must* be spent in order to assess their worthiness, the evaluation process should still be done in the way that we are advocating, but it should be done sequentially. In the early stages, the range of uncertainty about costs and benefits alike would be extremely wide. As reassessments were made and knowledge was acquired, the range would narrow until projections with about the same (still quite wide) margins of error as on EDP and DIPP projects, for example, could be made. Some estimate, however wide its potential margin of error, of the need for a subsidy and of its social worthiness is better than no estimate at all. And a gradually revised estimate is much better.

To the extent that IRAP-supported R & D is more innovative than the average, *ex post* evaluation becomes even more crucial. Thus, like the administrations of the other subsidy programs, but more so, the IRAP administration will need to be concerned with how subsidized projects have turned out and how subsidized firms have behaved generally, with respect to their total R & D spending. Such a retrospective look at the R & D behaviour of subsidized firms would shed light on how well IRAP's criteria are working and on whether the Program is producing a higher level of socially desirable innovative activity in Canada than would otherwise occur. As was explained in the context of EDP, there is a great deal to be gained in these evaluative exercises by a pooling of data and expertise among the administrations of all analogous subsidy programs.

Two Smaller Programs

The foregoing programs are not the only federal efforts to stimulate industrial innovation in Canada. In addition to regional programs, special tax incentives for corporate R & D spending, and various government procurement activities,[17] there are two relatively small programs administered by the National Research Council.

The Program for Industry/Laboratory Projects

This program was inaugurated in 1975 (PILP expenditures since the Program's inception are provided in Table A-11). It was conceived of as a cooperative program between the industrial sector and the NRC, whereby the Council would offer financial and/or technical assistance to firms undertaking research projects. PILP's objective is "to bring about the application and use in Canada of NRC scientific and engineering know-how having potential economic and social benefits to Canada."[18] Awards under the Program are made on a competitive basis. Proposed projects are ranked on the basis of certain criteria, and the available funds are then disbursed according to that ranking. These criteria include:

a) economic benefit to Canada;

b) good potential market;

c) qualified company management;

d) enhancement of company R & D capability;

e) level of company commitment;

f) level of National Research Council of Canada involvement in proposal;

g) social benefits to Canada;

h) level of technical and commercial risk;

i) coincidence with national priorities;

j) advancement of scientific knowledge;

k) contribution to regional development.[19]

Since April 1981, PILP has managed the transfer of technologies developed within all government laboratories, in addition to those of the National Research Council.

PILP's criteria, like those of EDP, DIPP and IRAP, have a simultaneous potential for both meeting and violating the two conditions viewed here as essential to the validity of government subsidization of specific projects undertaken by firms. It is quite possible, as was noted with respect to IRAP, that the degree of risk associated with a given project is so high as to render the project unattractive to a private entrepreneur unless it is subsidized and, at the same time, that the social benefits that the completed project might bring to Canada are sufficient to justify a subsidy. But a criterion such as "good potential market" is somewhat ambiguous. It could lead to a tendency to exclude projects that, although they might generate overriding social benefits for Canada, would not be profitable for applicant firms unless they were subsidized.

Although there is some evidence that PILP administrators are aware of the relevance of a proposed project's social benefits to Canada, that awareness is not generally incorporated into procedures that are likely to distinguish adequately those projects which warrant subsidization from those which do not. More specifically, adequate projections are not made, before support is extended, of either the revenues or the costs that the project will ultimately generate for the firm. Nor are the social benefits of the project usually estimated.

This is not to suggest that the concept upon which the PILP is based is unsound. Quite the contrary; the notion of making available to private firms the scientific and technical expertise that have been developed within government laboratories is, in itself, an excellent one. A lack of access to such expertise on the part of firms, especially smaller firms, has been widely recognized as an important barrier to technological advance.[20] But, as in the case of the other programs reviewed here, basic caveats must apply to the way in which this notion is translated into administrative reality.

The deployment of the federal government's resources generates costs to Canadian society. And, like any other activity involving costs, efficiency demands that the use of Canada's scientific and technical resources bring commensurate benefits. In the present context, this implies that the cost of the resources applied to a specific project should be computed and viewed as a subsidy to the recipient firm. Like any other innovation subsidy, it should then be subjected as much as possible to the tests that will indicate whether, or to what extent, the project really needs subsidization and whether the subsidy is likely to generate compensating social benefits.

Like the other subsidy programs discussed in this chapter, the PILP should also be subjected regularly to a retrospective evaluation to determine whether its activities have, in fact, resulted in a higher level of socially desirable R & D investment than would otherwise have occurred. The same methodology is involved here as in the preceding cases; and, again, interprogram co-operation would be to everyone's advantage.

The Technical Information Service

This program was established in 1945. Its objectives have been described as follows:

> The main objective of the Technical Information Service of the National Research Council is to provide industry in Canada generally, but particularly the small-industry sector, with the most direct access possible to current technology as it applies to the solution of industrial problems, and to assist directly in the use and application of this technology for the betterment of industry.
>
> Its secondary objectives are:
>
> 1. To assist industry to get easy access to laboratories, libraries and any other sources of scientific and technical information located in the Council;
>
> 2. To assist industry to become aware and to make effective use of sources of scientific, technical and other information located outside the Council;
>
> 3. To provide direct assistance to industry in the application of the scientific and technical information thus available;
>
> 4. To help to establish NRC as a valuable source of technical expertise and information in the improvement of Canada's industry situation generally;
>
> 5. Finally, to encourage and assist agencies in the provinces according to their situations and resources, to carry out these objectives on behalf of NRC.[21]

The TIS offers four interrelated programs (see Table A-12 for TIS budget allocations). The Technical

Enquiries Program assists firms with specific technical problems; the Industrial Engineering Program focuses on productivity improvement; the Technological Development Program conveys information to firms on developments relevant to their operations; and the Science and Engineering Student Program provides technical and financial support to firms hiring students who are undertaking short-term scientific or technical projects. The facilities of the first three programs are, for the most part, provided free of charge. The Service has 16 field offices across Canada; these are located in such a way that some 80 per cent of their potential users are within 80 kilometers miles of an office. Its target clientele is the overwhelming proportion of Canadian manufacturing enterprises that have little or no in-house engineering capabilities and whose management, for one reason or another, is not familiar with the current technological developments and literature that could be relevant for their operations.

It seems reasonable to suggest that the stringent criteria that we have applied to the other subsidy programs be relaxed in relation to TIS. There is a recognized need for smaller firms to avail themselves of the technical expertise and technological information that are available to larger firms. Since the Service seeks to meet this need in a nondiscriminatory manner, there is little inequity in its work that would tend to alter unfairly, at the taxpayer's expense, competitive relations between firms. And, given its relatively small cost, its overall impact is probably a positive one.

Conclusion

In a market economy in which a given commodity usually sells at a uniform price, firms cannot appropriate unto themselves all of the benefits generated by their products. For that reason, they may not undertake certain innovative projects because their prospective private returns are inadequate. If this inadequacy were offset by subsidies, these projects would likely produce social returns in excess of the subsidies plus the costs of delivering them. Thus government subsidization of certain innovative projects undertaken by private firms is necessary. Without it, the overall level of R & D and related activity forthcoming from the private sector would be less than socially optimal.

If project-specific subsidy programs could effectively confine their assistance to projects bearing the characteristics outlined above, such programs would be worthwhile, for they would increase total socially desirable R & D investment in the economy. Programs that operated by any other rules would be unlikely to produce this result. They would run the risk of subsidizing either desirable projects that did not really require subsidization or projects that were not in society's interests.

To attempt to increase socially desirable R & D investment by means of project-specific subsidies, as Canada has done, is quite difficult, however. The task imposes upon subsidy program administrators many challenges, which are all the more vexing because the necessary information is not easily obtained and the necessary knowledge has not yet been fully developed. To achieve an adequate degree of success, the ground rules need to be changed, in order that program administrators may cultivate a perspective and develop analytical mechanisms that are forward-looking in some respects and retrospective in others.

When considering any project submitted by a firm for subsidization, administrators should estimate the future flows of social and private benefits that its ultimate product is likely to generate, as well as the costs that it is likely to incur. They should also estimate the various costs of delivering the subsidy. It is only on the basis of such projections and estimates that good judgment is possible about whether, or to what extent, proposed projects warrant subsidization. The art of estimating the future flows of the private benefits and costs of a project in an uncertain world is reasonably well developed. It is practised by many firms and many institutions in the financial markets. There is no reason why program administrators could not practice this art just as competently as managers in the private sector, especially if both proceeded from a common and adequate information base. The estimation of the future social benefits attributable to a given project is definitely a more difficult exercise – the more so since it has hitherto been so rarely attempted. This problem, however, is practical more than conceptual. The necessary methodologies exist, justifying confidence that realistic estimates are possible in most situations. Much the same is true of the identification and estimation of the costs of delivering the subsidy. These costs – which will always add up to a considerable sum – are of various kinds, ranging from program operating costs to the out-of-pocket and deadweight costs of imposing the taxes with which to finance them.[22] Thus what is required now is the application of existing methodologies to proposed projects. The efforts (especially if they are co-operative) made along these lines by program administrators, in conjunction with applicant firms, will constitute a learning process bound to produce progressively more reliable estimates.

Examination of the past activities of program administrators is also needed; this task presents its own considerable difficulties. The prior estimates of the expected benefits and costs of subsidized

projects must be augmented by careful monitoring of the actual results of completed projects. This process will provide valuable insights into the effectiveness of decision making by program administrators and will suggest modifications that even the most efficient program is bound to require. In addition, the overall R & D spending activities of the subsidized firms need to be analysed carefully, in order to estimate the extent to which the subsidies have led to actual increases in their total R & D spending. Although progress has been made in analysing the factors (including subsidies) that influence the R & D spending behaviour of firms, matters are still at a relatively embryonic stage. Much more work needs to be done in this area, and no group has more reason to undertake it than the administrators of Canada's subsidy programs. Their mandates oblige them, at least implicitly, to ensure that subsidies augment, rather than replace, the autonomous R & D expenditures of recipient firms. The innovative behaviour of firms is a difficult problem area, as is their investment behaviour, but it must be confronted if the subsidy programs are to be made as effective as possible. While better methods of estimating the impact of subsidies on the innovational spending of firms are being developed, the existing methods could be used transitionally. These are capable of yielding rough, but useful, estimates; provided that they are used judiciously as transitional surrogates, they should serve for the next few years while the work goes forward. Since the analytical and data problems inherent in this exercise are common to almost all of the many federal subsidy programs and to most, if not all, of the various provincial programs, a co-operative effort is obviously called for in this area as well. Such an effort could only expedite the development of more satisfactory models, which would serve the needs of each program.

Project-specific subsidy programs have the potential to assist in closing the gap between the socially optimal level of innovative activity in the economy and the level that firms would, if left to themselves, find it worthwhile to undertake. But this potential can very easily be vitiated, and even negated, if the ground rules do not force administrators to operate their subsidy programs on the basis of appropriate decision and evaluation criteria. That a certain form of government involvement in the economy is justified in theory does not provide, by itself, a guarantee that it will be performed judiciously and effectively. Its administration must therefore incorporate mechanisms that will serve to control its workings and evaluate its effects.

The federal programs to which these comments apply most fully are EDP (and its predecessor, PAIT), IRAP, and PILP. (As indicated above, TIS appears to be well conceived and properly focused.) Under PAIT, administrators were given no mandate to attempt, nor did they attempt, to confine their subsidy awards to socially desirable projects that would not otherwise go forward. EDP's mandate and operating principles represent a marked improvement over those of PAIT, but further improvement is certainly possible. The need to confine subsidies to projects that are incremental to the recipient firms has clearly been recognized, although the means for accomplishing this are still inadequate. Most seriously, the need to ensure that these incremental projects are in society's interests has not been recognized. Nor has the need for sound retrospective evaluation been addressed in practical terms. Remedying these deficiencies of concept and practice could ensure that EDP will increase the economy's overall level of socially desirable R & D investment. At present, one cannot be certain that it fulfils that mission.

There is even greater scope for improvement, in our view, in the smaller IRAP and PILP schemes. The ground rules here do not even require administrators to confine subsidies to desirable projects that would not otherwise be undertaken. And, in our view, the doubts expressed within the National Research Council about the feasibility and desirability of applying these criteria are largely unwarranted.

DIPP is in a separate category by itself. It has a different underlying rationale that presents its own problems, and it has had an administrative history that is far more convoluted. Its mandate is unique: to foster activities resulting in the exportation of defence-related products. The fact that these are defence-related gives subsidies in this case a validity that could not easily be claimed for a general program of export subsidies. The awarding of project-specific export subsidies is, however, fraught with conceptual and measurement problems that are far more complex than in the case of ordinary projects, whose ultimate products will, for the most part, be consumed domestically. It would therefore be more efficient to make the recipient exporting firm, rather than the individual project, the focal point of most, if not all, DIPP subsidies. Thus the objective of the Program would be to enable designated firms to continue operating in the defence production field – a field essential to Canada's security and sovereignty – by ensuring that their average rates of return will be sufficient. Because of the unique nature of defence production, an intermediate decision-making mechanism may also be required. Its function would consist of overseeing the subsidization of the firms deemed essential to Canada, in order to reconcile the

sensitive nature of many modern defence production activities with the taxpayer's right to assurance that his resources are being efficiently deployed.

The actual, though varied, manner in which DIPP has been operated since its inception is extremely problematic. The Program's operating rules have not led its administrators to estimate the returns that firms could realistically expect to earn from the subsidized projects; hence there has been a failure to establish whether, or to what extent, the subsidies were really necessary. The question of the existence of social benefits attributable to the subsidized projects was no more given practical recognition in the case of DIPP than it was in the case of the other programs. There has also been a certain tendency on the part of the Program's administrators to provide subsidies to multinational firms, in order to induce them to assign specific production activities to their Canadian affiliates. Such subsidies are not necessarily inappropriate, especially in the defence production case, but the decision must always be based upon careful estimates of the relevant factors. It appears that this requirement has been largely honoured in the breach. Although the administrative procedures used by DIPP over most of its lifetime so far have been seriously inadequate, significant improvement is quite feasible. In fact, some improvement has occurred recently, but it does not yet impart a sufficiently coherent rationale to an unquestionably desirable program, nor does it yet endow DIPP with sound enough principles to distinguish those cases which warrant subsidization from those which do not.

Subsidy programs to foster innovation have a legitimate place in the government's tool box of measures designed to influence the economy in desirable directions. Like the other tools, however, their efficacy depends entirely upon how judiciously and effectively they are employed. It is apparent that there is a good deal of scope for improvement.

7 Future Policy Towards Technical Advance

In Chapter 3, we described the major components of the process of technical change: domestic production of new technology; first adoption in Canada of new technology from abroad; and diffusion of new technology within Canada, whatever its origin. The domestic production of new technology, up to the first successful commercial application by a firm in the market sector or the first practical use by an organization in the nonmarket sector, is partly dependent on applied R & D expenditures in Canada. The first adoption in Canada of new ideas and technology that have already seen successful commercial application abroad (in the market sector) or that have been put to practical use there (in the nonmarket sector) will sometimes require modification to suit Canadian conditions and associated expenditures in applied R & D; sometimes it will not. To cover both eventualities, it will be recalled that we use the term "adaptation," even though the degree of adaptation may often be rather minimal – as in the case of containerization in the transport industry or tower cranes in the construction industry. Finally, once a new product, process, or technique has been commercially or practically used in Canada for the first time, wherever it originated, there is its subsequent diffusion to other firms and to other regions within Canada. To the extent that, if everything is left purely to the normal operation of the market, R & D spending is unlikely to be high enough and adaptation and diffusion are unlikely to be rapid enough, all three components of the process warrant policy attention.

Three other characteristics of the technical change process are significant: 1) many new ideas and techniques are not the product of applied or basic R & D, important though the latter may be; 2) it seems unlikely that more than a minority of new ideas and techniques originate in the manufacturing sector; and 3) a rather high proportion of new ideas and techniques originate abroad. The examples of new ideas, products, and processes that were cited in Chapter 3 (see the beginning of the section entitled "The Process of Technical Advance") can be used to establish all three points, as can other kinds of evidence, such as the data on patents and on technology transfers. We confine ourselves here to the lessons to be drawn from considering examples of technical change.

With respect to the first of these characteristics, notice that although the instances of technical change cited in Chapter 3 were accompanied by significant productivity improvement, all were probably characterized by a rather minor dependence on applied R & D. Their adaptation and diffusion were mainly dependent on investment, production, and marketing activities, rather than pure or applied scientific activities. This is not to downgrade the importance of applied R & D, Canadian or foreign, or of adapting as quickly as possible new products, processes, and techniques that originate from such R & D, but merely to place both the R & D and the innovations that result from it in proper perspective.

With respect to the second characteristic of technical change, it is clear from the examples in Chapter 3 that technical advances occur in all sectors. Chapter 2 emphasized the great importance of the nontrading sector to Canada's GNP, in that market and nonmarket services, as well as construction, comprise well over half of GNP – a share that is much larger than that of manufacturing, for example. Obviously, policy on technical advance must take cognizance of this.

The third characteristic may seem so trivial as not to be worth belabouring. It is nevertheless useful to point out that the fact that a high proportion of all successful first applications of new ideas, products, and processes occurs abroad is relevant for policy. This is not to deny or diminish the importance of the domestic development of new technology, but simply to recognize that technical advances form a world resource pool upon which Canada fruitfully draws. The examples given earlier in our report show this clearly. They also show that while adaptation to Canadian conditions will sometimes require applied R & D expenditures here, that is by no means a universal occurrence.

The Present Policy Stance

Against this background, the general policy stance towards technical change in Canada appears to be too narrowly focused, in two quite distinct senses. First, it is focused mainly on manufacturing, with virtually no attention being paid to the enormous nontrading sector of services or to construction. This is tantamount to trying to make a jet plane fly better by overhauling only one of its engines. Second, policy attention is focused mainly upon the domestic production of new technology, while the important processes of adaptation and diffusion are badly neglected.

Our analysis of the case for more R & D spending (in Chapter 3) and our detailed investigation of five particular programs designed to assist technical change (in Chapter 6) lead us to comment on a third weakness of the present policy stance. It is that the analytical underpinnings of R & D policy are somewhat softer than they should be, in two respects.

The first relates to R & D "target setting." Our own analysis shows that more R & D would likely pay off nationally; thus there would indeed be advantages, in mobilizing much-needed public support, to setting a general target designed to raise R & D expenditures to a higher percentage of GNP. The analytical case for setting an aggregate target is weak, however, and such a target does not, by itself, provide a sufficiently precise basis for policy. Our research suggests that for policy purposes it would be an improvement to set targets appropriate for specific sectors and industries. The case for this is still not strong, but it is not as weak as that for an aggregate target (see Chapter 4). A suitable aggregate target would, of course, be implied by suitable disaggregated ones, even though the reverse is not true. Better yet, for that part of the target R & D expenditures which is financed by government, the general targets ought to be buttressed, in the light of the weak analytical basis that underlies them, by better cost-benefit analysis at the level of individual projects and programs.

Second, at the project level we found that the criteria used in giving subsidies are not defined carefully enough, so that the subsidies are not as socially beneficial as they could be (see Chapter 6). A mixed bag of motives has been given for subsidies, ranging from job creation to assistance to the balance of payments, to risk coverage in general – few of which are logically connected to whether the benefits generated by the subsidies will be higher than the costs. Some key concepts that should be used appear not to be used – the concept that a project should have an incremental impact to be worthwhile, for example.

While we are aware that the cost-benefit analysis of R & D expenditures is very complex, it is nonetheless necessary if there is to be accountability in the use of taxpayers' money. Matters are different in the private sector. Informed and practised "hunches" can legitimately play a bigger role there; and those whose hunches are not, in the end, generally sensible will find it hard to keep their jobs. This sanction has less force in the public service, where cost-benefit analysis must, willy-nilly, serve as a substitute for it.

Proposals for Improvement

To correct these three weaknesses of the general policy stance presently in place, we believe that three kinds of changes must be made.

First, we think that policy, while continuing to focus on increased R & D spending, should also pay more attention than hitherto to the adaptation of new ideas, products, and processes that originate abroad, as well as to the diffusion of new products and processes, whatever their origin, across firms and regions in Canada. An important corollary is that policy should better reflect an awareness of the tendency of a large part of technical advance (broadly conceived as new ideas, products, and processes) to originate from day-to-day business activity rather than large expenditures on applied R & D.

Second, we think that the focus of policy, from the point of view of the industrial structure, should be much less narrow than it is at present. Far more attention should be given to promoting quicker technical change and adaptation, in the broad sense stressed above, in the nontraded-goods and service sectors. (The latter includes nonmarket as well as market services.)

Third, we believe that the analytical underpinnings of policy pertaining to technical advance should be strengthened. The target for R & D expenditures should be disaggregated. And government assistance to R & D should be subjected to more formal cost-benefit analysis. Such analysis would be preferable to vague criteria such as promoting high technology or "picking winners," although these could certainly be used in the initial stages, when deciding what the assistance priorities of government should be.

To give effect to our ideas about adaptation and diffusion,

1 **We recommend that federal and provincial policy towards technical change put greater emphasis on a) the adaptation of new ideas, products, and processes already in use abroad but not in Canada, and b) the diffusion of new ideas, products, and processes, wherever they originate, to other firms and regions in the country subsequent to their first successful application.**

While we advocate that more emphasis be put on adaptation and diffusion than hitherto, this is not to be to the detriment of continued increases in R & D spending; our later recommendation on raising R & D spending (no. 8) is therefore quite consistent with this one. Our point is that both are needed to improve living standards but that adaptation and diffusion have, so far, been relatively neglected. At the same time, we do not advocate that adaptation and diffusion be promoted for their own sake, regardless of the social costs and benefits that government involvement might bring. Assistance to speed up adaptation and diffusion should be subject to the same requirement as assistance to R & D itself – i.e., that adequate cost-benefit analysis be done in each case. Moreover, policymakers should remember at all times that many of the new ideas, products, and processes that make up technical advance are not the outcome of great sums of money being expended on applied R & D, whether in Canada or abroad. Finally, we are well aware that for that part of technical advance that results from applied R & D, an indigenous R & D capability can help in adapting such advances to Canadian conditions. Our recommendation is consistent with this, as R & D is not the only factor causing technical advance.

In earlier chapters, we have stressed the need to achieve productivity growth in the service sector, as well as the fact that a significant proportion of this sector consists of nonmarket industries, which account for a proportion of GNP almost as large as that of manufacturing. We therefore need to pay attention to productivity improvement in the nonmarket sector as much as in manufacturing – perhaps more, in view of the relative neglect to which it has been subjected to date. Industries in this sector are administered directly by provincial and federal governments. Difficult though it may be even to measure productivity in the nonmarket industries under provincial control, it may be possible to raise productivity in those areas by specific application of the general principle enunciated in Recommendation 1 to the nonmarket industries. Most of these are under provincial jurisdiction: education, medical care, and provincial public administration. One requirement, necessary but not sufficient, would be a better flow of information on new ideas and techniques of operation in these industries, so that "best practice" from the point of view of productivity, wherever it originates, would be adapted and diffused as rapidly as is economically desirable for Canada. Therefore,

2 **We recommend that provincial governments allocate funds to provide information that would speed up the efficient adaptation of new techniques of operation, whatever their country of origin, as well as the diffusion of existing best-practice techniques of operation within Canada, in the nonmarket industries that fall within provincial or municipal jurisdiction – mainly the hospital and medical-care, education, and public-administration sectors.**

As part of the information that would be provided under this recommendation, we envisage the development of new concepts and techniques of productivity measurement that would apply to the raising of productivity in nonmarket industries; task forces might be needed for this. In the case of public administration, it could be argued that real progress in productivity improvement will require changes in the value system of the civil service that go beyond anything that this Council, as a body whose mandate is to focus on economic issues, can propose. We nevertheless believe that the provision of information, in a broad sense, would be helpful. Nor do we wish to promote "gold plating" in these nonmarket industries. Our stress is on more effort in finding the most efficient ways of operating, as disclosed by best practice wherever it is found. Finally, we do not exempt this information provision process itself, if it is adopted, from cost-benefit analysis. Providing information costs money, and it should be understood that what we are suggesting is simply that money spent in this way might well be cost-effective through the productivity improvements it could generate. Checks should nevertheless be made on its cost effectiveness, once the process has been tried for some time. Among these checks might be included the release by Statistics Canada of data pertaining to discoveries that would result from the implementation of our recommendation.

At the federal level, the only significant nonmarket industry under government control is public administration itself (including defence). Here we have a precedent for promoting productivity improvement; this was discontinued some time ago, but we believe it is worth reviving and extending. In the past, the Treasury Board sometimes required departments to provide productivity comparisons among their various offices across the country. Differences in efficiency were not uncommon; they offered the potential, we believe, for closing the gaps between best and average practice within public administration itself. While comparisons with best practice in similar agencies abroad were never required, we consider that other useful ideas might emerge if such comparisons were also made. Therefore,

3 **We recommend that the federal Treasury Board reinstate previous requirements for departments to provide productivity comparisons within federal government operations across the country and that it use this information, as well as information gathered from abroad, in a renewed effort to spread best-practice administrative techniques for the federal government across the nation.**

Is this proposal realistic, given the value system within which the public service operates? Many would argue that new information is less important than finding ways to restructure radically the incentive and reward system in the public service, so that it gives greater importance to efficiency.[1] While new information may do less good in a system where low weight is given to efficiency (such as the present one) than in a system where efficiency matters more (as some argue), it would do some good. Moreover, the effort to gather and use new information on best-practice techniques should, of itself, help to highlight the possible gains from a more radical reorganization of the ways in which all public services in Canada operate.

When considering the market service sector in relation to faster adaptation and diffusion of new ideas and best-practice technology, we believe that responsibility for economic promotion in this area should lie mainly with the private sector itself rather than with government. This might be done through the many service-sector associations that exist. Most of them provide information of one kind or another to their members, but only a few provide information on best-practice technologies, including organizational or management methods. These few are notable, for they illustrate what is possible. The Retail Council of Canada, for example, has recently sponsored a seminar on productivity improvement through technology; it has also recently conducted an operating survey of Canadian retailing and has provided its members with a financial and operating guide for various store types. Data on sales, profitability, productivity, advertising, turnover, and other performance indicators have been published, enabling firms to compare their own performance with the norm for the group. A similar service is offered by the federal Departments of Industry, Trade and Commerce/Regional Economic Expansion, which have a mandate to promote diffusion of best-practice technology, though only in the manufacturing sector. (Identification of best practice in use abroad is an underdeveloped aspect of the program.) Private service-sector associations could provide such a service for their members.

A problem that the Retail Council met was that, despite assurances of confidentiality, firms were reluctant to disclose sensitive financial and operating data to other member firms, which are, of course, competitors. To circumvent this difficulty, it would probably be better, as a general rule, for Statistics Canada to conduct surveys on behalf of service trade associations at their request and to analyse the data on a contract basis. Statistics Canada, which adheres strictly to confidentiality restrictions, also has unrivaled in-house capacity and expertise in conducting representative and valid surveys. Whoever does the work, emphasis should be placed not only on the provision of performance statistics but also on information regarding the role played by best-practice technology and management in Canada and abroad in contributing to superior performance. Accordingly,

4 We recommend that trade associations in the service sector adopt as one of their primary responsibilities the collection and dissemination to member firms of information on new ideas and best-practice technology and management methods in use in Canada and abroad.*

A precedent for this type of activity has been set in France, where co-operative industry research institutes have aided in the development and dissemination of technology, and have a mandate to provide training, advice, and information to member firms. The research institutes are funded by an association levy representing a small percentage of each member's turnover. Such a levy would also be appropriate in Canada. In our view, however, the social benefits arising out of the dissemination of information on best-practice techniques to private firms in the service sector are likely to warrant some public financial support as well. Therefore,

5 We recommend that government financial assistance be provided to service trade associations specifically for the purpose of spreading and diffusing to their members information on best-practice technology and management methods, whether found in Canada or abroad and whether resulting from R&D or not.*

As with our previous proposals, the costs and benefits of this assistance should be monitored and measured over a trial period, before making it a permanent program.

The Canadian branch plants of foreign corporations are an important channel through which new products and processes enter into this country (see Chapter 5). More importantly, it is the more sophisticated and advanced technology that Canada acquires in this preferential fashion. This outcome is not accidental: the nature of the process (as described in Chapter 5 and in the literature on industrial organization) is such that this route of entry conforms to logical expectations. There are of course many other important channels – e.g., consultants, engineering firms, equipment manufacturers, and so on.

The entry and behaviour of foreign-owned branch plants has long been a matter of concern to Canada's industrial policymakers, and most recently to the Foreign Investment Review Agency (FIRA). The Agency has used a variety of criteria to judge

*Mr. Lortie has registered a dissent with respect to this recommendation. See pp. 134-137.

whether foreign firms should be allowed to establish Canadian subsidiaries here. These criteria include job creation, increased resource processing, contributions to improved productivity and industrial efficiency, increased exports, enhanced technological development, and so on. Given the urgent need to restore lost productivity growth, we believe that FIRA should modify significantly the emphasis used in the applicaton of these criteria. Much greater importance should be given to the introduction of new technology in particular, and to the enhancement of productivity in general, when considering applications for new investment by foreign corporations. Productivity, innovation, and enhanced technological development have tended to rank low as criteria for acceptance in FIRA's decisions in the past. A recent assessment of 2,140 proposals accepted between 1974-75 and 1979-80 showed that they ranked sixth, seventh, and tenth, respectively, in order of importance.[2] This ranking should be raised. The first five criteria (outranking those which were related to productivity) were: compatibility with national industrial and economic policies; increased employment; new investment; increased resource processing in the use of Canadian products; and the participation of Canadians as shareholders, directors and/or managers. Therefore,

6 **We recommend that the Foreign Investment Review Agency give considerably greater importance to the introduction of new technology and the enhancement of productivity, when considering applications for new investment by foreign corporations.***

This recommendation applies to new investment. A code of behaviour also exists for foreign branch plants already in Canada. It is not clear how far adherence to that code is insisted upon, but to the extent that it is, we consider that the spirit of Recommendation 6, stressing the importance of introducing new technology and higher-productivity techniques, should be kept in mind here also.

In discussing the introduction of new products and processes into Canada from abroad and their subsequent diffusion through Canada, we had occasion to examine the role of the Patent Office (see Chapter 5). We found that, unlike most other countries, Canada does not presently give its Patent Office a mandate to spread information on patents to potential users. The Office is mandated only to administer the granting of patents. The normal practice of a double mandate, observed in other countries, is probably beneficial in aiding faster, but still economical, adaptation of new technology, particularly for small domestic firms. We also discussed the feasibility of setting up a patent technical-information service for this purpose. Accordingly,

7 **We recommend that the Patent Act be amended in order to give the Patent Office a mandate to establish and operate a patent technical-information service to promote innovation in Canada.***

It may be necessary, if this recommendation is adopted, to effect other amendments to the Act. For example, earlier disclosure of patented technologies might be needed, provided this were shown not to conflict with the basic protection purpose of the patent system as a whole. In such cases, any amendment of the Patent Act should encompass this and other necessary changes, in order to give substance to the spirit of the recommendation. There would also be a need to ensure that the service was not too expensive in relation to the benefits provided. Our research has established a good *prima facie* case that it would not be, but we would nevertheless stress the desirability of conducting a formal cost-benefit analysis of the program, preferably after a three-year trial period, and of deciding whether a system of user charges should be instituted.

Beyond our concern about changing the approach with respect to the speedier adaptation and diffusion of new ideas and technology, wherever they originate, and with respect to the need to put greater stress on the hitherto neglected service sectors, both market and nonmarket, we are also preoccupied with the domestic production of new technology and, in particular, with the rate at which R & D spending should be increased, with the problem of insufficient stress on careful analysis of the costs and benefits of public assistance to R & D, and with the effectiveness of methods other than assistance for increasing the domestic production of new ideas and techniques.

In Chapter 3, we concluded that R & D spending in Canada is probably too low. Hard evidence is lacking, however, and the case for more R & D is in part a judgment call. Combining the evidence and our judgment, we believe that Canadians in both the private and the public sector are insufficiently dedicated to R & D as a route to higher productivity. Given this assessment, we would endorse strongly the federal government's plan to raise R & D spending to at least 1.5 per cent of GNP by 1985. The achievement of this goal will involve higher spending by both the private and public sectors. At the same time, our analysis suggests that a global target of this nature is less useful than disaggregated targets would be. The disaggregation should be both among manufacturing industries and between manufacturing

*Mr. Lortie has registered a dissent with respect to this recommendation. See pp. 134-137.

*Mr. Lortie has registered a dissent with respect to this recommendation. See pp. 134-137.

and other sectors, such as natural resources and, most importantly, services. Therefore,

8 We endorse the federal government's target of raising R&D spending to 1.5 per cent of GNP by 1985, considering this a minimum requirement; and we recommend that the target be disaggregated by industry.

In Chapter 6, we examined five leading programs of assistance to R & D in Canada. We argued that, for government assistance to be warranted, it must meet two conditions. First, the projects that are being considered must be economically worthwhile, in the sense that their social benefits must be expected to exceed their social costs, including the expenses associated with collecting the taxes to pay for a subsidy if one is granted (and these expenses can be considerable). Second, the assistance given must be just enough – neither too much nor too little – to ensure that the projects can proceed. In short, assistance should be given only to worthy projects, and only to the extent needed.

The assistance should be adequate to generate at least the same rate of return on successful projects that successful private-sector projects are required to obtain. That rate is a high one because of the need to compensate for many potential failures when pioneering R & D is being done. That rate would certainly be much higher than that on government bonds.

This is not to say that the actual outcome of every assisted project must be such that benefits will always be in excess of costs. In a field like research and development, that would be ridiculous. It is impossible to find "winners" – especially "big winners" – without inadvertently picking some "losers" as well. Rather, there should be a reasonable attempt to ensure in advance that the benefits of a project will probably exceed its costs.

It is also important that the quality of such *ex ante* judgments be systematically checked by collecting and analysing data when the projects are over. This exercise will permit an assessment of whether socially assisted projects were beneficial on average; it may well show that adventuresome but mistaken help was extended to many "losers," but that will be acceptable as long as enough "winners" were assisted at the same time. Another important point is that the data and analytical capacity needed to make calculations of likely costs and benefits, both *ex ante* and *ex post*, can be obtained quite easily in the majority of cases. Recalling the two conditions described above,

9 We recommend that subsidies be awarded to technical innovation projects only when two conditions are met:

a) the projects must be worthwhile to the country; and

b) the subsidies must be necessary, in the sense that the projects would not provide a reasonable profit without them.*

This recommendation captures the essence of what we think should be done.[3] Its implementation is fundamental to our view that policy on technical advance needs more rigorous cost-benefit analysis of project subsidies than has been attempted until now.

As noted previously, the evaluation of subsidized projects after their completion can help a great deal in implementing our recommendation. Comparing actual results with expectations should improve the difficult, but essential, process of deciding in advance which projects are worth subsidizing. Our research has shown that this *ex post* exercise is only rarely done. It requires the development of a method for estimating the total incremental expenditures on innovation (on R & D, for example) made annually by firms that are attributable to the subsidies they have received. It also requires that the actual returns, both social and private, earned by completed, successful subsidized projects be calculated after enough time has elapsed, in order that comparisons can be made with the projections that were prepared when the subsidy was awarded.

These two aspects reflect the need to ensure that the subsidies have, in fact, produced the intended overall increases in the autonomous R & D spending of the recipient firms and that the ultimate *raison d'être* of a subsidy program is the generation of higher levels of socially desirable R & D investment than would otherwise obtain. Since the actual outcomes of subsidized projects will inevitably differ from their expected outcomes, the former must be monitored and compared with the latter. These comparisons will indicate to program administrators whether their *ex ante* evaluation procedures are, in general, too optimistic or too conservative.

Case histories of the process of subsidization of R & D under various federal programs reveal that a most important part of the process of examining a project's potential benefits is usually omitted. This has to do with the risk that a subsidized project could displace one or more worthwhile projects elsewhere. The project should be "incremental" if that risk is to be avoided. It could happen on occasion, however, that a project satisfying the conditions of Recommendation 9 has also been, or is about to be, undertaken by a more efficient competitor who – because of that very efficiency – does not qualify for a subsidy. A subsidy in these circumstances would clearly not be appropriate, because the project would not be incremental to the industry. Therefore

*Mr. Lortie has registered a dissent with respect to this recommendation. See pp. 134-137.

10 We recommend that subsidy program administrators ascertain that subsidized projects are incremental not only to the firm but also to the industry to which the firm belongs.*

Incrementality in assessing benefits is important in another way. When examining the case studies and looking at the job creation benefits of potential projects, we were struck by the neglect of this vital concept. Just as projects will be beneficial if they are incremental to the firm and the industry, so, too, any jobs that they create must be incremental to the economy as a whole in order to be viewed as benefits of the projects. If, contrary to assumptions, jobs are not created in fact, this is bad not only for a proper assessment of the R & D project but also for job creation and policy aimed at reducing unemployment, because it is bound to lead to false optimism about the actual achievement in job creation. Jobs created by subsidies or tax concessions to particular projects, firms, or industries cannot be automatically assumed to be incremental to the economy, because the higher taxes required to pay the subsidies have a dampening effect on demand, leading to the disappearance of some jobs. The overall impact of the subsidy on jobs in the whole economy is therefore different from the effect that it has within the firm obtaining the subsidy and on its suppliers. If the subsidy is financed not through higher taxes but through cuts in other government programs, a similar phenomenon of job loss may arise elsewhere. If the subsidy is financed through bond issues or money creation, then the extra jobs will indeed be incremental, but they will be logically countable as benefits of the project itself only to the extent that they exceed in quantity or quality the jobs created by other uses of the new bond issues or newly created money – e.g., tax cuts, public investment, and so on. In sum, job incrementality is more complicated than past assessments of the merits of R & D subsidies have allowed for. Consequently, both in the interests of proper evaluation of R & D and in the hope that the unintended creation of *too few* jobs can be avoided,

11 We recommend that greater care be taken, when assessing the benefits of projects that are actual or potential recipients of R&D subsidies, to evaluate the incrementality of the jobs created.*

In discussing the Defence Industrial Production Program (in Chapter 6), we considered the rationale for the subsidization of defence production exports. We stated that subsidies of specific projects are legitimate if the latter satisfy the two conditions that apply to any other innovation project. We also wrote that export subsidies can legitimately be paid to firms as such, either because they are "infants" that will later stand on their own feet and/or because they are indispensable to the defence production field. Here, the criterion should be the firm's average rate of return; in other words, the subsidy should enable the firm to earn the opportunity cost of staying in the defence production field, but no more. There is evidence that some DIPP subsidies have been directed towards recipient firms rather than specific projects. It would be preferable, in such situations, to apply firm-specific rather than project-specific criteria. It would also be appropriate to consider whether loans, instead of subsidies, might be the most efficient form of government assistance. Consequently,

12 We recommend that there be two categories of subsidies in the Defence Industry Productivity Program. The smaller category should include subsidies for specific projects that meet the two conditions that apply to innovation projects subsidized under other programs. The larger category of subsidies should be aimed at keeping in the defence production field certain firms that are deemed essential but that might otherwise wish to leave it because of insufficient profits. The subsidies should be calculated to offset this insufficiency.*

The subsidization of the earnings of firms that are deemed essential to the defence production industry requires that the need to maintain Canada's defence capabilities be reconciled with the need for economic efficiency and public accountability. The taxpayers-citizens ultimately bear the costs and reap the benefits, but they cannot, in their own interests, be made privy to all the sensitive information necessary for a rational judgment in specific cases. Since neither program administrators nor firm managers are satisfactory substitutes for taxpayers, some intermediate participant in the decision-making process is necessary. A properly constituted board, subject to questioning by Parliament, might adequately service this function. Accordingly,

13 We recommend that where the object of a Defence Industry Productivity Program subsidy is to ensure that the recipient firm will remain in the defence production industry, an appropriate board, responsible to Parliament, be created to oversee the relationship between the firm and the subsidy program.*

When the Lamontagne Committee recommended more contracting out by the federal government in order to stimulate private R & D and technological advance, it did not distinguish between departments and did not consider the methods for such contracting out as fully as seems appropriate to us. Our

*Mr. Lortie has registered a dissent with respect to this recommendation. See pp. 134-137.

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research (see Chapter 4) suggests that the likelihood that the contracting-out process would generate social benefits in excess of costs would be enhanced by confining enforcement of the contracting-out policy to those departments and projects where the process can be expected to bring net benefits.

A blanket approach leaves open the door to negative impacts, as in the case where the costs of administering contracts exceed the benefits gained. Net benefits vary with the nature of the research that is contracted out. They comprise such elements as the reduced need for technology transfer programs like PILP and spin-offs of acquired knowledge to projects other than that which is contracted directly. Costs arise from having to administer the contracting-out process itself. Benefits tend to be high in relation to costs for projects with specific research objectives, easy-to-quantify outcomes, little uncertainty, and relatively little need for significant specialized facilities. In the opposite case – more typical of complex, advanced research, often of a basic nature – contracting out may have negative net benefits relative to in-house research. Accordingly,

14 We recommend that enforcement of the federal contracting-out policy be confined to those departments and projects where contracting out can be expected to bring net benefits.*

Furthermore, our research indicates that setting performance standards rather than material specifications, whenever possible, in government contracting out would also be likely to generate social benefits in excess of costs. Therefore,

15 We recommend that the practice of setting performance standards rather than material specifications be more widespread. Federal departments, whenever possible, should define the ends and leave the technical means by which performance standards are met up to the firm(s) involved in the project. The extent to which this is possible will be constrained by the need for co-ordination when more than one firm is involved in a project.

Most governments support scientific research in government laboratories and in universities in the belief that the resulting knowledge and understanding will permit improvements in the defence, health, well-being, prestige, or economy of the nation. However, the effectiveness of any mechanisms designed to transfer scientific knowledge from government laboratories and from universities to industry varies enormously across countries. In many cases, the only direct mechanism is the transfer of people (including students) to industry. There are some relatively few examples where fortuitous circumstances have led to a form of "spontaneous combustion," with a large number of small, innovative firms spawning as a result of the transformation of public-institution researchers into entrepreneurs. The cases of "Silicon Valley" in California and Route 128 outside Boston illustrate this point. The question that matters is: How can governments best transfer to industry the knowledge and know-how developed in their laboratories and in the universities? One general answer would be to give greater emphasis to this issue in public research institutions. Another, more direct, means would be to develop programs whose primary goal would be to effect such transfers of knowledge through links with specific firms. The PILP is an example, one of its elements consisting of a rather vaguely defined provision for use of the Program to effect university-to-industry transfers of know-how. The need for formal means of liaison between the universities and industry is great. Therefore,

16 We recommend that the Program for Industry/Laboratory Projects of the National Research Council be broadened explicitly to include transfers of know-how from the universities to industry.

We note that this may also require additional funding for the universities – a provincial responsibility.

*Mr. Lortie has registered a dissent with respect to this recommendation. See pp. 134-137.

Part C

The Role of Trade

8 The Importance of Trade Policy

Opinions vary as to whether a faster approach to freer trade would be good for Canada. Most would agree that multilateral trade growth has helped Canadian living standards rise in the past and could do so in the future. There is disagreement, however, on the question of how harmful the other effects of trade growth may be in changing the nature of Canada's industrial structure and forcing workers out of jobs and firms out of business. These issues raise important questions concerning the recent evolution of industrial structure and trade patterns in Canada; the amount, duration, and incidence of costs of the adjustment associated with increasing trade; the effectiveness of compensation mechanisms; the size of the overall gains made; the way and time frame within which the gains arise; and the distribution of gains and losses.

As we have seen, the potential contribution of greater trade to living standard growth is more important to reflect upon than it ever was in the past. That is because the major past contributor to living standard growth – productivity improvement – has disappeared, and we have no idea when it will reappear. At the same time (and here is the rub), the two potentially harmful effects of greater trade – the changes forced in Canada's industrial structure and the adjustment costs imposed on firms and workers – are also more important to reflect upon than in the past. As far as the effects of increasing trade on Canada's industrial structure are concerned, increasing concern has been expressed lately about the long-run viability of the manufacturing sector and about the adverse consequences that would result from any serious decline in it. As far as the adjustment costs are concerned, at the time of writing Canada had its highest unemployment rate since the Great Depression. As long as that persists, any workers displaced by future import competition will have much greater difficulty than before in finding new work. Similarly, firms facing adjustment problems will have a much harder time.

Right now, the trade policy agreements in force under GATT mandate further multilateral reduction of tariff and nontariff barriers in coming years, and there is pressure to reduce government interventions on the export side also. For those who emphasize the increased urgency of obtaining the income benefits of greater trade, these planned changes are good and, perhaps, should even be accelerated. For those who emphasize the increased seriousness of structural and adjustment problems, these planned reductions do not seem so good and, perhaps, should be decelerated. Even if there are no changes in the present plans for trade barrier reduction, those plans will create shifts in demand and supply conditions that will induce changes in the structure of production and trade in Canada. Thus processes of structural adjustment will take place. It is useful to bring evidence of the adjustment processes to bear on the prospective structural adjustment, to indicate the likely prospective degree, form, and locus of the adjustment problems. No one, incidentally, is advocating either autarky or free trade overnight; what is at issue is the degree of acceleration or deceleration in current plans under GATT, if any, that is appropriate now and for the future, in the light of three factors: the increased urgency of promoting income growth; new evidence on adjustment processes; and the present severe unemployment.

Our approach to this question is in three steps. First, we examine whether trade policy needs modifying in light of the emerging effects of growing trade volume on the size and nature of Canada's manufacturing sector, including the so-called "risk of deindustrialization," and we assess the merits of a proposed partial corrective to this putative threat – namely, government support for export-oriented R & D. Second, in the following chapter, we discuss the adjustment costs of moving to freer trade and the income and productivity gains associated with that movement. Third, we pull all of this together in the last chapter, and we draw conclusions about the proper stance for trade policy.

Export Trends in Canada's Manufacturing Sector

The value of Canada's total merchandise exports rose from $5.4 billion in 1960 to $16.8 billion in 1970 to $76.2 billion in 1980 (and to $84 billion in 1982) – a pace of expansion roughly in line with that of world trade generally. Although the Canadian proportion of the exports of all OECD countries, measured in current dollars at prevailing exchange rates, has slipped from between 6 and 7 per cent in the 1960s and early 1970s to about 5 per cent now, that decline has largely been the result of inflation and currency fluctuations rather than real losses in the volume of trade. If a drop in Canada's share has occurred, it has been quite small.

This point is well illustrated by the exports of manufactured goods, which climbed from approximately $3.5 billion in 1960 to around $12.0 billion 10 years later and $52.9 billion in 1980 (and to $58.7 billion in 1982). These amounts represented higher proportions of the developed-nation total in the 1960s (around 5 per cent) and early 1970s (close to 6 per cent) than they do today (below 4 per cent), but they show little change over the period when measured in constant U.S. dollars: in those real terms the share rose slightly in the 1960s from 3 per cent to 4 per cent and then stayed there (Table 8-1). While that yardstick is not perfect, the evidence is that over the past 20 years Canada's relative position in world exports has remained approximately stable, as indeed has that of most industrial countries; Japan and Italy, however, have increased their shares, while the United Kingdom and (to a lesser extent) Sweden and Switzerland have lost ground.

Canadian exports have grown at a faster pace than the national economy as a whole during most of the two decades. Expressed in constant dollars, they rose at an average rate of 9 per cent annually in the 1960s, compared with 5 per cent for the GNP. In fact, for most industrialized countries exports in constant dollars have risen more rapidly than GNP in constant dollars. The pace of trade expansion slowed in the 1970s, but except for short spells it continued to exceed real growth in national output.

In a number of respects, recent export trade figures reveal an increasing integration of the Canadian economy with that of the United States. The proportion of Canada's total exports that found markets in the United States in 1960 was somewhat over half (56 per cent). By 1970 that share had increased to two-thirds (65 per cent), and it has been fluctuating around that figure ever since (Table 8-2). The big increase in the U.S. orientation of Canadian trade that occurred between 1965 and 1969 was, to a considerable degree, a reflection of the introduction of the Auto Pact.

As for commerce with other countries, exports to the United Kingdom have dropped sharply, in relative terms – from 17 per cent of the total in 1960 to 4 per cent in 1981; exports to the rest of the European Economic Community declined from 8 per cent to 7 per cent over the same period. On the other hand, shipments to Japan rose over the two decades – from 3 per cent to almost 6 per cent – making that nation Canada's largest single-country market

Table 8-1
Shares of the Major Industrial Countries in the Total Exports of Manufactured Goods of Developed Market Economies, Selected Years, 1960-81[1]

	1960	1970	1975	1978	1980	1981
				(Per cent)		
Belgium and Luxembourg	5.2	5.7	5.3	5.4	5.2	. .
Canada	3.3	4.4	3.8	4.3	4.1	4.2
Denmark	1.0	1.2	1.1	1.0	1.0	. .
France	9.1	8.4	9.2	9.2	9.0	8.9
West Germany	19.0	20.4	18.4	17.9	18.1	18.5
Italy	4.1	6.4	6.7	7.6	7.0	. .
Japan	5.3	10.3	12.3	13.4	14.0	14.8
The Netherlands	3.8	4.2	4.5	4.2	4.3	. .
Norway	1.2	1.3	1.2	1.1	0.9	0.8
Sweden	3.4	3.5	3.2	2.8	2.6	. .
Switzerland	4.0	3.2	2.8	3.0	2.8	2.8
United Kingdom	14.6	9.1	8.4	7.9	7.2	. .
United States	20.1	14.9	16.4	14.6	15.9	14.6

1 Based on data expressed in constant 1975 U.S. dollars.

SOURCE United Nations, *Monthly Bulletin of Statistics*, various issues; and D. J. McCulla, "Evaluating Measures of Canada's Industry Trade Performance," Department of Industry, Trade and Commerce, Economic Intelligence Branch, Ottawa, December 1980.

Table 8-2

Distribution of Canadian Merchandise Exports, by Area of Destination, 1960-81

	United States	United Kingdom	Other EEC countries	Japan	Other OECD countries[1]	U.S.S.R.	Other Eastern Europe	China	Other Asia	Other Africa	Latin America	Middle East and other countries
						(Per cent)						
1960	56.4	17.2	8.2	3.3	5.0	0.2	0.6	0.2	2.0	1.4	4.8	0.7
1961	54.5	15.6	8.0	3.9	4.5	0.4	1.7	2.1	2.0	1.1	5.3	0.9
1962	59.1	14.5	7.3	3.4	4.6	0.1	0.7	2.3	1.5	1.1	4.8	0.6
1963	56.1	14.5	7.0	4.2	4.7	2.2	0.9	1.5	2.0	1.3	5.1	0.5
1964	53.4	14.5	6.8	4.0	4.6	3.8	2.0	1.6	2.0	1.3	5.3	0.7
1965	57.4	13.5	7.3	3.6	4.7	2.3	1.3	1.2	1.8	1.3	5.0	0.6
1966	60.4	10.9	6.5	3.8	4.1	3.1	0.6	1.8	2.2	1.1	4.8	0.7
1967	64.2	10.3	6.0	5.0	3.7	1.1	0.5	0.8	2.4	1.0	4.3	0.7
1968	67.9	9.0	5.6	4.4	3.6	0.7	0.4	1.2	1.9	0.8	4.0	0.5
1969	70.9	7.5	5.8	4.2	3.4	0.1	0.2	0.8	1.6	0.8	4.1	0.6
1970	64.8	8.9	7.2	4.8	3.9	0.6	0.4	0.8	2.0	1.0	4.5	1.1
1971	67.5	7.8	6.2	4.7	3.5	0.7	0.4	1.1	2.0	0.9	4.2	1.0
1972	69.3	6.8	5.7	4.8	2.9	1.4	0.5	1.3	1.6	0.8	4.0	0.9
1973	67.4	6.3	6.2	7.1	3.1	1.1	0.5	1.1	2.0	0.7	3.6	0.9
1974	66.0	5.9	6.7	6.9	3.5	0.1	0.5	1.4	2.1	1.2	4.8	0.9
1975	65.1	5.5	7.2	6.4	2.8	1.3	0.8	1.1	2.4	1.3	4.8	1.3
1976	67.3	4.9	7.0	6.2	2.8	1.4	0.7	0.5	1.9	1.1	4.6	1.6
1977	69.8	4.4	6.2	5.7	2.7	0.8	0.6	0.8	2.0	1.1	4.4	1.5
1978	70.3	3.8	5.6	5.8	2.3	1.1	0.7	0.9	2.4	1.1	4.6	1.4
1979	67.8	4.0	7.1	6.2	2.8	1.2	0.7	0.9	2.3	1.2	4.4	1.4
1980	63.3	4.3	8.3	5.7	3.3	2.0	0.8	1.1	2.9	1.4	5.3	1.6
1981	66.2	4.0	6.6	5.4	2.9	2.2	0.6	1.2	2.4	1.5	5.0	2.0

1 Includes Yugoslavia and Turkey.

SOURCE Statistics Canada, CANSIM databank; and Department of Industry, Trade and Commerce, Economic Intelligence Group, *Canada's Trade Performance, 1960-1977* (Ottawa: Supply and Services Canada, 1978).

overseas. The importance of the other destinations in the total has not altered greatly over the years. The Middle Eastern nations have become a somewhat larger market in recent times, accounting for about 2.0 per cent of the total compared with 0.7 per cent 20 years ago, while the share provided by "other OECD" countries – that is, Western Europe outside the Common Market plus Australia, New Zealand, and a few others – has sunk from 5 per cent in 1960 to 3 per cent today.

A disaggregation of the value of Canadian exports by major commodity groups reveals, above all, a sharp increase in the share accounted for by fully finished nonfood manufactures ("inedible end products") from around 8 per cent in the 1960s to over 30 per cent in 1970, followed by a leveling-off in the following decade (Table 8-3). By contrast, the shares represented by agricultural produce ("food, feed, beverages, and tobacco") and by partially manufactured nonfood products ("inedible fabricated materials") fell during that period – from about 20 per cent to between 10 and 12 per cent, and from over 50 per cent to approximately 35 per cent, respectively. Nonagricultural primary commodities ("inedible crude materials") remained close to 20 per cent of the export package throughout the two decades, except for a short time in the mid-1970s when their share rose to almost 25 per cent.

The strong uptrend in the proportion of finished manufactures in overall exports in the 1960s (essentially between 1965 and 1969) was largely, but by no means exclusively, a result of the Auto Pact. Just under two-thirds of the increased proportion is traceable to the Auto Pact; just over one-third is a gain in other kinds of finished manufactured exports. The short-lived enlargement of the share represented by nonagricultural primary commodities was mainly a consequence of the increased price (and temporarily maintained volume) of Canadian oil and gas exports to the United States. If automotive products, as well as petroleum and natural gas, are excluded from the breakdown, most commodity-group shares over the 20 years change considerably less: partially manufactured goods show a roughly level trend around the 45 to 50 per cent mark (though perhaps with some new strength since the late 1970s); nonfood primary commodities slide from 22 per cent in the early 1960s

Table 8-3

Distribution of Canada's Domestic Exports, by Major Commodity Group, 1960-81

	Food, feed, beverages, and tobacco[1]	Inedible crude materials		Inedible fabricated materials	Inedible end products		Special transactions
		Total	Petroleum and gas		Total	Automotive	
				(Per cent)			
1960	18.8	21.2	2.1	51.9	7.8	1.3	0.3
1961	22.0	20.8	3.4	48.3	8.8	0.8	0.2
1962	20.1	22.0	4.9	47.1	10.6	0.9	0.2
1963	21.5	21.0	4.6	45.7	11.5	1.3	0.3
1964	22.7	20.0	4.4	43.3	13.7	2.2	0.3
1965	20.0	20.7	4.5	43.7	15.3	4.2	0.3
1966	19.5	19.3	4.3	39.8	21.2	10.0	0.3
1967	14.8	19.0	4.7	38.0	28.0	15.6	0.2
1968	12.1	18.5	4.5	36.4	32.7	20.6	0.3
1969	10.1	17.1	4.9	35.7	36.8	24.3	0.3
1970	11.4	18.8	5.2	35.8	33.8	21.3	0.2
1971	12.1	18.8	6.0	33.3	35.6	24.0	0.2
1972	12.0	18.1	6.7	33.4	36.3	24.0	0.2
1973	12.7	20.2	7.4	33.1	33.8	21.8	0.2
1974	12.2	24.6	12.4	33.8	29.2	18.0	0.3
1975	12.7	24.5	12.7	30.4	32.2	19.8	0.2
1976	11.4	22.0	10.4	32.5	33.8	21.8	0.3
1977	10.5	20.3	8.6	34.2	34.9	23.9	0.2
1978	10.1	16.9	7.2	36.7	36.1	24.0	0.2
1979	9.8	19.5	8.2	37.9	32.5	18.5	0.3
1980	11.1	19.8	9.2	39.4	29.4	14.7	0.3
1981	11.6	18.7	8.5	37.6	31.2	16.1	0.8

1 Including live animals.

SOURCE Statistics Canada, CANSIM databank; and IT&C, *Canada's Trade Performance, 1960-1977.*

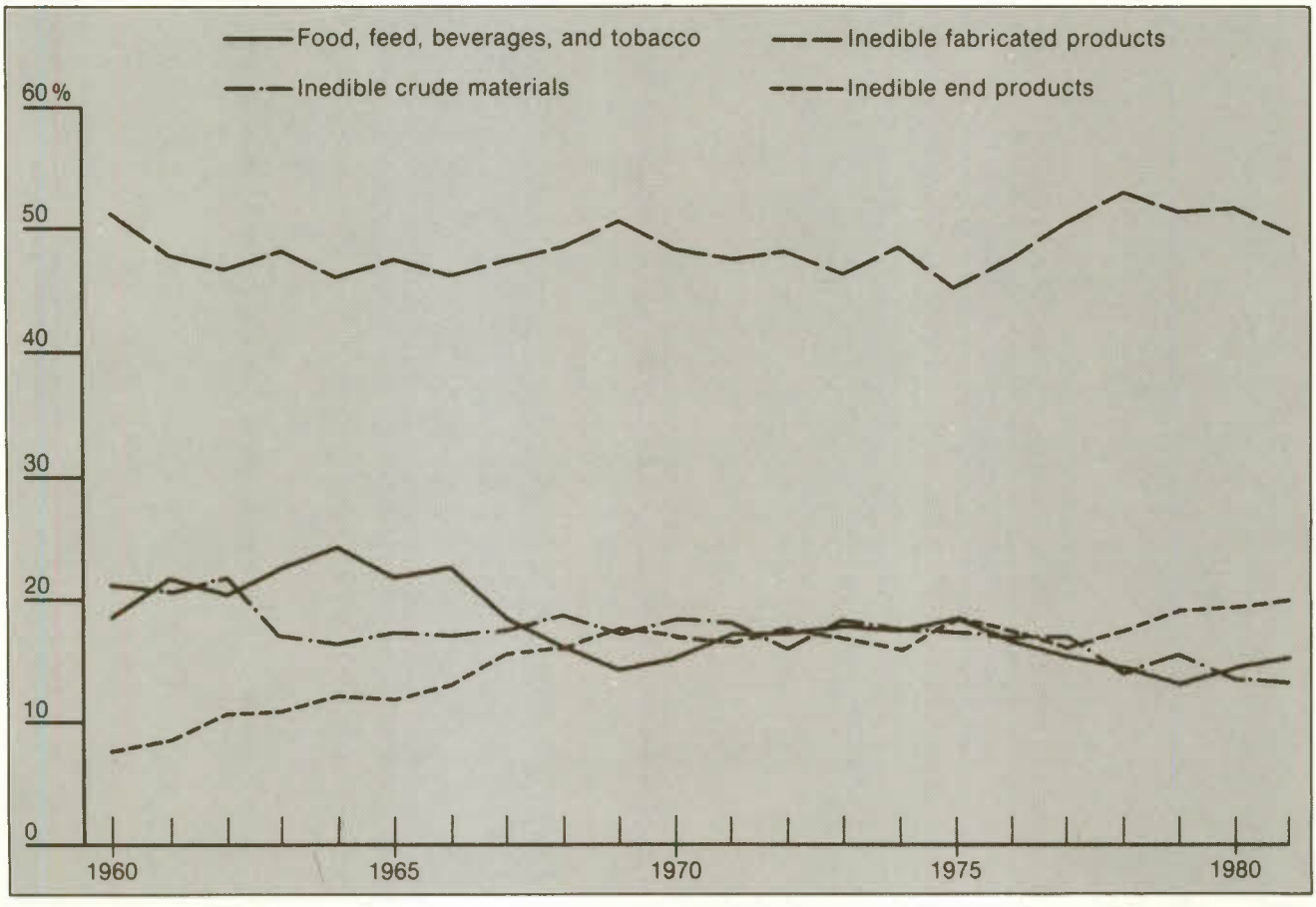
to 16-18 per cent between the mid-1960s and the mid-1970s, and to 14 per cent over the last few years; agricultural produce drops from between 20 and 24 per cent in the early 1960s to between 15 and 18 per cent in the late 1960s and in the 1970s, with an uncertain trend since then. Fully finished manufactures, however, still change considerably, more than doubling their share, which rises from 8 per cent in 1960 to 17 per cent in 1970, and to 19 to 20 per cent in 1980 and 1981 (Chart 8-1).

The interrelationship between the greater emphasis on finished-goods exports and the increased orientation of trade towards the United States emerges from the commodity composition of shipments to that country and to overseas markets, respectively. Between 1960 and 1980, the value of all Canadian exports to all countries other than the United States multiplied 12 times, while the value of exports of fully manufactured products multiplied by 26 – just over twice as fast. In respect of movements to the United States, however, the multiples over the period were 16 and 75, respectively. Nevertheless, the large difference with respect to end products was mainly a consequence of the Auto Pact: exports of nonautomotive end products to the United States and to the rest of the world grew at about the same pace over the two decades.

These trends on the export side contrast with a more static situation on the import side, where the proportion of total trade represented by purchases from the United States is much the same now as it was 20 years ago – about two-thirds – and the shift

Chart 8-1

Distribution of Merchandise Exports (Excluding Automotive Products, Petroleum, and Natural Gas), by Major Commodity Group, Canada, 1960-81



SOURCE Department of Industry, Trade and Commerce, *Canada's Trade Performance, 1960-1977* (Ottawa: 1978); and Statistics Canada.

Table 8-4

Distribution of Canadian Imports, by Area of Provenance, 1960-81

	United States	United Kingdom	Other EEC countries	Japan	Other OECD countries[1]	U.S.S.R.	Other Eastern Europe	China	Other Asia	Other Africa	Latin America	Middle East and other countries
						(Per cent)						
1960	67.3	10.7	5.3	2.0	2.1	0.1	0.2	0.1	1.7	0.6	7.7	2.2
1961	67.0	10.7	5.5	2.0	2.3	--	0.3	0.1	1.6	0.8	7.7	2.0
1962	68.7	9.0	5.4	2.0	2.5	--	0.3	0.1	1.8	0.8	7.6	1.8
1963	67.8	8.0	5.2	2.0	2.9	--	0.3	0.1	2.0	1.3	8.2	2.2
1964	69.0	7.7	5.4	2.3	2.9	--	0.4	0.1	1.7	1.3	7.8	1.4
1965	70.0	7.2	6.0	2.7	2.8	0.1	0.4	0.2	1.8	1.0	6.3	1.5
1966	71.5	6.7	5.8	2.7	2.9	0.1	0.5	0.2	1.6	1.2	5.2	1.6
1967	73.1	6.0	5.5	2.7	2.9	0.2	0.5	0.2	1.6	1.1	5.1	1.1
1968	73.2	5.6	5.4	2.9	2.8	0.2	0.5	0.2	1.6	0.9	5.5	1.2
1969	72.5	5.6	5.6	3.5	3.2	0.1	0.5	0.2	1.7	0.9	5.1	1.1
1970	71.1	5.3	5.8	4.2	4.0	0.1	0.5	0.1	1.9	1.1	5.0	0.9
1971	70.1	5.4	6.0	5.1	3.5	0.1	0.5	0.1	1.9	1.2	4.8	1.3
1972	69.0	5.1	6.2	5.7	3.8	0.1	0.5	0.3	2.2	1.3	4.2	1.6
1973	70.7	4.3	6.3	4.3	3.7	0.1	0.5	0.2	2.3	1.3	4.4	1.9
1974	67.4	3.6	6.1	4.5	3.5	0.1	0.5	0.2	2.2	1.4	6.4	4.1
1975	68.1	3.5	6.0	3.5	3.4	0.1	0.4	0.2	2.1	1.3	5.2	6.2
1976	68.8	3.1	5.3	4.1	3.3	0.1	0.4	0.2	3.1	1.4	5.5	4.7
1977	70.4	3.0	5.6	4.2	3.0	0.1	0.4	0.2	2.9	0.9	5.8	3.5
1978	70.7	3.2	6.1	4.5	2.9	0.1	0.4	0.2	2.9	0.7	5.0	3.3
1979	72.5	3.1	5.8	3.4	2.9	0.1	0.4	0.3	3.1	0.7	4.6	3.1
1980	70.2	2.9	5.2	4.0	3.1	0.1	0.4	0.2	3.0	0.8	5.8	4.3
1981	68.7	3.0	5.1	5.1	2.8	0.1	0.3	0.3	3.3	1.3	6.4	3.6

1 Includes Yugoslavia and Turkey.

SOURCE Statistics Canada, CANSIM databank; and IT&C, *Canada's Trade Performance, 1960-1977.*

towards fully manufactured products is less pronounced, some 60 per cent of Canadian imports being in that category today, compared with 50 per cent in the early 1960s (Tables 8-4 and 8-5). Even so, the picture there is also one of substantial integration with the U.S. economy, especially in the manufactured-goods sector. The oft-cited expansion of imports from rapidly industrializing Far Eastern countries like South Korea and Taiwan ("the new Japans") is a relatively minor factor as yet, since the share of Canada's total foreign purchases that came from Asia (excluding the Middle East) in 1981 was only just over 8 per cent, of which 5 per cent was from Japan alone. Admittedly, that 8 per cent figure is well up from the corresponding 3.8 per cent (2.0 per cent from Japan) in 1960, but it is still not very impressive. And proportions from just about all of the other regions, with the notable and obvious exception of the Middle East, are down.

In other words, the most pronounced feature of the Canadian export position, mirrored (at least in broad outline) in the import situation, is the growing linkage to the U.S. market. A lesser feature is the increased share of fully manufactured goods – a change that results largely, but by no means exclusively, from the Canada-U.S. Auto Pact.

What is recognized more and more about Canada's trade with the United States is that much of it is not the customary arm's-length commerce between unrelated buyers and sellers but rather the intracorporate transfer of equipment and goods between affiliates on each side of the border. According to data from a 1981 study, the greater part of all imports from Canada in recent years has occurred through trade between firms "related by ownership" (that is, where one owned at least 5 per cent of the equity of the other). Some proportions for 1975 were: pulp and paper, 40 per cent; textiles and related products, over 40 per cent; chemicals, 57 per cent; petroleum and gas, 58 per cent; pharmaceutical products, 74 per cent; machinery, 76 per cent; beverages, 86 per cent; tobacco products, 92 per cent; transportation equipment, 97 per cent.[1]

Table 8-5

Distribution of Merchandise Imports, by Commodity Group, Canada, 1960-81

	Live animals, food, feed, beverages, and tobacco	Inedible crude materials		Inedible fabricated materials	Inedible end products		Special transactions
		Total	Petroleum and gas		Total	Automotive	
				(Per cent)			
1960	10.6	13.6	5.1	24.4	49.7	10.6	1.7
1961	10.9	13.2	5.0	24.1	50.1	9.2	1.8
1962	10.6	13.2	4.9	23.8	50.3	10.0	2.0
1963	11.9	13.7	5.1	24.0	48.4	10.2	2.1
1964	10.6	12.8	4.3	24.2	49.4	10.9	2.9
1965	8.9	11.7	3.6	24.5	51.9	13.0	3.1
1966	8.2	10.4	3.1	22.7	55.3	15.8	3.3
1967	7.9	9.4	3.0	20.7	59.5	19.9	2.5
1968	7.4	9.1	3.0	19.7	61.6	24.3	2.1
1969	7.5	7.7	2.8	20.6	62.9	25.1	1.4
1970	8.0	8.4	3.0	20.7	61.8	23.3	1.2
1971	7.4	8.5	3.5	20.1	63.0	26.3	1.1
1972	7.5	8.2	3.6	19.2	64.0	26.4	1.1
1973	8.5	8.7	4.0	18.4	63.4	26.1	1.1
1974	7.9	12.8	8.3	20.4	57.9	22.5	0.9
1975	7.7	14.6	9.5	17.1	59.6	23.7	0.9
1976	7.7	13.6	8.7	16.6	60.9	25.2	1.3
1977	7.8	12.6	7.6	16.5	62.1	27.3	1.0
1978	7.6	11.7	6.9	17.5	62.5	26.7	0.8
1979	6.7	12.7	7.2	19.1	60.6	24.1	0.9
1980	6.9	16.4	10.0	18.3	57.2	19.6	1.1
1981	6.6	15.4	9.9	18.4	58.4	20.2	1.2

SOURCE Based on data from Statistics Canada CANSIM databank; and IT&C, *Canada's Trade Performance, 1960-1977.*

The Policy Picture

Reflecting the overall environment outlined above, Canada appears to have attached a good deal of importance, in the Tokyo Round of trade negotiations completed in 1979, to obtaining the kind of open access to U.S. markets that would permit rationalization of the structure of firms and industries on a North American basis. Naturally, because of the system of tariff cutting, Canadian negotiators could not obtain precisely the benefits vis-à-vis the United States that they wanted. But, even so, the accords reached in the Tokyo Round provide for a drop of close to 40 per cent in the trade-weighted average of import duties facing Canadian industrial goods in the United States, which is one of the deeper cuts obtained among trading partners in the bargaining. This means that by the end of the staging period in 1987, four-fifths of all current Canadian exports to the U.S. market will be able to enter duty-free, and over nine-tenths at a tariff rate of 5 per cent or less.[2]

Various suggestions for providing specific incentives to foreign firms to give their Canadian subsidiaries export freedom or world product mandates – that is, the opportunity to develop their own lines of products for home and foreign markets – have been discussed among officials in the Department of Regional Industrial Expansion. It has been considered whether such incentives might be offered through selective access to government trade promotion and export financing facilities for these subsidiaries. Up to now, however, these ideas have not been translated into policy.

The reduction of U.S. tariff barriers facing Canadian exporters implies, of course, that the integration of Canada's economy with that of the United States is likely to increase in the future. Past policy stances have indicated some government uneasiness with this trend. The present government's commitment to the so-called "Third Option" – a determination, articulated in the early 1970s, to encourage overseas links as a counterweight to the U.S. connection[3] – is not entirely certain, but there are many reasons to believe that greater independence from our neighbour to the south is still a priority. Therefore, this aspect of the Tokyo Round results must be seen in part as a means of effecting, through rationalization of production in U.S.-owned firms, the improvement of efficiency and export capability that will favour trade with areas outside North America also.

Unquestionably, the goal of expanding exports throughout the world, especially in new markets, has been given a great deal of attention by the federal government over the last few years. Probably the most important developments in this respect have been the publication of the report of the Export Promotion Review Committee (the Hatch Committee) in November 1981 and that of the Special House of Commons Committee on a National Trading Corporation in June 1981, as well as the submission of a bill in the House of Commons in July 1982 proposing the establishment of a public corporation, Canagrex, to "promote, facilitate and engage in the export of agricultural and food products from Canada." Also relevant in this connection was the governmental reorganization in January 1982 that shifted the international-trade functions of the federal public service out of the Department of Industry, Trade and Commerce into the Department of External Affairs.

The report of the Export Promotion Review Committee made a number of recommendations with regard to government support of exporting. Some of these – urging revisions in export financing and insurance arrangements, a change in the emphasis of foreign aid programs to assist Canadian trade, and the creation of a special mixed facility to help evaluate and cover major risks in large capital projects overseas – are still being studied, but the proposal for an Export Trade Development Board was implemented in August 1981. The Board, which includes 21 business, labour, and academic representatives, along with 8 senior federal officials, will attempt to focus and co-ordinate Canada's export strategy. Another recommendation of the Hatch Committee that has been translated into action is the identification of certain foreign markets for concentration. Using techniques to match the demands of other countries to evident Canadian abilities to satisfy these demands on a competitive basis, the relevant government departments have prepared a list of especially promising markets, and a series of reports has begun to appear outlining an "export development plan" for each country.[4]

After consultation with the private sector, the government turned down the report of the Special Commons Committee favouring the establishment of a national trading corporation. The Canadian Export Association (CEA), which speaks for the great majority of companies involved in foreign trade, campaigned vigorously against such a governmental intrusion in the marketing system, urging instead that public support be given to independent trading houses, and in June 1982 that policy was adopted. Meanwhile, however, the Canagrex proposal has moved ahead despite opposition from the CEA and other groups, showing that government interest in these far-reaching schemes is strong.

The reorganization that has seen the responsibility for trade matters moved from the Department of

Industry, Trade and Commerce to that of External Affairs likewise represents an important manifestation of the increased emphasis that is being placed on exports. The intent of the shift is to make Canada's diplomatic posts abroad, and indeed its whole foreign policy apparatus, more attuned to the promotion of this country's commercial interests.

There is, even today, a much wider range of instruments to aid exporters than most Canadians realize. Between them, such programs as the Trade Commissioner Service, the Program for Export Market Development (PEMD), the Promotional Projects Program (PPP), the Export Development Corporation (EDC), and the Canadian Commercial Corporation (CCC), as well as certain features of other bodies or programs such as the Foreign Investment Review Agency (FIRA), offer a considerable amount of support, at government expense or through a direct governmental intervention, to the export trade.

The PEMD helps to finance market-identification trips abroad by individual Canadian businessmen, as well as visits to Canada by potential foreign buyers; it also assists Canadian firms to participate in trade fairs abroad, shares the costs of bidding on specific projects outside Canada, and supports the formation of export consortia among small firms. The PPP offers a complete exhibition service on a shared-cost basis, covers the travel and other expenses of exploratory trade missions abroad or of incoming missions examining Canadian products and capabilities, and sponsors certain other types of trade visitors. The EDC assists exporters by providing loans to foreign purchasers at rates well below those available from commercial sources, as well as insurance against risk of nonpayment by purchasers of Canadian exports. The CCC helps firms to obtain government contracts in foreign countries. As for FIRA, it does not so much aid specific exporters as encourage Canadian exports in general. It does this by including, among the criteria for judging whether or not a foreign company should be permitted to set up operations in Canada, whatever evidence the company is able to provide as to its capacity and intention to export.

The Fear of De-industrialization

Is there, at present, a special crisis that justifies further government support to exports, or enrichment and extension of the types of support already available? Are we faced with the necessity to transform, through exports, some major problem of industrial inadequacy in this country? It is important that these questions be asked, because export assistance provided out of general government revenues could easily become an economic distortion as damaging as protectionism. We must be sure that we are correcting a difficulty rather than creating one.

As noted earlier, Canada seems to be holding its position in world markets, and there does not appear to be any failure to match the export performance of other nations. In most interpretations of Canada's trade difficulties, it is the import side that is perceived to be at fault. Current import patterns are seen as prejudicial to the long-run prosperity of our society. According to this argument, manufacturing industries that are disappearing under the pressure of import competition are not being replaced by others that produce for export instead. As a result, it is said, our capacity to pay for imports by exporting unprocessed or semiprocessed raw materials could be jeopardized at some point in the future. In a word, Canada is "de-industrializing": while the total trade position may look perfectly satisfactory, foreign competition is driving domestic producers of manufactured goods to the wall and threatens to turn Canadians into "hewers of wood and drawers of water" once again.

The shortcomings of Canada's secondary industrial sector have preoccupied economists and businessmen for a long time. Almost 25 years ago, Stykolt and Eastman summarized them in these words:

> The most widely accepted hypothesis concerning the discrepancy in productivity in manufacturing between Canada and the United States holds that the small size of the Canadian market for manufactured goods necessarily results in sub-optimal scale for plants and firms . . . . The machinery used in Canada is often less efficient because indivisibilities in the use of the most efficient methods of production can be overcome only at higher scales of production than exist in Canada.[5]

Actually, the problem is a little more subtle than that, as there can be difficulties of specialization even within optimally sized plants and firms. Whereas a facility in the United States will typically manufacture very few product lines in long runs, the comparable Canadian operation, in a smaller market sheltered by import barriers, will produce a greater variety of items in short runs and at lower levels of efficiency.

This "scale and specialization" syndrome is attributed to the import protection created to foster manufacturing, starting with the National Policy implemented by Macdonald in the late nineteenth century. It is a difficulty familiar to all but the very largest countries, and writings about it abound in the literature on economic development. While the effects of a protectionist policy are positive initially, as people are pulled out of traditional rural industries into a dynamic urban-industrial culture, where they learn the skills and attitudes of a more productive society, ultimately its benefits level off and the

drawbacks of the fragmentation of the manufacturing structure are felt. At that point, further progress requires the switch from an "import substitution" to an "industrial rationalization" strategy.

Yet the switch often appears very hard to make. Because domestic markets are of insufficient size for fully competitive production to develop, any attempt to achieve greater efficiency must include an extensive penetration of foreign markets. That requires the reduction of trade barriers abroad, which (in light of the reciprocal concessions that are demanded in tariff negotiations) in turn necessitates a corresponding drop in the home country's import protection. And, given the fundamental limitations of scale in its secondary industry, the obvious consequence – so this reasoning goes – is that its costs will inevitably be out of line with those of its competitors, and manufacturers will thus be overwhelmed by imports. The prospect is, in short, a type of "catch 22" situation from which escape is impossible.

The view among many Canadians at present is that their country is caught in this trap. Since Canada has been forced to participate in successive rounds of trade bargaining over the past 30 years or so, they say, it now finds that its manufacturing sector is increasingly opened up to the chill winds of international competition. Indeed, the Tokyo Round of negotiations resulted in a package of changes that will bring tariff barriers down to very low rates. The trade-weighted average of import duties levied by Canada is due to fall to 7.9 per cent at the end of the adjustment period (Table 8-6).[6] While that level will still be among the highest of the advanced nations by then, many fear that it will be insufficient to shield fully a secondary industrial complex thought to be inherently fragile and vulnerable.

According to those who share this pessimistic view of the future, damage to Canadian manufacturing has in fact already begun by virtue of the reductions in trade protection that have taken place under the six earlier rounds of tariff negotiations. As evidence of the jeopardy in which secondary industry has been placed, they cite the behaviour of the trade balance in the major sectors. There are large and growing surpluses in the commerce in farm commodities and related products, in basic raw materials, and in partially manufactured goods. On the other hand, though, there is a huge and rapidly escalating deficit in fully manufactured items, amounting to some $16 billion in 1980 (but down to $11 billion in 1982 because of the recession), compared with $2 billion in 1960 (Table 8-7). And, of course, it is the industries producing this last category of merchandise that are commonly felt to be the most important and rewarding, both to those who work in them and to the community at large.

Table 8-6

Tariff Averages[1] on Industrial Imports (Excluding Petroleum) before and after Implementation of the Tokyo Round Agreements, European Economic Community and Nine Other Developed Countries

	Tariff averages		
	Before the Tokyo Round	After the Tokyo Round	Reduction rate
	(Per cent)		
European Economic Community	6.6	4.8	27
Sweden	5.2	4.3	23
Norway	4.2	3.2	23
Switzerland	3.2	2.5	23
Austria	9.0	7.8	13
Finland	6.0	4.8	20
United States	6.2	4.4	30
Canada	12.7	7.9	38
Japan	5.2	2.6	49
New Zealand	22.4	17.6	21

1 The comparability of tariff levels and of their practical incidence is affected by differences in the methods of valuation for customs purposes. The averages set out above include duty-free items. Note that averages disguise variations in tariffs, which are wider in some countries than in others. Here, the simple average on each tariff line is weighted by each market's MFN imports (those subject to "most favoured nation" treatment).

SOURCE Trade Policy Research Centre (London), *The World Economy* 2, no. 3 (September 1979), p. 328.

Some react to this perceived problem by urging a return to protectionism – if not through conventional tariff barriers, then by using various other obstacles to restrict the entry of foreign goods into Canada. Those who fear the repercussions of such a policy, with its risk of retribution from other countries, say that we have no alternative but to accept the fact of freer trade. They believe that we must suffer the pains of adjustment in industries that cannot compete but that active policy intervention is needed to ensure that the resultant losses will be offset by gains in other industries. If it is true that Canada is essentially incapable of maintaining a large industrial sector without either a market larger than the domestic one or protection to keep that home market to itself, then they conclude that the penetration of foreign markets must somehow be contrived. And this seems to mean government subsidization of exports to overcome their inherent competitive drawbacks. Such is, in

Table 8-7

Canada's Merchandise Trade Balance,[1] 1960-81

	Live animals, food, feed, beverages, and tobacco	Inedible crude materials	Manufactured goods			Special transactions	Total
			Total	Inedible fabricated materials	Inedible end products		
				($ Millions)			
1960	410	380	-812	1,419	-2,230	-74	-96
1961	641	442	-871	1,411	-2,282	-85	127
1962	582	544	-928	1,454	-2,382	-108	90
1963	690	538	-699	1,579	-2,278	-107	422
1964	1,054	662	-711	1,746	-2,457	-189	815
1965	950	766	-1,345	1,671	-3,016	-238	134
1966	1,146	908	-1,479	1,772	-3,251	-303	271
1967	802	1,091	-1,102	2,031	-3,133	-245	547
1968	707	1,346	-519	2,481	-3,000	-215	1,319
1969	423	1,388	-918	2,335	-3,253	-153	741
1970	785	1,921	288	3,060	-2,772	-127	2,868
1971	975	1,950	-587	2,776	-3,363	-135	2,202
1972	981	2,030	-1,376	3,128	-4,504	-154	1,481
1973	1,218	3,027	-1,952	4,107	-6,059	-197	2,095
1974	1,395	3,739	-4,211	4,446	-8,657	-204	720
1975	1,505	2,892	-5,541	4,130	-9,671	-243	-1,387
1976	1,461	3,238	-3,361	6,195	-9,555	-357	981
1977	1,337	3,544	-2,343	8,071	-10,414	-346	2,192
1978	1,563	2,959	-1,179	10,549	-11,728	-268	3,075
1979	2,120	4,585	-3,547	12,515	-16,062	-387	2,771
1980	3,517	3,434	459	16,848	-16,389	-525	6,885
1981	4,263	3,075	-2,547	16,339	-18,887	-242	4,549

1 On a customs-value basis. This measure is not completely consistent with the more common balance-of-payments measure; however, the latter is not available on a commodity basis.

SOURCE Based on export and import data from Statistics Canada; and IT&C, *Canada's Trade Performance, 1960-1977.*

large part, the rationale for greatly increased support to export industries.

The argument on the other side of this issue is advanced with equal conviction. First, while it is granted that the trade deficit in respect of fully manufactured goods has multiplied almost 10 times over the past two decades, its size *relative* to the total two-way trade in such products is much smaller today than it used to be. In 1960 the deficit was equivalent to almost 70 per cent of the trade in end products, but it fell sharply during the following decade to reach a low point of 19 per cent in 1970; since that time it has hovered in the 20 to 30 per cent range without any apparent trend up or down (Table 8-8).

The explanation for what is viewed by the proponents of this interpretation as a generally satisfactory situation is that the Canadian problem of scale and specialization either has been exaggerated or is less serious than it used to be. Some feel that minimum efficient plant sizes are much smaller than had been supposed, while others believe that Canadian plant sizes have increased; but, in any case, it is considered that escape from the protection/noncompetitiveness trap can be a lot easier than we tend to think. On this score, work done by Scherer and his associates in 1975 indicated that: 1) the size of the top 50 per cent of Canadian plants in 12 important manufacturing fields was, on average, only about three-quarters of the minimum economic size, whereas comparable U.S. plants were typically somewhat larger than the MES; 2) in the vast majority of cases, a plant of minimum economic size was nevertheless well within the dimensions of the Canadian market – usually enough that three or more plants could exist in Canada and all could achieve efficient scale; and 3) in half of the cases studied, the difference in unit costs of production between plants of minimum economic size and those only one-third that size was 5 per cent at the most.[7]

Despite the relatively small size of many Canadian plants, therefore, it would seem that reasonably

Table 8-8

Canada's Normalized Merchandise Trade Balance,[1] 1960-81

	Live animals, food, feed, beverages, and tobacco	Inedible crude materials	Manufactured goods			Total
			Total	Inedible fabricated materials	Inedible end products	
			(Per cent)			
1960	26.0	20.3	-11.1	34.4	-69.1	-0.9
1961	33.8	22.4	-11.3	33.5	-65.2	1.1
1962	30.4	24.8	-11.1	32.8	-60.8	0.7
1963	30.7	23.1	-8.0	33.4	-56.0	3.1
1964	39.9	25.6	-6.9	32.5	-49.7	5.2
1965	38.2	27.6	-11.4	28.3	-50.8	0.8
1966	40.8	30.2	-10.4	27.9	-41.2	1.3
1967	31.9	34.8	-6.7	31.1	-32.0	2.5
1968	27.8	37.4	-2.6	33.8	-24.5	5.1
1969	16.6	39.0	-4.0	28.7	-22.4	2.6
1970	26.0	45.1	1.2	34.7	-19.2	9.3
1971	29.6	42.5	-2.3	30.7	-20.6	6.6
1972	25.9	39.7	-4.6	30.4	-23.2	3.8
1973	23.5	42.9	-5.4	32.4	-25.7	4.3
1974	21.7	31.5	-9.3	25.5	-30.8	1.1
1975	21.9	22.1	-11.6	25.8	-30.5	-2.0
1976	20.3	24.1	-6.1	33.3	-26.5	1.3
1977	16.8	25.0	-3.6	36.6	-24.7	2.5
1978	17.1	20.1	-1.5	37.6	-23.1	3.0
1979	20.0	22.3	-3.7	34.2	-26.7	2.2
1980	26.8	13.1	0.4	39.9	-26.0	4.7
1981	28.9	11.2	-2.1	36.0	-25.7	2.8

1 The normalized trade balance is the trade balance as a percentage of total trade (exports plus imports).

SOURCE Data from the Department of Industry, Trade and Commerce, Economic Intelligence Group; and estimates by the Economic Council of Canada, based on data from Statistics Canada.

competitive production ought to be possible in most instances. The question remains as to whether Canadian plants, regardless of size, are sufficiently specialized with respect to product line. But, presumably, there is no reason why greater specialization should not occur if import protection at home and abroad is reduced, enabling potentially efficient plants to develop longer runs in a narrower product range.

Thus what happens under a regime of declining international trade barriers, say the people who are persuaded by this evidence, is much the same in Canada as it would be in larger economies. Import penetration increases in some spheres, and export success is experienced in others, producing greater specialization but not necessarily any net loss. In order to determine whether that has been the Canadian experience, one needs to assess the data on competitive performance over an appropriate time period. One excellent measure is that which examines changes in import penetration and export orientation directly – the former, by reference to trends in the ratio of imports to "apparent domestic availability" (Canadian factory shipments plus imports minus exports); the latter, through observation of ups and down in the ratio of exports to factory shipments.

At first glance, the most striking feature of these two ratios is the broad picture presented for manufacturing industries as a whole. Import penetration increased over the period between the mid-1960s and 1980 from about 20 per cent to more than 30 per cent, but export orientation also grew from less than 20 per cent to around 30 per cent (Table 8-9). That is certainly a *prima facie* indication of greater specialization and interpenetration without loss. The benchmark of Canada's net position from such a process is the ratio, derived from the other two, sometimes referred to as "implied self-sufficiency" (ISS) – factory shipments relative to apparent domestic availability (ADA) – and how it behaved over the period in question. Interestingly, that ratio remained almost constant from the mid-1960s to

Table 8-9

Import Penetration, Export Orientation, and Implicit Self-Sufficiency in Canadian Goods Production, Selected Years, 1966-80

	Import penetration[1]				Export orientation[2]				Implicit self-sufficiency[3]			
	1966	1970	1975	1980	1966	1970	1975	1980	1966	1970	1975	1980
	(Per cent)											
Agriculture	8.1	8.9	9.9	12.8	29.4	24.5	29.7	36.4	130.2	120.7	128.2	137.1
Forestry	1.9	1.9	2.9	2.2	4.4	4.1	2.2	2.5	102.6	102.4	99.2	100.3
Fishing and trapping	2.7	3.8	10.5	12.1	32.6	37.9	36.2	42.6	144.3	155.0	140.3	153.0
Mining	28.3	25.7	49.6	36.6	47.2	52.2	62.9	45.2	135.8	155.6	135.8	115.8
Manufacturing	21.0	25.5	28.8	31.5	18.8	26.2	23.9	30.8	97.2	101.0	93.6	98.9
All sectors	20.4	23.5	28.4	30.2	21.3	27.1	27.6	32.2	101.1	105.0	98.8	103.1

1 Ratio of imports to "apparent domestic availability" (domestic shipments plus imports minus exports).
2 Ratio of exports to domestic shipments.
3 Ratio of domestic shipments to "apparent domestic availability."
SOURCE Data from the Department of Industry, Trade and Commerce, Economic Intelligence Group.

1980, ranging from a high of 101 per cent in 1970 to a low of 94 per cent in 1975 but not trending systematically one way or the other over the whole period.

Because of the timing of the main work on this project, our cutoff was 1980, and the analysis therefore does not examine developments in the subsequent recession years. It should be noted, however, that in fact the "implied self-sufficiency" ratio did not change markedly in 1981 (it was 98 per cent, compared with 99 per cent in 1980 and 97 per cent in 1979). Also, although figures for 1982 are not yet available, other evidence suggests that no serious deterioration in the ratio occurred then either. (One of the very positive factors in Canada's favour in 1982 was the strong U.S. demand for full-sized automobiles, a large proportion of which are produced in the big companies' Canadian plants.)

Unfortunately, the classification "manufacturing" in this case does not distinguish between fabricated materials and end products, and the statistics available do not permit one to make the same assessment for end products alone. For our purpose, though, a fair proxy can be obtained by taking the ratio of exports to imports, which roughly mirrors the more accurate relationship of factory shipments to apparent domestic availability and thus gives at least a sense of implied self-sufficiency. For end products by themselves, that ratio climbed from 30 per cent to 50 per cent in the late 1960s (again, a consequence of the Auto Pact, to a significant degree), and it has ranged between 50 per cent and slightly over 60 per cent ever since (Table 8-10). On the face of things, that does not look much like de-industrialization.

Table 8-10

Ratio of Domestic Exports to Imports of End Products,[1] Canada, 1960-81

	Exports	Imports	Export/import ratio
	($ Million)		(Per cent)
1960	411	2,718	15.1
1961	506	2,880	17.6
1962	655	3,151	20.8
1963	779	3,172	24.6
1964	1,109	3,701	30.0
1965	1,300	4,476	29.0
1966	2,137	5,570	38.4
1967	3,116	6,465	48.2
1968	4,352	7,620	57.1
1969	5,318	8,885	59.9
1970	5,551	8,618	64.4
1971	6,193	9,832	63.0
1972	7,136	11,948	59.7
1973	8,386	14,798	56.7
1974	9,236	18,362	50.3
1975	10,473	20,679	50.6
1976	12,711	22,826	55.9
1977	15,231	26,321	57.9
1978	18,855	31,304	60.2
1979	20,924	38,074	55.0
1980	21,850	39,656	55.1
1981	25,351	46,237	54.8

1 Fully manufactured nonagricultural products.
SOURCE Based on data from Statistics Canada; and IT&C, *Canada's Trade Performance, 1960-1977.*

More useful than the general story is the item-by-item appraisal made possible by the publication of all three ratios for some 100 categories and 50 subcategories of manufactures in the 20 sectors into which Canadian secondary industry is customarily divided. Utilizing the subcategories rather than main categories, where feasible, gives 130 items, whose "good health" or "ill health" can best be judged in terms of the ISS measure over the years from the mid-1960s to 1980. It turns out that, of the 130 cases, there were 22 clear (and four less clear but probable) instances of improvement, 38 (with two probable) cases of deterioration, and 64 instances of no change one way or the other (Table C-1). Needless to say, since the ratio for manufacturing as a whole remained constant, it follows that the 26 instances of certain or probable improvement involved values almost double those in the 40 cases of deterioration.

Perhaps the most interesting feature of these gains and declines is how rarely an improvement in the ISS position can be adduced, even in part, to a fall-off in foreign competition or, likewise, how unusual it is that a drop in the ISS ratio can be attributed in any way to a slippage in Canada's export performance. Of the 26 cases of improvement or probable improvement in the shipments/ADA standing, only six witnessed a decrease in the ratio of imports to ADA, whereas this latter ratio remained unchanged in five cases and actually rose in 15. Similarly, of the 40 cases of certain or probable deterioration in the ratio over the period covered, only six experienced a weakening of Canadian exports relative to shipments, while 19 saw their export position holding steady and 15 saw it improve. This confirms the impression that increased interdependence between Canada and other manufacturing economies is leading to greater specialization. Even within categories and subcategories in which Canadian factories are losing out to foreign competition, there are products that Canada is managing to sell abroad in growing amounts. By the same token, even within categories and subcategories where Canadian manufacturers are gaining ground overall vis-à-vis foreign producers, there are particular lines in which imports are penetrating the domestic market ever more effectively.

This, of course, is exactly what one would expect, and indeed hope for, in an environment of falling trade barriers. Given our preoccupation with scale-and-specialization problems in the manufacturing sector, a reduction in the number of product items that are made in Canada, if it can be undertaken in such a way as to maintain the output and employment of industry in total, is very much to be desired.

There is thus no evidence that the manufacturing sector has languished and left only primary production to yield the advantages of a more open international economic context, as many observers would suggest. Even so, we need to probe a little further, because the concern about loss of position in fully manufactured goods, as opposed to fabricated materials, has not entirely been dispelled and because there are worries, also, about particular kinds of fully manufactured goods – the so-called "high-technology" items. Those misgivings are only slightly illuminated by the evaluation noted above, since industrial categories in the data employed are generally not differentiated in satisfactory fashion. For example, one could form a superficial impression of the "gainers" and "losers" with respect to implied self-sufficiency by looking at the 20 main industrial sectors as groups (Table 8-11). On that basis it is certainly clear that the overall gainers – wood industries, paper and allied industries, and petroleum and coal-product industries – are involved more with the output of fabricated materials than with that of end products. The overall losers – knitting mills, possibly the clothing industries, electrical-product industries, miscellaneous manufacturing industries, and leather industries – are, with the single exception of the last (which is hard to place), all end-product industries. But the remaining 12 broad groups – the majority – showed no change.

Table 8-11

Gainers and Losers in the Shipments/ADA Ratio over the Period 1966-80, by Main Sector, and Value of Shipments in 1980

	1980 shipments
	($ Millions)
Gainers:	
Textile industries	
Carpet, mat, and rug industry	651
*Miscellaneous textile industries, n.e.s.	638
Clothing industries	
Fur goods industry[1]	221
Wood industries	
Sawmills, planing mills, and shingle mills[2]	4,921
*Sash, door, and other millwork plants, n.e.s.[3]	813
Miscellaneous wood industries[1]	395
Furniture and fixture industries	
Office furniture manufacturers	383
Miscellaneous furniture and fixture manufacturers[3]	554
Paper and allied industries	
Pulp and paper mills[2]	10,998
Asphalt roofing manufacturers	241
Miscellaneous paper converters[3]	1,170

Table 8-11 (cont'd.)

	1980 shipments
Primary metal industries	
Iron foundries[3]	465
Metal fabricating industries	
Wire and wire product manufacturers	1,459
Transportation equipment industries	
Truck body and trailer manufacturers	973
Shipbuilding and repair[1]	1,019
Nonmetallic mineral products industries	
Cement manufacturers	623
Concrete product manufacturers	621
Lime manufacturers[1]	94
*Miscellaneous nonmetallic mineral product industries, n.e.s.	657
Petroleum and coal product industries	
*Petroleum refining	14,522
*Manufacturers of lubricating oils and greases	220
Miscellaneous petroleum and coal product industries[2]	109
Chemical and chemical products industries	
Manufacturers of mixed fertilizers[2]	186
Manufacturers of plastics and synthetic resins	1,182
Manufacturers of industrial chemicals[1]	4,575
Miscellaneous manufacturing industries	
Signs and display industry	197
All gainers	47,887
Losers:	
Food and beverage industries	
*Miscellaneous food processors, n.e.s.	2,798
*Distilleries[1]	756
*Wineries	161
Leather industries	
Leather tanneries	196
Shoe factories	624
Leather glove factories	36
*Miscellaneous leather product manufacturers	164
Textile industries	
Man-made fibre, yarn, and cloth mills	1,282
Cordage and twine industry	29
Cotton and jute bag manufacturers	144
*Narrow fabric mills	77
Knitting mills	
Hosiery mills	190
Knitting mills (except hosiery mills)	718
Clothing industries	
Men's, women's, and children's clothing industries	3,204
Foundation garment industry	97
*Fabric glove manufacturers	24
*Hat and cap industry	41
*Miscellaneous clothing industries, n.e.s.[1]	70
Wood industries	
Coffin and casket industry	34
Furniture and fixture industries	
Household furniture manufacturers	1,147

Table 8-11 (concl'd.)

	1980 shipments
Primary metal industries	
Copper and copper alloy rolling, casting, and extruding[1]	595
Electrical product industries	
Manufacturers of small electrical appliances	268
Manufacturers of household radio and television receivers	250
Communications equipment manufacturers[1,3]	2,316
Manufacturers of electrical industrial equipment[3]	1,575
Manufacturers of electric wire and cable	1,112
*Battery manufacturers	243
*Manufacturers of miscellaneous electrical products, n.e.s.	684
Nonmetallic mineral product industries	
Clay product manufacturers	201
Abrasives manufacturers[2]	191
Chemical and chemical product industries	
Paint and varnish manufacturers	714
Manufacturers of toilet preparations	492
Miscellaneous chemical industries	1,588
Miscellaneous manufacturing industries	
*Instrument and related product manufacturers[2]	927
*Clock and watch manufacturers	118
*Orthopaedic and surgical appliance manufacturers	118
*Ophthalmic goods manufacturers	107
*Toy and game manufacturers	271
*Broom, brush, and mop manufacturers	76
*Pen and pencil manufacturers	62
All losers	23,700

*Subcategories; the main categories have been omitted in these cases to avoid double counting.

1 Products of which Canada is a substantial exporter; the ratio of exports to shipments averages over 20 per cent.

2 Products of which Canada is a very substantial exporter; the ratio of exports to shipments averages over 50 per cent.

3 Cases where the trend is not certain because of wide fluctuations recorded over the period.

SOURCE Department of Industry, Trade and Commerce, Economic Intelligence Branch, Economic Policy and Analysis, *Manufacturing Trade and Measures, 1966-80: Tabulations of Trade, Output, Canadian Market, Total Demand and Related Measures for Manufacturing Industrial Sectors* (Ottawa: IT&C, 1981).

Much the same indication is given by viewing the gainers and losers within each overall industry group and adding up the score depending on a fabricated-materials/end-products identification. Without question, more of the gainers are to be found among sectors predominantly producing fabricated materials (four) than among those mainly producing end products (three); in the case of the losers, the reverse is apparent (one and four, respectively). Yet the other eight industry groups are awkward to line up on this basis, either because they are difficult to classify or because they show no gaining or losing tendencies.

Further, there are much less straightforward indicators within each of the groups; for example, three categories of chemical products are among the gainers and three among the losers, and so on. Moreover, the amounts of the gains and losses vary considerably in different cases, so that one cannot simply add up the categories class by class (Table 8-11).

A similarly equivocal position may obtain with respect to the high-technology industries. In our analysis, we sought to isolate such activities on the basis of some U.S. definitions; admittedly, however, the correlation between Canadian and U.S. items was somewhat arbitrary, and thus the results are tentative (Table 8-12). Of the 14 main product categories thus identified, only two (plastics and synthetic resins, and industrial chemicals) were shown to have gained by the ISS measure, while seven (three categories of electrical equipment and four specialized items in the miscellaneous group – all subcategories of scientific and professional equipment) were among the losers. The standing of the remaining five categories did not change. The status of loser, however, was decidedly uncertain in two of the most prominent categories in that list (communications equipment and electrical industrial equipment) because of their strong recent performance. In any case, shipments of the two gaining categories were more valuable in 1980 than those of all the losing categories put together. So the evidence of net loss is by no means unambiguous.

Ostensibly more troubling is a 1978 study by the Ministry of State for Science and Technology, which examined this issue in more detail than we were able to do and pinpointed high-technology sectors with much greater accuracy.[8] Depending upon the method used, Canada's trade deficit in the products of these industries was shown to have risen between 1965 and 1976 from $588 million to $2.6 billion or from $1.8 billion to $6.5 billion (Table 8-13). Yet the MOSST study did not note that, as in the case of end products generally, these figures bore an almost exact correlation to the trade itself: they increased from 34.2 per cent to 38.0 per cent of all Canadian trade in high-technology goods if one employs the narrow definition or fell from 45.2 per cent to 42.1 per cent if one chooses the wider specification. Calculated in relation to all end-product trade or to total merchandise trade, the deficit for these high-technology goods dropped or remained unaltered under either definition. Unfortunately, MOSST has not maintained the series up to the present. However, some tentative work using a definition very close to the wider of the two noted above has been extended to 1981, and it shows a continuation of the trend:

Table 8-12

Shipments by the High-Technology Industries, Canada, 1980[1]

	1980 shipments
	($ Millions)
Machinery industries	
Miscellaneous machinery and equipment manufacturers	4,669
Office and store machinery manufacturers	800
Transportation equipment industries	
Aircraft and aircraft parts manufacturers	2,226
Electrical product industries	
Manufacturers of household radio and television receivers	250
Communications equipment manufacturers	2,316
Manufacturers of electrical industrial equipment	1,575
Chemical and chemical product industries	
Manufacturers of plastics and synthetic resins	1,182
Manufacturers of pharmaceuticals and medicines	1,198
Manufacturers of industrial chemicals	4,575
Miscellaneous manufacturing industries	
Instrument and related products manufacturers[2]	927
Clock and watch manufacturers[2]	118
Orthopaedic and surgical appliance manufacturers[2]	118
Ophthalmic goods manufacturers[2]	107
Sound recording and musical instrument manufacturers[2]	120
Total	20,181

1 This is a tentative and very approximate list, using the categories in Table C-1.

2 Subcategories of larger categories.

SOURCE Based on Ministry of State for Science and Technology, *Canadian Trade in Technology-Intensive Manufactures, 1964-76*, Background Paper 5 (Ottawa: MOSST, July 1978), using data from Department of Industry, Trade and Commerce, Economic Intelligence Branch, Economic Policy and Analysis.

while the deficit in technology-intensive manufactures has widened further to almost $10 billion, as a proportion of the two-way trade it has shrunk. On the face of things, therefore, all that this means is that Canada has always imported more of the most highly sophisticated manufactures than it has exported; the situation on that score did not change appreciably, in relative terms, over the period examined by MOSST, even though the absolute numbers naturally grew a great deal. And subsequent evidence suggests at least a stable position, and possibly even some improvement, in respect of the relative performance from 1976 to 1981.

In sum, the manufacturing sector has not withered, and is not withering, in the face of increasing international competition. Moreover, while Canada is gaining

Table 8-13

Canadian Trade in Technology-Intensive Products, Selected Years, 1965-81[1]

	1965	1968	1971	1974	1976	1978	1980	1981
				($ Millions)				
Exports								
DOC-2	566	1,000	1,134	1,682	2,128			
NSF	1,105	1,697	2,099	3,582	4,448			
PRG		1,186	1,612	3,116	3,652	6,150	10,244	11,917
Imports								
DOC-2	1,154	1,860	2,288	4,390	4,739			
NSF	2,931	3,940	4,861	9,407	10,909			
PRG		3,232	4,124	8,098	9,564	12,993	18,869	21,472
Balance								
DOC-2	-588	-950	-1,154	-2,709	-2,611			
NSF	-1,826	-2,243	-2,762	-5,825	-6,461			
PRG		-2,046	-2,512	-4,982	-5,912	-6,843	-8,625	-9,555

1 The three series were calculated on the basis of alternative definitions of high-technology trade:
DOC-2 adopted the second of two methods developed by the U.S. Department of Commerce;
NSF employed an adaptation of U.S. National Science Foundation data;
PRG derives from work currently under way in the Policy Research Group, Industry Branch, MOSST.

SOURCE MOSST, *Canadian Trade*, p. 13; and Max Gassend, "Canada's International Trade Performance of Manufacturing Industries by Levels of Research Intensity," draft report, Ministry of State for Science and Technology, Policy Research Group, Ottawa, November 1982.

in the exporting of fabricated materials but not in high-technology items, that is not to say that it is losing, relatively, in the latter. The upshot of all this is that Canada is a far cry from de-industrialization. In our considered judgment, there is no evidence of this process even beginning.

Exports and R & D Activities

Since the view is widespread that certain high-technology exporting activities will prove essential to Canada's future economic success and security, we think it worthwhile to ask whether these activities could, in practice, be enhanced by government policy initiatives. One method that has been proposed is public funding of R & D in exporting industries.

Exports incorporating the very latest technological features are viewed as especially valuable by virtue of several peculiarities of relevance to Canada. First, their pace of expansion has been faster in recent times than that of exports of either primary commodities or the more conventional manufactured products. Second, they seem to offer an opportunity to offset undue dependence on resource-based materials as the essence of Canadian shipments abroad – a consideration that, despite what has been noted regarding the spread of risk resulting from the large number of major categories involved, still appears worthwhile to some in light of the possibility that certain of these resources may become exhausted. And, third, they are in most cases skilled-labour-intensive and thus capable of creating desirable jobs.[9]

The notion that the promotion of exports should be an active part of government industrial strategy thus tends to converge with the common idea that fostering high-technology industry must be a major element of Canadian policy for the future. What is strange, given the amount of enthusiasm in many quarters for this nexus of concepts, is the absence of any apparent evidence linking the support of research and development by government grants, loans, tax rebates, or similar devices with the propensity of firms to export. Obviously, government aid to R & D as an indirect means of promoting exports would only make sense if a clear relationship of cause and effect could be shown and if the ratio between R & D funding and export earnings were reasonably favourable. Yet no one, until now, seems to have attempted to discover whether such a connection exists.

Accordingly, we have sought to explore this issue. Although the results are tentative, they do represent a net addition to the understanding of what is involved here. In the study specially commissioned for this purpose, use was made of an earlier survey by Council staff members that investigated various aspects of innovation and technological change in five industries: telecommunications equipment and components; electrical industrial equipment; plastics compounds and synthetic resins; nonferrous smelting and refining; and crude petroleum exploration and production.[10] In particular, that survey had analysed the characteristics and behaviour of firms with respect to 283 major innovations, the firms having been selected because of their success in coming up with such innovations.

The principal conclusion of the new study was that the R & D expenditures of the firms sampled did, in fact, show a positive correlation with export propensity.[11] The finding held good, in most cases, whether measured by the firms' total activities or in terms of their major products only, or simply in terms of those products in which they had developed significant innovations. It was arrived at by means of accepted techniques of cross-tabulation and regression analysis, and it was checked in several ways to ensure its validity. Thus the main point that was intended to be tested appears to conform to the hypothesis: strength in R & D, at least as calculated with respect to the amount of money expended for this function, is linked statistically to strength in export sales, and the connection appears to be causal. For the total sample, incremental spending of about 0.8 per cent on technological innovation was shown to yield a 1 per cent increase in exports.

Unfortunately for the proposition that we are discussing, however, the research found no measurable relationship between government support of R & D activities in the private sector and effective performance in export markets. Such a contradiction leads us to question whether the tendency of the firms that spend substantially on R & D to do well as exporters might result from other factors – factors about which we have insufficient data. Could it be that "organizational factors" or "managerial leadership" contribute both to R & D intensity and to export success? If there were another element of this kind in the causal linkage, then governmental support for research and development – "throwing money" at private firms in general for those purposes – would not, of itself, necessarily have any effect on exports.

Because of this doubt about the role of other factors and the absence of a clear relationship between public R & D funding and export propensity, we are reluctant to suggest that government could contribute to Canada's position as an international trader by supporting the R & D function rather than the export activity itself. There is nothing conclusive in this evidence, of course, since the data used in our work relate to no more than a few industries and the study undertaken covered only direct government funding (as opposed to, say, a system of tax rebates for R & D spending). Even so, as it is seemingly the sole effort in this field, it has to be taken seriously. It must be said, therefore, that its failure to detect positive consequences for Canadian export trade from governmental support to technological innovation rather undermines the view that such an approach constitutes a viable policy.

9 The Adjustment to Import Competition

The increase in import competition that has taken place over the past two decades has had important repercussions – both positive and negative – on firms and workers in Canada. On the positive side have been the gains from increased trade – in particular, higher real incomes resulting from greater specialization, longer production runs, larger plant scale, and an increase in productivity. On the negative side has been the need for firms and plants to adjust to import competition, with some even going out of business, and for workers displaced by this competition to find new jobs.

A Framework for Analysis

Trade and industrial policy play a crucial role for those industries which face actual or potential import competition. The problems caused by imports in such industries as textiles, footwear, automobiles, and steel are discussed in the media almost daily. Increased tariff and nontariff barriers, assessment of dumping duties, and voluntary export quotas are often requested by the representatives of the affected industries, and supported by their workers as well as by the municipalities and provinces where these industries are located. Government often responds to such requests by complying, because it judges that the social costs occasioned by rapid industry contraction are too high, especially where there are few other employment opportunities. Nevertheless, the danger with such a policy of creeping protectionism, currently followed by many countries, is that the gradual erosion of the liberal international trading system could result in a substantial decrease in living standards throughout the trading world.

The problems posed by import competition are not likely to abate during the 1980s. In the late 1970s the value of imports of goods and services was equal to almost one-third of Canada's GNP, and 60 per cent of the imports purchased from the United States, our largest trading partner, entered duty-free.[1] With the implementation of the tariff reductions agreed upon in the Tokyo Round of multilateral negotiations, both of these proportions are likely to increase during the current decade, thus exacerbating the problems occasioned by imports.

The Barriers to Trade

In any market, the act of voluntary exchange between two nations will take place only if both parties believe it to be mutually beneficial. The existence of comparative advantages is the underlying explanation for such gains through trade, as each country specializes in what it can do best.

Governments restrict the flow of goods and services between countries through a variety of policy instruments, usually divided into tariff and nontariff barriers to trade imposed by both Canadian and foreign governments. Tariffs refer to the actual customs and excise duties paid on the importation of a good, whether they be *ad valorem* or product-specific. Thus they are very explicit, visible impediments to trade. Nontariff barriers comprise a host of policy measures intended to achieve similar results, sometimes in a more indirect fashion. Some of the nontariff barriers reveal a considerable degree of ingenuity on the part of the importing countries in their attempt to circumvent international codes and agreements, such as those negotiated under the General Agreement on Tariffs and Trade (GATT). Examples include quotas, required standards, procurement policies, and in some instances an outright ban on the importation of a particular good. At times, it is difficult to detect a nontariff barrier, when a particular program, regulation, or law that is seemingly unrelated to trade is used and supported because it effectively constitutes an obstacle to the entry of certain goods. Because of the successive tariff reductions implemented in the 1960s and 1980s as a result of the Kennedy and Tokyo Rounds, nontariff barriers have become relatively more significant in recent years.[2]

Usually, the impact of tariff and nontariff trade barriers on the Canadian economy is seen as being confined primarily to the traded-goods sector.[3] Most of the service sector is thus excluded, although it should be noted that in some service industries –

such as banking, commercial aviation, and broadcasting – the right of a foreign firm to compete with domestic suppliers in Canada is restricted considerably by public regulation,[4] and Canadian firms face similar barriers abroad. Within the traded-goods sector, we focus on the manufacturing sector, which accounted for 20.7 per cent of GDP in 1978. The exclusion of trade in raw materials (mining, forestry, fisheries, and agriculture) from our analysis is justified by the much lower level of trade barriers that exists in the primary sector. For example, in 1970 the nominal tariffs averaged 0.37 per cent in this sector, compared with 10.31 per cent in manufacturing.[5] Nevertheless, trade barriers are significant in some parts of the primary sector, particularly with respect to agricultural products such as eggs, chickens, turkeys, and dairy products, where severe import controls are combined with supply management for the domestic market. We discussed these problems in our earlier report on public regulation and made a number of recommendations to deal with them.[6]

The effects of Canadian and foreign trade barriers on the manufacturing sector fall into three broad categories: the direct impact on specialization and on income gains from trade; the direct effects on the structure of trade, industry size, plant size, the length of production runs, and the degree of competition; and the indirect effect on the level of foreign ownership. The indirect effect can, through the establishment by transnational firms of subsidiaries in Canada, reinforce the direct effects significantly.

Tariff schedules are usually structured in such a way that the tariff increases with the degree of processing (or value-added) that is embodied in the good, thus favouring the importation of unprocessed or semiprocessed goods over that of final or heavily processed products. For example, an assembled car is likely to have a higher tariff than a car imported in kit form and ready for assembly, while strip steel to make the car body is likely to bear a lower duty than the car, either assembled or in kit form. This tariff structure is designed to promote the manufacture of end products behind the tariff wall. The final output of an industry receives higher tariff protection than the inputs and components, thus enabling the industry to price its output up to the tariff and increasing its value-added – that is, the difference between the value of output and the inputs purchased from other industries, which constitutes the returns to labour and capital.[7]

One of the major objectives of tariff policy is to create an industry where none existed before or to prevent the demise of an industry that has become vulnerable to import competition. To the extent that imports are replaced by domestic production, industries that could not exist otherwise are able to survive. Because this is likely to result in inefficiency and high-cost domestic production, however, prices are likely to be higher than they would otherwise be. This leads to smaller market size, as consumers purchase less at the higher price.

The Canadian market is small, compared with those of the United States, the European Common Market, or Japan, viewed individually. This is true with respect to: 1) the length of production runs required to minimize unit costs; 2) the total cumulative production of a given product needed to realize all of the economies of scale to be derived from learning by doing – i.e., moving down the experience curve; and 3) the smallest size of plant required to minimize production costs – the "minimum efficient size," or MES. Small, in this context, does not mean that the MES could not be reached in Canada, as noted in the preceding chapter. Rather, it means that only a few (fewer than 10) MES plants could be accommodated. At the same time, it will take many years for a firm to realize the economies of scale generated by its cumulated production volume. In addition, a number of factors serve to fragment the market, with the result that all of the potential scale economies in production may not be realized. When combined with the smallness of the market, transportation costs lead to regionalization, and product differentiation leads to oligopoly – market control by a limited number of suppliers.

Tariffs help to insulate Canadian producers against competition from imports produced in much larger markets by firms that are able to realize all production scale economies. They enable Canadian producers to survive at scales and rates of output that fall short of that level of efficiency. Thus they are one of the major factors that permit the oft-cited short production runs and suboptimal plant sizes that characterize much of Canadian industry. Furthermore, to the extent that other countries also have tariff barriers, Canadian producers are prevented from offsetting the effects of a small domestic market by exporting.

Competition is a major spur to efficiency. An essential ingredient of the competitive market, especially when a small number of firms account for a large share of the output and their prices exceed actual costs or the prices of potential alternative sources of supply, is the threat that these sources will enter the market. Tariffs reduce this threat by simultaneously limiting imports and new domestic producers (since, by assumption, all countries impose tariffs, a new domestic producer would have difficulty in exporting and would thus be required to sell

exclusively in the domestic market). Such conditions, combined with a relatively ineffective competition policy, particularly in the areas of merger and monopoly, weaken the competitive environment.

In serving a foreign market, a firm has the option of either exporting or establishing a subsidiary. In the case of U.S. firms wishing to do business in Canada, exports are likely to be an attractive option because of the geographical proximity of the two countries and the language and cultural similarities between them. Because a tariff barrier separates the two markets, however, the choice between the two options is weighted heavily in favour of establishing a subsidiary in Canada. The tariff change, combined with some market advantage enjoyed by the U.S.-based firm (embodied in a patent, trademark, or the reputation for a reliable and quality product), is likely to lead to increased foreign ownership in the Canadian manufacturing sector. The firm will have already incurred the costs of developing a market advantage in the United States; given the many similarities between the two countries, the additional cost of exploiting or adapting that advantage to Canadian conditions is thus likely to be low. The evidence on this is somewhat ambiguous, however, reflecting the complexity of the factors that influence investment decisions and the difficulty in using data from the 1960s when investment decisions had taken place much earlier.[8] At present, approximately 50 per cent of shipments in the manufacturing sector are accounted for by foreign-owned firms, mainly those of U.S. origin.

As mentioned above, foreign ownership (an indirect effect) is likely to reinforce some of the direct effects of the tariff, particularly with respect to the realization of economies of scale in production. Because of its market advantage, the foreign firm is able to command considerable brand loyalty and to carve a niche in the market. This, combined with the small costs of adapting its market advantage to Canadian conditions, enables the firm to offset the disadvantages of small scale and, at the same time, to earn at least a normal rate of return. The Canadian industry thus becomes, in certain instances, a smaller version of its U.S. counterpart, with all U.S. leading firms present. This is sometimes referred to as the "miniature replica effect."

Offsetting the scale inefficiencies that result from foreign investment are certain facets of such operations that may increase efficiency, compared to a situation where the tariff and exclusive Canadian ownership prevail. First, as we have seen in an earlier part of this report, technology transfers may be much more rapid through a parent-subsidiary relationship than through arm's-length transactions. Second, the foreign firm obtains its input and components from its base country to a considerable extent. As a result, scale economies may be realized, with the final product using fewer resources than would otherwise be the case. (On the other hand, such economies might be dissipated because a greater number of foreign firms would exist.) As this discussion implies, the evidence available on the impact of foreign ownership on productivity and efficiency is somewhat equivocal.[9]

Trade Liberalization

Just as tariff barriers can increase, so can they decrease. Since the Second World War, conscious attempts to lower barriers to trade have been made. While these efforts have taken a variety of forms, perhaps the two most significant for Canada have been the multilateral tariff reductions under GATT (particularly the Kennedy Round in the late 1960s and the Tokyo Round in the late 1970s) and the bilateral (United States/Canada) arrangements pertaining to defence equipment and automobiles. Although we are mainly concerned here with the impact of multilateral tariff and trade relaxations, it is of interest to note that studies of the Canada-United States Automobile Agreement show that substantial increases in Canadian productivity have occurred since 1965 as a result of the bilateral trade liberalization.[10]

Trade liberalization is likely to have the opposite effect to that of the imposition of trade barriers, in that it can lead to income gains through trade and specialization, realization of scale economies, and increased competition. (In some cases, particularly with respect to foreign ownership, the result is ambiguous.) By and large, trade liberalization is likely to lead, eventually, to higher real incomes for Canadians. The potential gravity of the transition or adjustment problems that can arise must not be underestimated, however. At one extreme is the possibility of grave economic and social dislocation, as imports – not only from the United States but also from the newly industrialized countries (South Korea, Taiwan, Singapore, Hong Kong, and Brazil, for example) – replace domestic production over a wide range of industries. The workers released from these industries – textiles, footwear, automobiles – may well be narrowly specialized or located in areas with few employment opportunities. At the same time, the new growth industries require different skills and may be located in other areas. The upshot could be long periods of high unemployment in some areas. On the other hand, we must avoid the risk of exaggerating the problems. There is a possibility that the transition could be relatively painless if plants, both in Canada and abroad, were to specialize in particular products

– a situation that would result in increased exports and imports, as well as in productivity gains. Such a pattern of trade is referred to as "increased intra-industry trade."

A reduction in trade barriers need not imply a drastic reduction in manufacturing, as the data in the preceding chapter have shown. There are four reasons for this.

First, one of the rationales for the introduction of import tariffs is the "infant industry" argument: in order to become competitive in international markets, an industry must attain a certain size before it can reap all the available scale economies; if imports are allowed free access to the domestic market, it may be very difficult to attain that critical size; by imposing tariffs and sheltering the industry from import competition for a limited period, the critical size can be reached, and the industry will become "mature." If this argument has validity, then it can be assumed that tariff reductions will have no adverse impact on "mature" industries, since they will no longer need a "lifeline."

Second, since the introduction of Canada's tariff structure, certain induced effects may well have become practically irreversible. The situation with respect to foreign ownership is particularly relevant here. Having established a subsidiary in Canada, trained its labour force, developed a market, and gained an understanding of all the federal and provincial rules and regulations, a foreign firm is unlikely to sell out to a potential competitor in Canada and revert to exporting from its country of origin, simply because tariffs have fallen. There may be closer integration with the parent company, in order to reap economies of scale. In any event, it should be added that an attempt to discern the impact of tariffs on the level of foreign investment could be made quite difficult by the presence of the Foreign Investment Review Act.

Third, since tariffs were first imposed, a large number of changes have taken place in the Canadian economy. In general, markets have grown substantially as a result of increases in income and in population; the economy has become much more national in scope; tremendous advances in technology have been made; and the role of government has increased considerably. These developments, combined with the presence of foreign investment, have undoubtedly altered Canada's comparative advantage and enhanced its manufacturing potential.

Fourth, the present costs of Canadian manufacturers include some that result from the presence of Canadian and foreign trade barriers; such costs will tend to be eliminated as Canada and other countries move towards freer trade. In particular, trade barriers may prevent an industry from achieving economies of scale in production; in addition, they may directly raise the costs of some of the inputs into the production process.

Having said that tariff cuts may not necessarily result in a drastic reduction in manufacturing, the likely consequences of trade liberalization must nevertheless be considered. Tariff reductions and increased import competition have the potential at least to trigger a series of intra- and inter-industry responses. Intra-industry responses could result in larger plant sizes; increased plant specialization and longer production runs; mergers designed to take advantage of multiplant economies of scale; and, perhaps, increased exports. Inter-industry adjustment could involve the movement of resources away from slow-growth industries, where Canada has little or no comparative advantage and suffers from the effects of import competition, to industries with the reverse set of characteristics. The likely conduits for such reallocation include firm entry, exit, and diversification, either through mergers or through a shift of resources within firms across industry boundaries.

These responses to the stimulus of import competition are likely to result in more-efficient industries and firms, as well as in a more efficient pattern of specialization among firms and products. In other words, the more competitive the market, the greater the spur to efficiency. As a consequence, plants should move closer to the minimum efficient size; the scale of industry output should be less inefficient; particular production runs should be closer to the optimum; productivity in Canada should be closer to that in the United States; and the pattern of specialization should favour achievement of the highest possible real-income level. The net result would be lower prices and higher real incomes for Canadians.

In evaluating these responses and consequences, several important factors should be borne in mind. These are areas for potential government intervention.

First is the time dimension: the jobs created by new industries and by the expansion of existing ones may emerge only after unemployment has occurred in those industries which are most vulnerable to import competition. In other words, even if trade liberalization does lead to increased efficiency, there remains the question of how long it will take for such benefits to materialize. Much of the controversy surrounding trade liberalization centres over whether unemployment in those industries which are hit hard by imports will materialize long before expansion in other industries takes up the slack. Positive adjustment policies, aimed at making the economy more flexible and

capable of adapting to change, may be required. Adjustment then occurs mainly through changes in the relative size and importance of industries (inter-industry adjustment) rather than through increased specialization within industries and plants (intra-industry adjustment).

A second factor, related to the first, is the presence of forces that inhibit or slow down the response of firms to import competition. For example, an international oligopoly may effectively prevent (or at least slow down) entry into, or exit from, an industry slated for expansion or contraction, respectively. The capital used in any industry may be specific to that industry and very durable, thus forming an effective barrier to exit and redeployment of the resources. (In this case, however, it might be socially optimal to contract the industry gradually, since the capital is essentially valued at zero.) If analysis permits the identification of the areas where such barriers exist, then government has a role to play by strengthening its competition policy, for example, or by providing incentives for persons to move out of slow-growth industries.

The third factor is the reaction of foreign- and Canadian-owned firms to the stimulus of import competition. There is evidence suggesting that foreign firms react differently from domestic firms with respect to entry determinants and diversification patterns. Hence distinct patterns may also exist with respect to import competition. For example, because of the miniature-replica effect, some foreign firms may disappear, but not their Canadian counterparts.

The Evidence on Tariffs and Trade

Our empirical analysis pertains to the 20 major industry groups that comprise the manufacturing sector. Naturally, each group encompasses a wide array of industries, when measured at a finer level of aggregation. For example, the food and beverage group contains 18 industries, ranging from wineries to poultry processors.[11]

The major groups differ considerably in their economic significance, when this is measured by value-added (Table 9-1). The advantage to using this measure is that no double counting takes place (as in the case of the value of output or of sales) and that the contribution of all factors of production is considered.

The three largest groups (food and beverages, paper and allied industries, and transportation equipment) accounted for approximately one-third of the manufacturing sector's value-added throughout the 1970s, while the five smallest groups (tobacco products, leather, knitting mills, furniture and fixtures, and petroleum and coal products) accounted for only 6 to 7 per cent. The most significant increase in the relative importance of major groups was seen in the wood and transportation equipment industries, with food and beverages showing the greatest decline. Several industries showed no clear trend upward or downward.

Table 9-1

Distribution of Value-Added, by Major Industry Group in the Manufacturing Sector, Canada, 1970, 1975, and 1979

	1970	1975	1979
		(Per cent)	
Food and beverages	14.7	14.0	12.8
Tobacco products	1.0	1.0	0.8
Rubber and plastics	2.8	2.6	2.9
Leather	1.0	0.8	0.8
Textiles	3.3	2.9	2.8
Knitting mills	0.8	0.8	0.6
Clothing	3.1	3.0	3.0
Wood	3.8	4.5	6.4
Furniture and fixtures	1.8	1.9	1.7
Paper and allied products	8.6	9.1	9.1
Printing and publishing	4.9	5.0	4.8
Primary metals	8.4	7.8	7.9
Metal fabricating	8.4	8.6	7.8
Machinery	5.7	5.2	5.4
Transportation equipment	9.9	10.2	11.2
Electrical products	6.4	6.5	5.8
Nonmetallic mineral products	3.5	3.9	3.5
Petroleum and coal products	1.7	2.3	2.3
Chemicals and chemical products	7.0	6.9	7.4
Miscellaneous manufacturing	3.1	3.0	2.9
All industries	100.0	100.0	100.0

SOURCE Based on data from Statistics Canada.

Tariffs

Nominal tariffs refer to the actual customs duties payable on imported goods, as listed in the tariff schedule. The net effect of the nominal-tariff structure on the protection afforded an industry's output is an increase or decrease in its value-added, compared with a no-tariff situation. This difference, when divided by the value-added with protection, is referred to as the "effective tariff rate."

Tariffs, both nominal and effective, for each of the 20 major groups are presented in Table 9-2.[12] For the purpose of the table, nominal tariffs are defined as the total duty collected for all of the items classified in a given group, divided by the value of total imports (excluding duties). Hence the nominal tariffs in the table represent an average level, across many different commodities or items. The effective tariff, as

Table 9-2

Nominal and Effective Tariffs on Imports, and Proportion of Imports not Subject to Tariffs, by Major Manufacturing Industry Groups,[1] Canada, 1966, 1970, 1975, and 1978 or 1979

	Nominal tariffs				Effective tariffs[2]				Imports not subject to tariffs		
	1966	1970	1975	1978	1966	1970	1975	1978	1970	1975	1979
	(Per cent)										
Food and beverages	21.1	21.2	11.2	9.9	27.8	20.4	15.7	10.1	23.5	22.7	41.1
Tobacco products	55.6	50.9	41.9	28.3	94.8	79.5	94.8	22.9	–	--	1.0
Rubber and plastics	13.4	10.0	9.0	12.2	19.3	16.0	13.3	19.6	20.7	10.2	14.6
Leather	19.7	19.0	18.4	17.6	31.6	30.0	27.6	27.5	4.7	4.2	8.7
Textiles	16.3	14.2	14.2	12.5	22.9	17.9	20.3	18.7	9.9	7.4	13.3
Knitting mills	26.2	27.6	24.1	22.9	37.4	43.0	34.5	35.0	--	0.1	8.0
Clothing	22.5	21.6	21.9	20.3	28.8	25.0	28.2	25.7	0.2	1.3	6.6
Wood	6.1	5.2	6.0	4.4	11.4	10.5	10.6	7.9	58.9	59.3	72.3
Furniture and fixtures	18.9	15.5	15.6	15.7	24.7	19.5	20.6	20.6	1.4	1.0	5.2
Paper and allied products	10.5	8.7	9.6	7.7	16.6	15.4	17.1	13.8	29.2	22.8	36.6
Printing and publishing	5.1	4.9	6.5	6.8	2.8	3.8	5.7	7.1	59.5	58.9	65.7
Primary metals	4.8	4.6	4.7	4.2	8.0	7.2	9.8	8.7	50.4	49.0	50.4
Metal fabricating	10.7	9.0	8.6	8.0	13.9	11.4	11.8	10.8	19.6	13.4	22.3
Machinery	8.3	6.9	5.9	5.9	8.0	6.1	5.6	6.0	48.8	59.2	61.6
Transportation equipment	4.1	2.7	3.2	2.5	1.9	1.0	1.7	0.6	77.5	78.4	84.0
Electrical products	14.1	10.9	10.3	9.5	18.1	14.0	12.9	12.3	21.3	19.9	29.6
Nonmetallic mineral products	6.9	6.2	5.5	5.7	9.8	8.8	7.5	8.1	30.5	31.6	37.4
Petroleum and coal products	5.4	6.3	1.5	3.1	35.7	44.1	7.9	59.7	23.4	92.8	88.7
Chemicals and chemical products	9.5	7.9	6.6	6.7	14.5	11.7	10.3	11.1	45.2	46.3	51.2
Miscellaneous manufacturing	12.6	11.6	10.3	9.1	17.4	15.9	14.4	13.2	29.0	28.2	32.6
All industries	11.9	10.7	8.8	7.8	16.4	13.8	12.8	11.7	35.4	36.2	45.8

1 For each major group the relevant variable is the weighted average for the four-digit industries into which the group is divided. The weights used are the industries' total value-added in the year for which the variable was estimated (except for 1966 and 1978, when 1970 and 1979 weights were used, respectively). All 167 manufacturing industries were employed.

2 Simple effective tariff rates, calculated as the decline in value-added that may occur if tariff protection is removed.

SOURCE Special tabulations provided by Statistics Canada.

noted, is measured as the change in industry value-added that results from elimination of the tariffs on both inputs and outputs, divided by the value-added with protection. Effective rates of protection will be higher than the corresponding nominal rates if the tariff schedule raises duties for each successive stage of production to the end product. Manufacturing is then protected more than the nominal tariff structure would indicate.

For most of the 20 major manufacturing groups, effective tariffs generally exceeded nominal tariffs throughout the 1966-78 period. In three cases, however – printing and publishing, machinery, transportation equipment – the opposite was true. It should be noted that both nominal and effective tariffs were low in all three industries, compared with those for all manufacturing, and that for two of them (printing and publishing, machinery) the difference between nominal and effective rates narrowed considerably during the late 1960s and the 1970s. In each case, particular circumstances explain the difference. For example, the transportation equipment group includes motor vehicles – an industry in which, under the Canada-United States Automobile Agreement, there exists "free trade" in new vehicles and parts, while replacement parts are subject to duty.[13]

Over the period 1966 to 1978, nominal and effective tariffs declined for the manufacturing sector treated as a whole. Nominal rates fell somewhat faster – by 34.5 per cent compared with 28.7 per cent. This trend was reflected in most of the 20 major groups, particularly for nominal tariffs.[14] There were few instances of continuously falling tariff rates in the late 1960s and the 1970s, however, as most groups showed at least one increase between 1966 and 1978. This reflects a number of factors. For some goods, tariff protection may have increased. Others were not imported as long as high tariffs were assessed; trade was observed when tariffs were reduced, thus leading to an increase in the duties collected (although the tariff schedule had actually been lowered). In sum, tariffs have declined, although it has seldom been a smooth, year-by-year process.

A final indicator of the degree of trade liberalization is the percentage of total imports not subject to tariffs (columns 9 to 11 of Table 9-2). Overall, this indicator rose during the 1970s, especially from 1975 to 1979. The same occurred for every major industry group except two (rubber and plastics, and primary metals), although declines were frequently experienced between 1970 and 1975. Hence, not only have tariffs (effective and nominal) declined, but so also has the total trade that is subject to import duties. These results are in accord with the general perception that the protection afforded the Canadian manufacturing industry has decreased over the past 10 to 15 years.

Trade

Imports as a percentage of domestic disappearance or consumption and exports as a percentage of domestic production are likely to provide good indicators of the adjustments required as a result of changing trade patterns. Large increases in imports are likely to be associated with industry shrinkage, while industry expansion is probably the result of a rise in exports. Adjustment may be somewhat different where exports and imports increase simultaneously, requiring intra-industry rather than inter-industry adaptation. Table 9-3 provides measures of the significance of imports, exports, and intra-industry trade. All three measures must be examined together, since the intra-industry trade measures the amount of trade that is of a two-way nature – i.e., the amount of imports or exports that overlaps – with no attention being paid to the significance of such trade relative to the size of the industry or of the domestic market.

For the manufacturing sector as a whole, it can be seen that the relative importance of imports decreased between 1970 and 1979, after an increase in 1975. At the individual industry-group level, exports consistently exceeded imports in such industries as wood, paper and allied products, primary metals, and (except for 1970) petroleum and coal products – all closely linked to, and drawing upon, the natural-resource base that is considered to represent Canada's comparative advantage. On the other hand, imports were of considerable significance in such industries as textiles, leather, knitting mills, and electrical products.

Overall, and in many of the major groups, trade liberalization resulted in increased intra-industry trade: the ratio of imports to exports changed little, but both imports and exports increased. In a few trade-sensitive industries, however, imports grew relative to exports – most notably in leather, knitting mills, clothing, furniture and fixtures, and electrical products. For these five industries, the negative numbers in the last three columns became larger, thus revealing that inter-industry adjustment took place. For textiles, also considered a trade-sensitive sector, the negative numbers became smaller in absolute value from 1970 to 1979, which points to intra-industry adjustment. Hence there were gains from specialization across, not just within, industries.

The important point, however, is that none of the changes involved is drastic, as shown by the figures in the first three columns of Table 9-3. For textiles

Table 9-3

Significance of Imports and Exports, by Major Manufacturing Industry Group,[1] Canada, 1970, 1975, and 1979

	Imports as a proportion of domestic disappearance[2]			Exports as a proportion of domestic production			Measure of intra-industry trade[3]		
	1970	1975	1979	1970	1975	1979	1970	1975	1979
	(Per cent)								
Food and beverages	7.6	8.7	9.9	10.5	8.9	11.8	5.4	-11.8	1.5
Tobacco products	0.8	0.5	0.5	4.3	2.4	3.1	98.2	97.8	98.7
Rubber and plastics	17.0	22.5	20.9	3.6	5.7	9.7	-69.3	-67.7	-46.3
Leather	22.1	30.0	30.7	5.3	6.3	6.8	-68.7	-72.8	-72.1
Textiles	22.6	23.3	24.9	5.2	4.4	6.3	-64.1	-66.5	-57.6
Knitting mills	25.1	30.1	29.8	2.3	1.4	1.5	-81.2	-93.4	-93.2
Clothing	6.4	8.6	10.4	4.5	3.6	3.7	-20.4	-44.7	-57.0
Wood	9.1	11.1	7.7	41.4	30.4	52.2	54.5	29.8	64.5
Furniture and fixtures	5.9	9.9	12.0	4.7	4.0	8.5	-15.6	-42.7	-31.2
Paper and allied products	7.4	12.9	11.0	51.3	55.0	58.6	57.8	54.2	66.0
Printing and publishing	11.7	12.2	14.2	1.9	2.3	3.0	-70.2	-68.6	-66.4
Primary metals	20.0	21.8	21.2	34.9	32.5	33.3	21.1	12.3	17.8
Metal fabricating	11.9	13.8	15.1	5.8	6.3	9.4	-50.9	-54.8	-37.5
Machinery	58.1	65.7	68.0	30.4	37.7	42.7	-53.4	-54.3	-50.4
Transportation equipment	56.5	55.0	59.1	61.9	55.0	60.0	--	-9.3	-4.5
Electrical products	24.8	27.7	36.4	11.6	12.5	19.5	-38.8	-45.5	-40.4
Nonmetallic mineral products	12.8	12.6	13.9	6.9	5.8	10.9	-2.2	-12.0	6.6
Petroleum and coal products	10.9	6.2	24.2	4.9	6.3	13.5	-49.0	30.7	66.4
Chemicals and chemical products	25.6	26.8	51.5	18.4	18.5	29.7	-36.6	-38.4	-19.7
Miscellaneous manufacturing	40.0	40.8	45.6	16.0	14.4	20.3	-64.1	-69.6	-62.0
All industries	21.5	23.1	27.2	22.4	21.8	28.1	-14.5	-20.1	-6.8

1 For each major group the relevant variable is the weighted average for the four-digit industries into which the group is divided. The weights used are the industries' total value-added in the year for which the variable was estimated. All 167 manufacturing industries were employed.

2 Domestic disappearance = domestic production - exports + imports.

3 (Exports - imports)/(exports + imports), expressed as a percentage. This index will vary from +100 when there are only exports to -100 when there are only imports. If imports and exports are equal, then the index is zero. A positive value indicates that exports exceed imports; a negative value, the converse. Hence as the index moves towards -100, imports are becoming more significant, while the converse occurs when they move towards +100.

SOURCE Special tabulations provided by Statistics Canada.

and knitting mills, imports rose very little as a proportion of domestic disappearance; quotas may have played a role here. For clothing and furniture, the increases are sharper – from 6 to 10 per cent and from 6 to 12 per cent, respectively – but they emanate from very small bases. Only in leather and electrical products did significant (though not all that extensive) import penetration occur, with the level of import penetration stabilizing in the late 1970s for leather, perhaps because of import quotas. Moreover, increased export penetration also occurred for four of these six industries, especially electrical products.

The conclusions drawn from Tables 9-2 and 9-3 would appear to coincide with *a priori* expectations. As tariffs fell worldwide, following the Kennedy Round of the late 1960s and early 1970s, trade was stimulated, and both imports and exports increased. This interpretation is too simplistic a view of the world, however, because there are other important factors that determine trade flows. Indeed, it has been argued by some that tariff levels and changes therein bear only a weak relationship to imports.[15] For example, the economy plunged into a deep recession in 1974-75, following the OPEC oil price hike of 1973-74, before a period of expansion in the second half of the decade. These events heavily influenced the trade patterns that were observed during that period. While the recession was a key factor leading to a drop in exports and to slower import growth, the subsequent recovery saw both imports and exports increase. In sum, although changes in tariffs may have an important influence on trade, they must be viewed as part of the broader economic environment, which is likely to be just as important, if not more, in determining trade flows.[16]

The Adjustment Process

As the exposure of the Canadian manufacturing sector to trade and competition increased during the 1970s, it is important to examine how these largely external changes have affected the behaviour of various economic agents. What has been the reaction of firms and employees to this increased exposure?

Firms[17]

Our analysis of firm adjustment is based on data for 1970 and 1979, covering the firms that accounted for virtually all of the employment in those years, together with their ownership characteristics – i.e., whether they were foreign- or Canadian-controlled, the identity of the controlling corporate entity, and so on. Thus questions concerning the entry and exit of firms – a reflection of resource reallocation – can be investigated. What was the extent of entry and exit? What was the relative importance of plant scrapping or divestiture for exiting firms and of plant building or acquisition for new entrants? How does the entry/exit process react to trade? Are the reactions of foreign- and Canadian-owned firms different?

For our purposes here, firms within each industry are divided into three categories: new firms, or "births" (those which existed in 1979 but not in 1970); exiting firms, or "deaths" (those which existed in 1970 but not in 1979); and continuing firms (those which existed in both 1970 and 1979). The birth of a new firm into an industry can occur in two ways: the firm can build a new plant, or it can acquire an existing plant. Similarly, the death of a firm can occur in two ways: it can scrap a plant (demolish or abandon it), or it can sell it.

A surprising and little-known fact is that "birth rates" and "death rates" are very high. This is true in the average Canadian manufacturing industry (Table 9-4), but it is also true in other industries and in the United States. As we shall see, the implications of this single fact for the adjustment process are profound. Consider Table 9-4 in detail. An average industry had 88 firms in 1970. By 1979, no fewer than 38 deaths had occurred (accounting for 31 per cent of industry shipments in 1970), with 32 of them being actual scrappings. At the same time, 25 births of new firms occurred (accounting for 26 per cent of industry shipments in 1979), with 22 of these occurring through the construction of new plants. Bearing in mind that these averages cover 141 industries, the picture is one of an extremely dynamic industrial structure, with literally thousands of entries and exits over the decade. The turnover is enormous.

Table 9-4 shows that exits via plant scrapping involved firms with relatively small employment, compared with those firms where divestiture was the chosen route – 55 and 206 employees, respectively. Firms entering via plant creation were also much smaller than those entering through acquisition. Hence much of the burden of adjustment – in terms of plant closings and openings – was on smaller firms.

Given these high birth and death rates in the normal course of events, the possibility emerges of two extreme ways in which any particular industry might adjust to the need for contraction or expansion. Contraction could occur, in principle, either through a rise in death rates (increased frequency of exits via scrapping or divestiture) or through a decrease in birth rates (decreased frequency of entry via new plant building or acquisition). The first route would be very painful, from a social point of view,

Table 9-4

Number of Firms, Share of Shipments, and Firm Size for Three Categories of Firms in the Manufacturing Sector, Canada, 1970 and 1979

	Average per industry[1]					
	Number of firms		Share of shipments		Firm size (wage and salary earners)	
	1970	1979	1970	1979	1970	1979
	(Number)		(Per cent)		(Number)	
Firm category:						
Entry ("births")[2]	. . .	24.6	. . .	26.2	. . .	113.8
By plant creation	. . .	21.7	. . .	14.0	. . .	55.7
By plant acquisition	. . .	4.9	. . .	12.3	. . .	227.9
Exit ("deaths")[3]	37.8	. . .	30.7	. . .	113.9	. . .
By plant scrapping	32.0	. . .	16.2	. . .	54.6	. . .
By plant divestiture	6.6	. . .	14.5	. . .	206.1	. . .
Continuing firms[4]	50.3	50.3	69.3	73.8	275.9	308.1
All firms	88.1	74.6	100.0	100.0	208.2	225.1

1 Unweighted average across 141 four-digit industries; 26 industries were excluded mainly because they were in the miscellaneous category.
2 Firms present in the industry in 1979 but not in 1970.
3 Firms present in the industry in 1970 but not in 1979.
4 Firms present in the industry in 1970 and 1979.
SOURCE Special tabulations provided by Statistics Canada.

especially if scrapping dominated, relative to divestiture. This route – plant closings – is probably in conformity with the conventional picture of how industries contract or die off. The second route – decreased births – certainly has costs also, but if an industry adjusts by building (or acquiring) fewer plants than might otherwise have been the case, this method seems intrinsically less painful, socially, than plant closings. It becomes very important to know, therefore, whether contracting industries become smaller because death rates rise above normal levels or because birth rates fall below normal levels. Some combination of the two phenomena is also possible. It is interesting also, though not as important from a social perspective, to know whether expanding industries become larger because of an increase in the birth rates of new firms or because of a decrease in the death rates of existing ones. Table 9-5 presents the relevant information on these matters.

The final column shows birth and death rates in percentage form. From 1970 to 1979, new entries (births) were equal to 36 per cent of the number of firms existing in 1970, while exits (deaths) were equal to 42 per cent. Thus the death rates exceeded the birth rates, so that the average number of firms fell from 88 to 75. Notice, however, that surviving firms were consistently larger, so that industries contracted much less than the number of firms did.

The first four columns show (in the first panel) what kind of firm adjustment occurred in each of these kinds of industries: declining, slow-growing, moderate-growing, or fast-growing, respectively. The first remarkable feature of the table is that death rates in all four categories are much closer to the Canadian industry average than are birth rates. This means that the brunt of the adjustment to changing industrial fortunes – good or bad – occurs through changing birth rates of new firms rather than through changing death rates. That is an important result, and it is significant enough to be worth looking at in more detail.

On the entry side, in declining industries the birth rate was only 27 per cent, compared with an all-industry average of 36 per cent; in other words, it was lower than the industry average by 26 per cent. On the exit side, the death rate was 47 per cent, compared with 42 per cent; in other words, it was higher than the all-industry average by only 11 per cent. Thus the adjustment through reduced entry was more than twice as important as that through increased exit, for declining industries. For slow-growing industries, death rates were actually slightly below the industry average, so that all of the adjustment occurred through a fall in the birth rate of new firms. Entries were 32 per cent, compared with the industry average of 36 per cent. Moderate-growth industries show behaviour that was very close to the industry average, as one might expect. Finally, fast-growth industries show the *same* death rate as the average, but a much higher birth rate – 47 per cent versus 36 per cent.

The second panel of Table 9-5 also presents entry and exit information, but as a proportion of industry shipments rather than of the number of firms in the industry. This panel tells an almost identical story, but there is one exception: for industries in actual absolute decline, the lower birth rate and the higher death rate are now of almost equal importance relative to the average, instead of the birth rate being more than twice as important as the death rate, as we saw above in the case of the number of firms. That means that, in this case, the exiting firms had larger shipments, on average, than the firms that failed to enter would have had. But the main picture is confirmed: the dominant mode of adjustment, whatever the degree of contraction or expansion of an industry, takes the form of shifts in the birth rates of firms, with shifts in death rates playing a much lesser role.

The results are not, apparently, a quirk of Canada in the 1970s. Very similar findings regarding job losses and gains obtain when U.S. industries are classified according to their growth rates.[18]

Some interest attaches also to whether domestically controlled firms fare better or worse than foreign-controlled firms. The relevant information is in Table 9-6. On average, Canadian-controlled firms represent the vast majority of firms in an industry; by virtue of this fact, they bear the brunt of the adjustment that occurs, good or bad. They also show a stronger tendency to exit by scrapping – a more painful route than divestiture; at the same time, they show a stronger tendency to enter via new plant construction rather than acquisition.

Let us consider now the determination of births and deaths. The factors that influence entry and exit are likely to be many and varied: industry profitability; the level of research and development; the smallest efficient plant size in relation to industry size; the cost advantage of small plants relative to large plants; industry concentration; the advertising-to-sales ratio; trade exposure; increases in the size of the market; and regionalism. We are concerned here with trade and tariffs, and so the questions that interest us are:

Table 9-5

Firm Entry and Exit in the Manufacturing Sector, by Industry Growth Rate, Canada, 1970-79

	Industry growth rate[1]				Canadian average
	Decline	Slow	Moderate	Fast	
			(Per cent)		
1 As a proportion of the number of firms in 1970:					
Entry	26.6	31.9	35.9	46.5	36.1
By plant creation	19.0	25.0	27.9	37.1	28.1
By plant acquisition	7.9	7.3	9.8	11.3	9.2
Exit	47.1	40.4	40.8	42.3	42.3
By plant scrapping	38.4	31.3	29.5	31.4	32.2
By plant divestiture	10.2	9.8	13.7	12.2	11.6
2 As a proportion of industry value of shipments in 1970:					
Entry	25.8	26.9	37.3	62.0	39.5
By plant creation	12.3	16.2	17.9	36.0	21.6
By plant acquisition	13.5	10.7	19.3	26.0	18.0
Exit	40.7	28.0	28.7	28.6	30.7
By plant scrapping	23.9	16.5	11.6	15.4	16.2
By plant divestiture	16.8	11.6	17.1	13.2	14.5
Number of industries	26	36	39	40	141
Number of firms per industry:					
1970	53.7	98.3	69.2	119.7	88.1
1979	44.8	79.1	60.4	103.7	74.6
Number of employees per industry:					
1970	5,442	9,378	11,683	8,127	8,935
1979	4,744	9,238	13,222	10,528	9,874

1 Growth rates are for industry shipments. The annual rates for the four categories are as follows: decline, from 0 to -2 per cent; slow growth, from 0 to 2 per cent; moderate growth, from 2 to 4 per cent; fast growth, 4 per cent and over.

SOURCE J. Baldwin and P. Gorecki, with J. McVey and J. Crysdale, "Entry and Exit to the Canadian Manufacturing Sector: 1970-1979," Economic Council of Canada, Discussion Paper 225, Ottawa, February 1983.

Table 9-6

Firm Entry and Exit in the Manufacturing Sector, by Ownership Status, Canada, 1970-79

	Average number of firms per industry[1]	
	Canadian-controlled	Foreign-controlled
Firm category:		
Entry[2]	20.4	3.9
By plant creation	18.3	2.2
By plant acquisition	2.4	2.0
Exit[3]	33.2	4.6
By plant scrapping	29.2	2.8
By plant divestiture	4.4	2.1
Continuing firms[4]	43.3	6.9
Total, 1970	76.6	11.5
Total, 1979	63.9	10.7

1 Unweighted average across 141 four-digit industries; 26 industries were excluded mainly because they were in the miscellaneous category.
2 Firms present in the industry in 1979 but not in 1970.
3 Firms present in the industry in 1970 but not in 1979.
4 Firms present in the industry in 1970 and 1979.
SOURCE Special tabulations provided by Statistics Canada.

What impact have changes in imports and exports and in tariffs over the 1970-79 period had upon entry and exit? Have foreign-owned and domestic firms reacted differently?

Broadly speaking, one would expect that, other things being equal, increases in imports would reduce entries and increase exits, while increased exports would be likely to augment the number of firms and to slow down exits.

The opportunities available (or the adjustments required), in terms of firm entry and exit, because of increased trade flows in the 1970s were chiefly seized upon (or borne) by Canadian-owned firms rather than foreign-owned corporations. In general, foreign-firm entry and exit reacted little to the growth in imports, exports, and the size of the domestic market. This does not necessarily mean, however, that foreign-owned firms did not rationalize in response to increased trade flows, but only that it did not take the form of firm entry or exit. In particular, foreign firms may have made adjustments on a product-line basis within a plant, but only on a worldwide basis or North American basis. Such global opportunities are usually unavailable to Canadian firms.

In contrast with foreign firms, Canadian-owned firms reacted strongly to trade flows. Imports led to less firm entry either by the building of new plants (an indirect effect through a reduction in domestic production) or by acquisition. Increased exports resulted in increased firm entry, irrespective of the method. These findings suggest that Canadian firms bear the brunt of increased import competition; at the same time, they are able to take advantage of opportunities provided by increased exports. Thus it could be argued that this rationalization process should boost the domestic sector's competitive position.

On the firm exit side, the evidence suggests that for both foreign- and Canadian-owned firms the prime determinant is a random process associated with the number of firms in an industry. In other words, a fairly constant percentage of an industry's firms exit, with other factors (such as those mentioned above) playing little part. This result is consistent with the finding in Table 9-5 that exits vary little by industry growth rate.

Turning now to the impact of trade flows upon firm exit, we find that as exports increase there is less exit of Canadian-owned firms, but there is no impact on foreign-owned firms. On the import side, for both foreign-owned and domestically-owned firms, exit is lower, the *greater* the growth of imports in the 1970s. This result is counter-intuitive since as imports increase, displacing domestic production, more exit is expected to result. This suggests that some barriers to rationalization are preventing resources from being reallocated in order to increase efficiency and productivity.

Our analysis of firm entry and exit and of adaptation to changing trade flows can be summarized as follows: rates of both firm entry and exit are astonishingly large in the normal course of events, and they open up the possibility of significant and rapid adjustment, in principle, through changes in either the birth rates or the death rates of firms. In practice, it turns out, surprisingly, that the major adjustment mechanism to variation in industry growth rates takes the form of changes in birth rates, and this implies that the conventional picture of a rather traumatic adjustment process is somewhat misleading. Only for industries that recorded a decline in real output over the 1970s did increased death rates play a significant role; and, even there, changes in birth rates dominated on one measure and were of almost equal importance on another. Canadian firms are in the majority, and largely for this reason they bear the brunt of the adjustment cost to increased trade flows, but they also seem to have exploited the opportunities more.

Workers

The other side of the debate about the adjustment of industry to increased trade focuses upon the employment experience of persons who are laid off permanently, either because the plant where they work shuts down or because it undergoes a permanent reduction in activity. Of all the aspects of the adjustment process, perhaps the most significant, from a public-policy viewpoint, is the possibility that considerable social and economic dislocation will result from freer trade. Whole towns and regions with few alternative local employment possibilities may enter a long period of economic decline and high unemployment, with workers being subjected to lengthy and debilitating spells without work. The costs in human suffering and output forgone are such that the political authorities may find it difficult to advocate freer trade in the vulnerable industries and regions. Indeed, considerations of this nature have recently led to increased trade restrictions in some areas. It is therefore critical that the available evidence on this point be carefully considered in the light of the significance of this aspect of the adjustment process.

In 1977 and 1978, the Department of Industry, Trade and Commerce (IT & C) undertook surveys of several thousand workers laid off between 1974 and 1977 in three important import-sensitive industries – clothing, textiles, and electrical products.[19] While this evidence pertains to a period when unemployment rates were significantly lower than they are today, it still seems to us to be relevant and important. Each of the three industries was characterized, during that period, by a moderate rise in import penetration, a small drop in employment, and a modest decline in domestic production. For example, employment in the textile industry declined by 7.7 per cent; the comparable figure for the clothing industry was 4.1 per cent. An analysis of the results permits discussion of several aspects of labour adjustment to import competition: How long does it take to find another place of employment? Does the duration of unemployment vary by industry and region? Does it vary by age and sex of worker?

In the 1977 survey, the workers who had been laid off between 1974 and 1976 were divided into three categories: withdrawn from the labour force; employed; in labour force but still unemployed. Overall, one-third fell into either the first or the third category, while the other two-thirds found new employment (Table 9-7). This pattern was found in each of the three industries, although the proportion leaving the labour force was somewhat higher in the clothing industry. In fact, about 80 per cent of the workers who had been made redundant in the 1974-76 period remained in the labour force in 1977; and of those who did, about 80 per cent had found employment.

Although a worker may have been employed at the time of the survey (1977), he/she may nevertheless have experienced a long period of unemployment after the layoff actually took place (1974-76). The results of the survey showed that half of all those who

Table 9-7

Labour Force Status of Workers Laid Off Following Trade Liberalization, Three Industry Groups, Canada, 1974-76[1]

		Laid-off workers who:					
				Had remained in the labour force and:			
	Total number laid off	Had left the labour force[2]		Had found a job[2]		Were still unemployed[2]	
		Number	%	Number	%	Number	%
Clothing	753	189	25.1	465	61.8	99	13.1
Primary textiles	2,664	456	17.1	1,772	66.5	436	16.4
Electrical products	879	145	16.5	524	59.6	210	23.9
Total	4,296	790	18.4	2,761	64.3	745	17.3

1 A number of workers who had been laid off permanently between 1974 and 1976 were examined in the Labour Force Tracking Survey, administered by the Department of Industry, Trade and Commerce between June and August 1977. The samples are considered representative of all major layoffs (50 workers or more) in the three sectors in Nova Scotia, New Brunswick, Quebec, Ontario, and Manitoba. The samples were provided by firms that had closed down their plant(s) or had reduced employment permanently but had remained in operation.

2 At the time of the survey.

SOURCE Department of Industry, Trade and Commerce, Economic Policy and Analysis Group, *A Report on the Labour Force Tracking Project/Costs of Labour Adjustment Study* (Ottawa: IT&C, 1979).

had remained in the labour force (i.e., the median) had been unemployed between 13 and 16 weeks, depending upon the industry (Table 9-8). For those who had actually found work, the spell of unemployment was much shorter – between 5 and 8 weeks. There was a small proportion (4 per cent) of workers still in the labour force, however, who recorded unemployment spells of two years or more. It is primarily this group that causes the average to exceed the median substantially. In summary, most of those who find another job after having been made redundant do so quite quickly, but a small percentage of apparently "hard-core" unemployed are still without work two years after having been laid off.

The age and sex of laid-off workers are important determinants of their labour force status, as Table 9-9 shows. Older workers are more likely than younger workers to withdraw from the labour force, and they are less likely to find employment if they decide to seek another job. This result is not surprising, since older workers have the alternative of retirement and are likely to be more attached to a

Table 9-8

Duration of Unemployment for Workers Laid Off Following Trade Liberalization, Three Industry Groups, Canada, 1974-76[1]

	Laid-off workers still in the labour force[2]			Laid-off workers who had found work[2]		
		Duration of unemployment			Duration of unemployment	
	Total	Average	Median	Total	Average	Median
		(Weeks)			(Weeks)	
Clothing	564	28	13	465	22	7
Primary textiles	2,208	29	16	1,772	21	8
Electrical products	733	25	16	524	17	5

1 A number of workers who had been laid off permanently between 1974 and 1976 were examined in the Labour Force Tracking Survey, administered by the Department of Industry, Trade and Commerce between June and August 1977. The samples are considered representative of all major layoffs (50 workers or more) in the three sectors in Nova Scotia, New Brunswick, Quebec, Ontario, and Manitoba. The samples were provided by firms that had closed down their plant(s) or had reduced employment permanently but had remained in operation.
2 At the time of the survey.
SOURCE IT&C, *Labour Force Tracking Project*.

Table 9-9

Labour Force Status of Workers Laid Off Following Trade Liberalization, by Sex and Age Group, Three Industry Groups, Canada, 1974-76[1]

	Laid-off workers who:				Laid-off workers remaining in the labour force who:			
	Were still in the labour force[2]		Had left the labour force[2]		Had found work[2]		Were still unemployed[2]	
	Number	%	Number	%	Number	%	Number	%
Sex								
Male	1,959	88.0	268	12.0	1,666	85.0	293	15.0
Female	1,546	74.8	522	25.2	1,095	70.8	451	29.2
Age								
Under 55	3,295	85.1	579	14.9	2,652	80.5	643	19.5
55 or over	211	50.0	211	50.0	109	51.7	102	48.3

1 A number of workers who had been laid off permanently between 1974 and 1976, were examined in the Labour Tracking Survey, administered by the Department of Industry, Trade and Commerce between June and August 1977. The samples are considered representative of all major layoffs (50 workers or more) in the three sectors in Nova Scotia, New Brunswick, Quebec, Ontario, and Manitoba. The samples were provided by firms that had closed down their plant(s) or had reduced employment permanently but had remained in operation. The three industry groups are: clothing, primary textiles, and electrical products.
2 At the time of the survey.
SOURCE IT&C, *Labour Force Tracking Project*.

particular locale – and thus to be less mobile. At the same time, employers are probably more reluctant to invest in the training of older workers who are likely to leave the labour force in the not-too-distant future.

The problem of older workers who are laid off because of import competition was addressed specifically in the case of textiles and clothing (since 1972), as well as in that of footwear and tanning (since 1979), by the introduction of pre-retirement benefits. Each displaced worker who is at least 54 years old at the date of layoff and remains unemployed is entitled, after unemployment benefits have been exhausted, to a pre-set proportion (currently 60 per cent) of his/her average weekly insurable earnings immediately prior to layoff. Such a benefit continues to the age of 65 unless the worker finds employment. Eligibility for such benefits applies to workers who constitute part of a substantial reduction in the size of a plant because of import competition and who have had considerable past employment in the given industry – for at least 10 of the 15 years preceding layoff – and have been paid for at least 1,000 hours for each of those years. The officials administering the program report that determination of layoffs that occurred because of import competition was usually done fairly quickly. As of October 1982, 1,405 claims had been allowed for those in textiles and clothing and 81 for those in footwear and tanning. Recently, with the passage of the Labour Adjustment Benefits Act, pre-retirement benefits may be applied to any industry that, in the view of the government of the day, "is undergoing significant economic adjustment of a non-cyclical nature by reason of import competition." We shall comment further in the next chapter concerning benefits and adjustment policies related to trade.

Men are more likely than women to remain in the labour force (Table 9-9); they are also more likely to find employment and to find it sooner. For example, in the three industries surveyed (clothing, textiles, and electrical products), half of the male workers who remained in the labour force found employment within 9, 10, and 5 weeks, respectively, while the corresponding figures for female workers were 16, 27, and 25.

An examination of the sectoral and occupational mobility of laid-off workers reveals that in all three industries studied, a clear majority find employment in other industries and/or occupations (Table 9-10). In textiles, for example, only 10 per cent remained in that industry, while 90 per cent changed occupation; although for those who managed to remain within the same industry and occupation, unemployment was usually of shorter duration.

One final factor is the unemployment/employment experience of workers in different provinces: Do local labour market conditions affect the probability of finding employment? More specifically, given the fact that the trade-sensitive industries are located in central Canada, is the unemployment/employment experience of the typical worker worse in Quebec

Table 9-10

Sectoral Mobility of Workers Laid Off Following Trade Liberalization, Three Industry Groups, Canada, 1974-76

	Proportion of workers who found other work	Sector of new employment	Average duration of unemployment prior to finding other work
Industry left:	(Per cent)		(Weeks)
Clothing	37	Clothing	18
	24	Other manufacturing	26
	39	Services and other industries	23
Total	100		
Primary textiles	10	Primary textiles	17
	39	Other manufacturing	20
	51	Services and other industries	22
Total	100		
Electrical products	19	Electrical products	17
	47	Other manufacturing	15
	34	Services and other industries	19
Total	100		

SOURCE IT&C, *Labour Tracking Survey.*

than in Ontario? Table 9-11 shows, quite unequivocally, that the answer is Yes. That being said, one should not overlook the fact that the variations attributable to sex, age, and overall labour market conditions (represented by the unemployment rate for prime-age males) can be just as important, if not more so, than interprovincial differences.

These findings must be viewed in perspective; in particular, while the evidence drawn from the IT & C survey points to relatively small changes resulting from freer trade, the consequences could be much worse, particularly in the present recessionary environment, if tariffs and other barriers to trade were removed completely. To what extent, then, can one generalize from the results of the IT & C survey?

This issue concerns the relevance and universality of the evidence. We believe that the evidence is of considerable significance. Nobody is advocating that free trade be implemented overnight; thus massive dislocation and job displacement are not likely. The evidence indicates that if gradual tariff reductions continue to be made along the lines agreed upon during the Kennedy and Tokyo Round negotiations, the layoffs that occur would likely be small, when compared with the total labour force in the manufacturing sector. The number of jobs saved in the manufacturing sector because of protection has been estimated at 40,000 for 1978.[20] Total employment in that sector was 1.8 million in 1978, up 166,200 from 1966, when the Kennedy Round reductions began to be implemented.[21]

* * *

The results of the analysis of the firm and labour market experience in adjusting to greater import competition do not suggest that the "doomsday scenario" – massive unemployment, increased imports without any offsetting increase in exports, and scrapping of plants – is near reality. On the firm side, the most significant findings show that changes in birth rates of new plants dominate changes in death rates in the adjustment process. On the labour side, adjustment is also less traumatic than might have been thought. Indeed, as the Task Force on Labour Market Development remarked, "although the need for labour force adjustment is expected to

Table 9-11

Duration of Unemployment for the Average Worker, Assuming Two Alternative Unemployment Rates, by Age and by Status, Quebec and Ontario[1]

	For workers aged:				
	25 years		45 years	50 years	
Assumed unemployment rate for prime-age males	4.5%	5.5%	4.5%	4.5%	5.5%
			(Months)		
Calculated duration of unemployment:					
Quebec					
Single workers					
Male	2.2	4.0	2.3	3.7	6.9
Female	6.0	11.1	6.5	10.3	19.1
Married workers					
Male	1.5	2.8	1.7	2.6	4.9
Female					
Spouse not working	4.3	7.9	4.6	7.4	13.6
Spouse working	7.1	13.2	7.7	12.3	22.6
Ontario					
Single workers					
Male	1.4	2.2	1.5	2.3	3.9
Female	3.7	6.3	4.1	6.5	10.8
Married workers					
Male	1.0	1.6	1.0	1.7	2.7
Female					
Spouse not working	2.7	4.4	2.9	4.6	7.6
Spouse working	4.5	7.4	4.8	7.7	12.7

1 It is assumed that the worker has an average education (about 9 years) and an average level of skill, was employed 100 per cent of the time prior to the last separation, did not resign, and did not leave the labour force temporarily while he/she was unemployed.

SOURCE IT&C, *Labour Force Tracking Project.*

be great, a review of Canadian experience to date indicates that Canadian workers have substantial ability to adjust" [pp. 192-93]. An important *caveat* must be mentioned with respect to women, older workers, unskilled workers, and those with fewer years of education – all of whom have greater than average difficulty to adjust. On the other hand, most workers do find jobs and display considerable mobility between sectors and between occupations.

Efficiency Implications[22]

An important facet of the impact of greater trade exposure is its implication for efficiency and productivity. Have the predictions of those who believe in the efficaciousness of markets and the competitive process been realized – namely, greater plant specialization, larger plant sizes, plants closer to the minimum efficient size, and increased productivity?

Plant Specialization

One of the most persistent themes of the studies on the Canadian manufacturing industry is that production runs are too short because of the smallness of the Canadian market, lack of competition, tariff protection, and other factors. In other words, the typical plant produces too many different products. If tariffs are lowered, Canadian plants become subject to competition from firms located in other countries, such as the United States. Because they enjoy a larger and more competitive market, these firms are likely to realize all the scale economies afforded by longer production runs. Hence Canadian plants have to adapt to import competition by lengthening production runs and reducing the number of products per plant.

Because of the lack of data, it has been virtually impossible, until now, to come to grips empirically with the question of product diversity. Most of the earlier work, such as that conducted in the late 1960s by Daly, Keys, and Spence on behalf of the Economic Council,[23] relied on the opinions of businessmen and other data gathered by interview, while later work was conducted at the industry, rather than the product or commodity, level. The special data base created for the Council makes it possible, for the first time in Canada, to address the issue directly by measuring product heterogeneity based on actual "census plant" data.

Product diversity and length of production run at the plant level were measured with the use of the industrial commodity classification system, which defines an industry in terms of the products or commodities classified to that industry. Two levels of the industry commodity classification were used to measure diversity, with one system being two to three times as detailed as the other, as indicated by a comparison of the number of commodities per industry used in the two classification levels.[24] The measures of product diversity and production run length attempted to capture both the number of products manufactured in the plant and their relative importance.

Over the period from 1973 (the first year for which the output profile of plants on a product basis is available) to 1979, the average length of production run, measured in 1971 constant dollars at the plant level, across more than 120 Canadian manufacturing industries increased substantially, while product diversity declined by several percentage points as plants became more specialized. Hence, as output grows, plants tend to concentrate on their existing product lines.

In attempting to examine the influence of trade and tariffs on product diversity and length of production runs, a number of different factors were introduced in order to provide the context within which trade and tariff influences can be assessed. In industries characterized by high tariffs combined with high concentration – industries where the impact of trade barriers is often thought to be most pervasive – production runs were shorter and product diversity greater. Hence the tariff in these industries served to reduce efficiency. Exports and imports usually resulted in increased length of production runs and less product diversity, but it was only in the early 1970s that this influence was significant. Tariffs without concentration did not have the same effect in the early 1970s as in the latter part of the decade. Finally, foreign investment had no measurable impact on product diversity and the length of production runs.

Relative Plant Scale

Just as familiar as the concern about short production runs is the problem that plants in the manufacturing sector are too small to realize all the available scale economies; they tend to be smaller than the minimum efficient size. As with short production runs, the tariff, combined with the small size of the Canadian market, is believed to be responsible for this suboptimality problem, and it is thought that trade liberalization might improve the situation.

In discussing plant size, our attention was concentrated upon the size of larger Canadian plants relative to larger U.S. plants. The latter were taken as the indicator of minimum efficient size, since the U.S. market, because of its size and competitiveness, is not subject to the same constraints that result in Canada's scale and specialization problems. At the same time, the geographical closeness of the United States, combined with similar tastes, a common

language, and significant U.S. ownership of Canadian industry, ensures that the U.S. experience is relevant to Canada. Finally, the United States is often used as the benchmark with which to compare Canada's level of productivity.

Our findings on relative plant scale – the ratio of larger Canadian to larger U.S. plants – showed that, on average, this ratio was, across 125 comparable Canadian and U.S. manufacturing industries, approximately 0.7 during the 1970s. Thus there may be a scale problem of some importance if cost disadvantages are related to scale disadvantages, as many suggest. One problem with such average ratios is the implicit assumption that plants larger than MES somehow offset instances where the converse is the case. However, average or unit costs at greater than MES are assumed to be constant. Hence, relative plant scale is re-estimated but is set to unity in all instances where Canadian plants are greater than MES. The resulting averages are approximately 0.6. This suggests that lack of appropriate scale is of much more significance than simple averages imply.

The methodology used in examining the impact of trade and tariffs on relative plant scale is the same as that used above for product diversity. What are the determinants of relative plant scale in 1970 and 1979? How did these factors change over the period? What are the determinants of the change in plant scale over the decade?

Our statistical analysis showed that one of the major determinants of relative plant scale in 1970 and 1979, and over time, is the size of the Canadian domestic market. The larger the market, the greater the value of relative plant scale. The coefficient attached to the market size variable implies that if Canada were to form a bilateral free trade area with the United States, the size of the market adjacent to Quebec and Ontario would raise the mean value of the relative plant scale index to unity; in other words, larger Canadian plants would be, on average, the same size as larger U.S. plants.

In addition, we found that tariffs lead to smaller Canadian plant sizes compared with those of U.S. plants, but only when they are high and combined with high concentration, or with high concentration and high foreign ownership. A decrease in tariffs under such conditions resulted in an increase in the relative plant scale. Exports in those industries in which Canada has a comparative advantage appear to encourage the building of plants closer to the MES. On the other hand, increasing imports reduced plant sizes in Canada relative to those in the United States. A rationalization process appeared to be taking place, whereby plants adapted to import competition either by becoming small and specialized or by disappearing. This could mean that as imports increase, the industry in Canada consists of much smaller plants assembling and finishing semifinished imported products. On the other hand, the result may indicate that government policies are hindering adjustment by propping up an inefficient industry structure. The available evidence does not enable us to distinguish between these two explanations. In sum, tariffs have had the expected impact, but only in a restricted set of industries, while exports resulted in increased plant size relative to the MES. As for imports, they did not result in increased plant size, but they did result in smaller plant size. This is consistent with industry reorganization and specialization. Foreign investment had no measurable impact on relative plant scale.

Productivity

The final efficiency indicator is the level of productivity – the relationship between inputs (plant and equipment, raw materials, workers, and management) and output. Productivity increases when output increases without any change in the level of inputs. Thus it is the primary factor responsible for increases in the real living standards of Canadians, since each unit of output costs less than before.

As with our examination of plant scale, we take the United States as the benchmark against which to measure Canada's productivity performance, in doing our analytical work. Hence, we seek to explain relative productivity across industries in the manufacturing sector by comparing net output per employee in Canada with the corresponding figure for the U.S. industry. Our data indicate that over the 1970s, Canada's productivity, relative to that of the United States, changed only slightly – a result consistent with the findings of other observers. This does not imply that increasing trade or decreasing tariffs had then, or have now, no effect on productivity, because these are only two of many factors influencing the evolution of productivity over this period. And our analysis enables us, as we shall see, to isolate trade and tariff effects despite the absence of such overall changes in productivity.

The impact of trade and tariffs on relative productivity can occur in two ways. First, much of Canada's lagging productivity is considered to be the result of inadequate scale and specialization. Hence, to the extent that trade and tariffs influence relative plant scale and produce diversity, they will have an indirect impact on relative productivity. Second, trade and tariffs may have a direct impact on relative productivity that is not related to scale and specialization or that the variables used to proxy scale and specialization do not capture.

The empirical results show that relative plant scale and product diversity both had the expected impact upon relative productivity: the closer one gets to optimal scale and specialization, the greater is the relative productivity. Hence we find confirmation of the first way in which trade and tariffs have an impact upon relative productivity. This implies, for example, that as market size increases or exports rise, the relative plant scale will increase, causing a rise in relative productivity.

Our analysis also enabled us to assess whether trade, tariffs, and other variables had an influence independent of that which occurred through their effects in creating greater possibilities for exploiting economies of scale and specialization. In general, our findings indicated little additional impact. Two points are worth noting, however. In industries characterized by high tariffs and high concentration, relative productivity was low. This may be a reflection of what economists refer to as "X-inefficiency": although production runs are shorter and product diversity greater in such industries, the lack of competition allows costs to rise well in excess of those implied by the level of relative plant scale and product diversity. Second, the larger the Canadian market, based on the number of efficient-size plants that can be accommodated, the greater the relative productivity, even taking into account the influence of market size on relative plant scale. Indeed, in 1979, where this is found, market size swamps the impact of relative plant scale, reflecting the difficulty in separating the two effects. Hence, to the extent that trade liberalization results in a large market size, relative productivity will increase.

Conclusion

Three conclusions stand out. The adjustment process that firms go through when industries contract or expand is quite different from what we believe is conventionally assumed. On average, natural turnover is very high across industries, with the birth and death rates of firms being surprisingly large. This means that adjustments to changes in absolute and relative industry size could, in principle, occur through changing either the birth rates or the death rates. In practice, changes in birth rates are the dominant route of adjustment. The social costs of this mode of adjustment are less, in our view, than they would be if changing death rates were the main mode. Consistent with this, changing levels of trade and tariffs do, by and large, affect the birth and death rates of firms in the various industries, in the expected directions.

As far as labour adjustment problems are concerned, these also appear to be somewhat less traumatic than could have been the case in principle. The majority of displaced workers find work, mostly in other industries, and the spells of associated unemployment, while not exceptionally short, are not exceptionally long either. That would seem to imply that coping with labour adjustment problems in a constructive way, through policy, may not be as difficult as has been thought hitherto. And these conclusions remain important and useful, in our view, despite the fact that they are based on evidence from the 1970s, when unemployment was much lower than now.

Finally, the data suggest that the productivity gains much touted in the free-trade literature of the 1960s do, in fact, occur. The picture is not simple, and the evidence is not completely clear-cut, but the brunt of it is that lowering trade barriers does, in general, yield higher productivity, larger plant sizes, longer production runs, and lessened product diversity.

10 Future Trade Policy

The threat to growth in living standards resulting from the productivity slowdown makes any income gains from trading more valuable than ever before. Even so, it is far from easy to arrive at a balanced view of the record and the options for Canadian international specialization and trade. At one extreme, some people argue that we have come close to the best of all possible worlds by exploiting the postwar opportunities of reduced trade barriers, which have led to the expansion of trade relative to output, real income, and productivity gains, and to participation in a wide range of exporting and importing activities – though with a net export balance in resource products and a net import balance in highly manufactured goods. At the other extreme, there are those who claim that we have fallen far short of the ideal and that we have done too little in pushing exports of highly manufactured goods; in their view, the record is one of worsening export balances and increasing imports in these goods, and Canada may even face de-industrialization if we do not mend our ways.

Our own interpretation suggests neither of these extremes. Canada has shared in, and benefited from, the increase in trade and specialization that has been boosted by the reduction of trade barriers and other factors such as the vast improvements in communications. Both the export share of Canadian production and the import share of Canadian consumption have risen. The range of goods and services exported and imported by Canada has diversified greatly. Highly manufactured goods occupy a prominent place in this activity, with the balance on these accounts being towards imports, although that effect is not as large as suggested by some highly aggregated statistical classifications. These developments reflect many factors, including the Auto Pact, defence-sharing agreements, trade promotion, the size and structure of changes in trade barriers, the development of world product mandating, the successes and failures in Canadian innovation activity, and so on. Sometimes the effects of these factors are clear; sometimes they are not. It is against this background that we consider the trade policy stance that seems appropriate to us.

Exports

Nearly every country aims at promoting its exports – in particular, those of manufactured products. The basis for such policies and the emphasis that should be put on them within the overall policy setting differ a great deal from one country to another. For those countries which have few resources and little agricultural land, exports (predominantly those of manufactures) are the only way to pay for imports, in particular food and resource products. Other countries have found it difficult to obtain access to, or to build, networks for exports in respect of which they have developed comparative advantages. Some countries see manufacturing as a preferable form of economic structure for themselves but realize that they could not industrialize successfully without export markets for some of their products. While the desire to industrialize is understandable and some of the efforts to do so are worthwhile, there is a widespread tendency to exaggerate the importance of industrialization relative to other forms of development and to overestimate the benefits that accrue from manufactured exports, compared with other areas of specialization and trade.

On the Canadian scene, in particular, there is a school of thought that is very concerned about the dependence of our exports on resources, on the one hand, and about the threat of "de-industrialization" as trade expands, on the other. There are significant risks, in this view, of instability in export receipts through time and of a drop in export earnings over the long term, as resources run out. The proponents of this interpretation hold that export policy should therefore take cognizance of the need to shift the industrial structure of our exports away from resource dependence and to prevent deterioration, in the form of a trend to de-industrialization, in both export-oriented and import-competing manufacturing industries. This would involve the stimulation of types of exports other than resources (even in processed form) – essentially those of manufactured products, since service exports are minor. Often, a preference

for high-technology manufacturing exports is also expressed.

Evidence pertaining to these views was presented in Chapter 8. We showed that the manufacturing sector has performed rather well, on both the export and import-competing sides. Significant changes have occurred, but they could not reasonably be interpreted as showing a trend either towards increased dependence on resources in exports or towards a withering of the domestic import-competing manufacturing industries.

We consider, therefore, that the facts do not justify policy emphasis on stimulating manufactured exports, whether high-technology or not, more than other kinds of exports. Such emphasis would not matter, of course, if it were costless. Since that is unlikely, there is the risk that emphasis on manufactured exports could create a production pattern that would lower real incomes in Canada. This would be the price for significantly moving away – unnecessarily, in our view, for the reasons given – from the exploitation of our present comparative advantages in exporting. Income growth is slow enough at present, and income loss from unemployment is serious enough, that this kind of inefficiency would carry a high social cost. This view does not preclude the possibility that occasional assistance – say, to develop a clearly identifiable infant industry – might be worthwhile at times. Rather than applying any blanket policy, however, each such case should be considered strictly on its own merits. Accordingly,

17 We recommend that government assistance to exports, insofar as it is permitted under Canada's international trading obligations, not discriminate among exports according to whether or not they involve manufactured products. This does not exclude other reasons for assistance, such as the desire to develop infant industries.

By "assistance" we mean not only direct subsidies such as low-interest loans, which are permitted under GATT, but also indirect help through programs, such as those falling within the ambit of industrial and regional policies, that are not explicitly proscribed under GATT but can be appealed. Some examples will help to clarify the scope of the recommendation.

Consider high-technology exports. In the section of our report devoted to technical change, we recommended that projects whose social benefits exceed their private benefits receive government assistance provided they would not otherwise be undertaken. What our Recommendation 17 adds is that any high-technology project that does not meet these two conditions should not be subsidized simply because it may contribute to manufacturing exports; nor should it be given concealed assistance in other forms, such as preferential procurement.

Consider also the subsidies given to firms at a time when they need to become large enough to compete successfully in world markets (the "infant industry" case). Here, subsidies are warranted, not because manufacturing exports are valuable as such but because of the need to break into a market large enough to permit the exploitation of scale economies or of the need to acquire experience in the new field. This may require selling outside national boundaries.

As a final example, consider government subsidies for the promotion of Canadian products abroad. They are warranted when the scale economies in the provision of information to foreigners are such that no individual exporter would find it worthwhile to do his own promotion and government can provide this service at less cost than can private companies. This can occur when consular officials, already in place for diplomatic purposes, have easy access to knowledge that could only be obtained at great expense by private companies. A subsidy is desirable in such situations, not because manufacturing exports are involved but because the social value of a certain activity – the promotion of sales – exceeds the social cost of undertaking it and there is not enough profit in it for private firms.

Imports

In the area of import policy, the issues concern the reduction or removal of trade barriers, the growing volume of trade, and the effects of these developments on living standards, on the industrial structure, and on adjustment costs. As with exports, we do not believe that great concern is warranted over the adverse effects that imports could have on Canada's industrial structure. Consequently, in considering policy on imports, we focus our attention on how best to balance the need to maximize improvement in living standards against the need to minimize adjustment costs as trade barriers fall.

The simultaneous reduction of trade barriers through bilateral or multilateral action increases trade volume and generates increases in real incomes and productivity in Canada. At the same time, adjustment problems arise because workers and businesses have to move out of industries or product lines when products are displaced by imports and into expanding industries or product lines. The latter include not only industries and product lines in the expanding export sector but also those in industries of the nontrading sector, where the demand for products and services is stimulated by the higher real incomes that the growing trade brings about.

An important issue is how best to balance the modest income gains that result, for a large proportion of the population, from lower trade barriers on both the export and the import sides and from a higher volume of trade, against the possibility of heavy transitional losses for a smaller proportion of people. This is not easy to do. Information on the size and nature of the gains and losses would certainly help in choosing the fairest course. Some relevant information was presented in Chapters 8 and 9.

We found in Chapter 8 that the total volume of trade, especially with the United States, has risen considerably over the past 20 years. And we saw in Chapter 9 that this increased volume has resulted in considerable changes in the number and size of firms in various industries. These adjustments have meant that some industries have grown faster than the average, while others have grown slower than the average and some have experienced actual declines. Our evidence showed that when an industry grows more slowly than the average and its relative importance within the economy declines, this usually happens through the least painful route. Typically, there is a decline in the number of births of new firms or plants, with very little change in the death rate. Since "normal" birth and death rates can run as high as 10 per cent a year, quite rapid adjustments in the total size of an industry can be achieved in this way. An industry that is still growing slowly but is nevertheless declining in relative importance because of import competition shows an abnormally low number of new business formations rather than an abnormally high number of business failures.

The situation is a little harsher, but not greatly so, in an industry that is actually contracting rather than just growing more slowly than average. Here, the death rate of plants does rise above normal levels, but the adjustment still occurs mainly through a decline in the birth rate.

The corresponding situation, from the point of view of workers, is that foreign competition usually involves the failure of new jobs to appear at the normal rate rather than a rise of redundancies above their normal level. Plants do close, and workers do find themselves on the street, but the numbers are much smaller than they would be if adjustments occurred mainly through rising death rates of firms rather than through falling birth rates. Understanding this mode of adjustment is clearly relevant to one's assessment of the seriousness of the adjustment process as a human and social problem.

Upon examining the evidence on the adjustments that workers themselves have had to make in response to redundancies in trade-sensitive industries, we discovered that about two-thirds of workers find new employment within a few months. The majority find jobs within three months, and the great majority within eight months. A substantial minority of displaced workers fare much worse, however, and do not find work within a reasonable period of time. About one-third of those made redundant are in this situation. Half of them withdraw from the labour force altogether, while the other half remain unemployed for a year or more. Older workers (those over 55 years of age) are more than twice as likely as the average to join the ranks of the long-term unemployed, and women are half as likely again as the average. This evidence relates to the 1974-77 period (see Chapter 9), when unemployment was much lower than it is now. It is important to be aware of this, as adjustment can be expected to be much harder during a deep recession than at other times.

Looking at the efficiency gains from increasing trade volume and declining trade barriers, we found evidence that the changes of the past decade have led to increasing specialization, lengthening production runs, and a partial convergence of plant sizes in Canada to the more efficient levels observed in the United States. This suggests that significant gains have recently been made in efficiency and real income levels as trade has increased. How big the gains are is not known with any precision. Had total and mutual elimination of trade barriers already occurred between Canada and her trading partners, it is estimated that the gains would have been between 8 and 15 per cent of GNP during the 1970s.[1] As the Tokyo Round of tariff reductions comes into effect, the gains to be expected from further tariff reductions will, naturally enough, be somewhat less than those estimated for the 1970s. Although these gains may not appear to be very impressive, they are very large both in comparison to what other feasible policies might achieve and in absolute terms. They are the equivalent of what used to take roughly between four and eight years to achieve through productivity growth.

With this background, we shall consider policy on adjustment, and then policy on the appropriate degree to which income gains should be exploited, if at all, through further reductions in trade barriers.

Adjustment Assistance

When considering the evidence on adjustment as a whole, we believe that it warrants some small but significant modifications to the present policy on compensation and assistance to those who suffer most during any move towards freer trade. The adjustment process is not as difficult for firms as many had anticipated, but it could require a fair

amount of new investment. Although a large proportion of the expected financial needs could be met through existing channels, the government might stand ready to assist in meeting the peak demands for investment capital that would emerge in any more rapid trade liberalization. Some of the types of programs required to assist the adjustment process are already in evidence (including some of those discussed in Chapter 6). In a previous report on Canada's trade policy, this Council noted that there was then (1975) a bewildering variety of loans, grants, technical assistance programs, and eligibility conditions, which made it difficult for individual firms to become familiar with all the programs for which they qualified.[2] Moreover, there were often long delays and uncertainties between the time of application for assistance and the time of actual receipt. Some progress has been made in simplifying the process, but more could be done. Therefore,

18 We recommend that the wide variety of existing programs for assistance to industry continue to be re-examined, with a view to further reconciling their objectives and simplifying eligibility conditions and provisions for assistance. This review should also focus on the degree to which there remains a need for further increasing assistance to business firms as the country moves towards freer trade – for such positive adjustment purposes as the expansion of distribution networks for exports and the financing of shifts to new product lines, new facilities, and new locations.

For workers, the problems are more serious than for firms. And these problems will remain, even if every attempt is made, by implementing Recommendation 18 and by other means, to minimize the need for adjustment by workers through positive adjustment measures aimed at industry. Unemployment is never pleasant, even though it does not last more than a few months for the majority of the people who are displaced in the trade-sensitive sectors; it is, however, a very serious problem for about one-third of those displaced. Substantial assistance is their right. And, in some cases, direct assistance may be required for the communities in which displaced workers live.

There has been considerable improvement, in recent years, in the programs designed to meet these needs. Apart from the general social safety nets (notably unemployment insurance), the recently instituted Industry and Labour Adjustment Program (ILAP) goes a long way towards helping those who are displaced by economic change of any kind, including that caused by increased import competition. We note that work is under way at the Department of Employment and Immigration to improve occupational demand forecasting; the labour adjustment component is what concerns us here. In addition, training allowances have been made available to firms and workers; a direct job-creation program component has been instituted for workers in designated communities whose unemployment insurance benefits have run out; a portable wage subsidy can be obtained by workers aged over 45; and mobility allowances have been generously increased.

In our view, ILAP already does much of what we think should be done, and what we have to say is not a criticism of this program. Rather, we wish to go beyond it and to take into account the special case of workers who suffer long-term unemployment specifically as the result of policy-induced import competition. Our reasons for wanting special compensation in such a case combine principle and practicality.

On the principle side, we believe that if a policy deliberately used to benefit the majority also penalizes a small minority, then the latter deserves compensation, as well as help in finding work. A policy aimed at relaxing trade barriers, as presently envisaged as part of Canada's future commitments under GATT, is precisely of the kind that necessitates this form of compensation. For this reason, the extra funds for such compensation should come from general taxation – i.e., at the expense of the gaining majority.

As far as practicality is concerned, we wish to remove, as far as possible, roadblocks in the way of the substantial gains that are available to the majority of the population as a result of freer trade. One such roadblock would be the understandable opposition from the small minority who, by becoming unemployed for a long period of time, would stand to lose a lot from freer trade. Compensation in the form not just of vigorous efforts to help them find new jobs but also of direct maintenance of their incomes until they find work could be a practical and valid way to lessen this legitimate opposition. Finding a new job is most important, to be sure; but income preservation in the interim is also desirable. Such income preservation should be more generous than is possible through the present unemployment insurance system, which in any case does not cover everyone who is displaced. It should also last much longer – perhaps until a new job is found. Compensation to this extent is not available under ILAP.

On the same grounds of policy-induced change warranting special compensation, we believe that more generous help in finding work should also be given. For example, the special increased training allowances and the portable wage subsidy might be made available to *all* long-term unemployed workers,

if they are the victims of policy-induced trade competition, rather than to just some of them, as at present. Bearing all these considerations in mind,

19 We recommend that, in addition to the assistance presently available, special assistance in the form of both direct income payments and help in obtaining new work be given to those of any age, in any industry or location, who, after losing their job for reasons among which policy-induced competition from imports played a significant role, cannot find work within a reasonably short time.*

The main difficulty with this recommendation is in devising administrative procedures that can successfully define who is qualified to receive help in time for the help to be valuable. Some experience has already been gained under the pre-retirement benefit program aimed at those in the textile, footwear, tanning, and clothing industries. It would be a matter of establishing an on-going investigation program to examine all permanent layoffs with a view to discovering whether the production of the firms concerned was subject to increasing import competition, whether the firms were losing business at least in part because of that, and whether the increase in competition was, at least in part, the consequence of policy actions aimed at reducing trade barriers. This could perhaps be undertaken, in part, by the Labour Adjustment Review Board. The difficulty in interpreting the results of such an investigation might be eased by erring on the side of generosity, especially when particular communities are strongly affected. The total number of people affected is small enough that the cost to the country of substantial per capita assistance would be much less than the gains that it would receive through the increase in trade, even if there were a significant risk that assistance might be granted to some who, on a very strict accounting, would not qualify for it. As noted above, we are not so much recommending new assistance programs but rather that existing benefits, such as those under ILAP, be more generous to a certain group of people.

An objection might be raised against Recommendation 19 on grounds of equity. It could be argued that all workers, irrespective of the reason for layoff and prolonged unemployment – recession, change in consumer tastes, technological change, or import competition – should be entitled to the same benefits. This equity argument has merit, but we believe that special assistance to trade victims can be justified if the damage is known to be the result of deliberate policy. In effect, the majority should compensate any group that it insists should make sacrifices for the greater good. The steps recommended should be financed by the gainers from trade through an increase in general taxation.

If those who are hurt seriously can be aided selectively through ILAP and through the implementation of Recommendation 19, one might think that it would be possible to achieve income gains for the majority of the population by hastening the multilateral or bilateral reduction of trade barriers, relative to the pace determined under GATT. After all, as we have seen, the adjustment problems for the remaining workers and for the firms, are not so daunting. Unfortunately, the situation is not quite that simple.

The Gains from Trade Barrier Reduction

At the time of writing, Canada is experiencing its highest unemployment since the Depression. Under these circumstances, reducing trade barriers any faster than planned at present would be very hard to justify. At the same time, it would be equally hard to justify a slowdown in trade barrier reduction, as some have advocated in the face of the persisting recession. Not only might such a course contribute to a trade war and lead to a rejection of the hard-won gains that have resulted from years of general trade barrier reduction, but those who maintain that threatened industries and workers should be shielded from the present pace of adjustment do not have a monopoly on morality in this area. The majority, who are feeling the pinch in private consumption from eight years of slow growth, are also entitled to fair treatment under economic policy.

The new evidence presented in Chapters 8 and 9, which pertains to the 1970s, is highly relevant to these issues. The implication of our findings is that faster trade barrier reductions could have been justified, since the reductions that were planned for and made were probably based on unduly pessimistic predictions about adjustment costs. Moreover, in the face of the productivity slowdown, it is now more urgent than before to achieve the real income gains that trade can provide, as confirmed by our evidence. On the other hand, the present high unemployment makes adjustment costs higher today than they were in the 1970s, since unemployment then was much lower.

Balancing all these considerations is a judgment call. Our judgment is that the new evidence and the urgency of achieving income gains for the majority jointly offset, at the present time, the effects of the

*Mr. Hickey has registered a dissent with regard to this recommendation. Mr. Kaplansky has also expressed some reservations about Recommendation 19, and these have been endorsed by Mrs. Goldenberg and Mr. Dalpé. Dissents and comments appear after Chapter 10.

recession in increasing the seriousness of adjustment problems, compared with earlier periods. We think, therefore, that Canada should stay firmly committed to its current plans for reducing barriers to trade under GATT. As a corollary to that belief, we urge that temptations to institute new nontariff barriers, even without breaking the GATT rules, be strenuously resisted. Accordingly,

20 We recommend that the federal government remain committed, for the time being, to present plans for reducing trade barriers under GATT and that it resist the temptation to create any new nontariff barriers.

This recommendation is not otiose. Even holding the line on present plans means that tariffs will continue to come down, generating income gains and adjustment problems. Pressures have arisen lately to slow this process down, particularly through the erection of new nontariff barriers or the strengthening of existing ones. Our view is that the balance of advantages lies with sticking, for the time being, with the rate of liberalization previously planned for.

Our evidence shows that once the recession is over, there will be a strong case for faster reduction of trade barriers. Consequently, Canada should then seek opportunities to review its present policy and to hasten the pace of barrier removal. Accordingly,

21 We recommend that as soon as clear evidence exists that the current recession has ended, consideration be given to accelerating the process of reduction of both Canadian and foreign tariffs and nontariff barriers.

Despite much progress in recent decades, many tariffs are still quite high. And nontariff barriers are quite severe. Both kinds of restriction on trade deprive Canadians of substantial potential income gains that, we have argued, will be more than enough, as soon as Canada enters a less recessionary economic period, to offset the adjustment costs involved.

* * *

We conclude on a note of guarded optimism – so guarded that it almost shades into pessimism. We began this report by pointing to three ferocious economic problems that Canada had to face over the past decade. Inflation, we said, is coming down. As we go to press, there are also faint but encouraging signs that the deepest recession since the 1930s may be subsiding.

But the productivity problem persists. Productivity has not grown for eight years.

When the recession does end, sooner or later, there will be a burst of productivity improvement, leading to substantial gains in living standards. These gains will supplement the even larger income gains that will come from moving closer to full employment and that would obtain even if productivity levels remained unchanged. As yet, however, there is no sign that the full-employment productivity level of the economy will resume the steady enriching growth that was so characteristic of the 1940s, 1950s, and 1960s. The possibility that this was a halcyon but transient span of rapid productivity growth cannot be ruled out. The consequences, measured in distributional problems and in forced revisions of expectations, could be profound.

What we have offered in this report is not a permanent cure for this problem. We do not know enough about the productivity slowdown to provide that. But we have described ways to cope with the slowdown for several years. Two broad kinds of policy have been suggested. First, significant productivity improvements can be made by revising government policies that affect the process of technical advance. We have stressed the need not only to do more R & D but also to speed up the adaptation and diffusion of new technology. We have stressed the need to broaden policy perspectives and to look at the service sector as well as the goods-producing industries, at nonmarket industries as well as market industries. And we have stressed the need to apply economically efficient criteria in deciding when, where, and how to provide government assistance to technical advance. Second, multilateral trade barrier reduction can continue to improve living standards and should be permitted to do so. Moreover, when the recession ends, the opportunity should be seized to accelerate the gains in living standards that will come from this source.

If our policy recommendations are adopted quickly, we are optimistic about living standard growth for several years to come. Our optimism is guarded, however, because delay for a short time could well mean delay for a long time. As the recession ends, income growth will be so large for a while that a sense of urgency about the need to safeguard growth over the longer term, through detailed policy revisions in the areas of technical advance and trade, may well be lost. Yet the need for these policies will not have been eradicated simply because we will have emerged from the recession. The best of all worlds would be to have these policies as well as an end to the recession; yet we fear that this may not happen and that the good will become the enemy of the best.

Comments and Dissents

*Comment by Mr. Kaplansky**

Although I still have reservations about some aspects of the report's emphasis on measures to stimulate productivity, I am particularly concerned that it has not paid sufficient attention to the human element, to problems of industrial relations, to meaningful consultation and to the need for effective programs now to ease the burden of change on particular individuals or groups.

Technical advance and trade concessions cannot be viewed in isolation from such problems. Certainly they could lead to a loss of employment and income, perhaps for fairly extensive periods and for fairly large groups. The individuals who are most susceptible to such hardship are the poorer segments of society – women, older age groups, and the less skilled. It is extremely difficult, frequently impossible, to find alternative employment for them and/or retrain them.

It is sometimes argued that the above problems are more imaginary than real. I disagree. These are real problems for the people and areas affected. True, adjustment is less of a problem during periods when aggregate demand is high, unemployment is low, and the economy is growing. But such is certainly not the case today.

To mitigate the hardships caused by technological change and trade concessions, it is imperative that there should be a great deal of planning well before the changes are introduced rather than after firm commitments are made. Such planning should include programs for retraining, mobility grants, alternative job opportunities and, most important, ongoing consultation with the groups which are going to be affected.

Dissent by Mr. Hickey

Recommendation 19 would provide special assistance in the form of additional income, training or placement to individuals who have lost their job "for reasons among which policy-induced competition from imports play a significant role, (and who) cannot find work within a reasonably short time." I can appreciate the sense of genuine concern for men and women who have spent many years in an industry and find themselves without work or adequate income or alternative skills to adjust to other opportunities. But I find the recommendation, in its present form, disturbingly imprecise and I question much of the rationale for it.

In a changing and competitive society, continuous employment cannot be guaranteed. In Canada, as elsewhere, the foundations of income security are built first on the labour force participation of more than one family member, and then on the combination of unemployment insurance which, now that it has been extended to farm workers has virtually universal application with the exception of the self-employed, social assistance and the various manpower and employment programs administered at federal and provincial levels. This recommendation would give extra income and assistance to a special group, the long-term unemployed, without demonstrating that the existing services and entitlements to them are sufficiently inadequate as to justify special treatment.

While the recommendation is phrased in a general way, the argument for it focuses more narrowly on those who are displaced as a result of trade policy initiatives. This somehow presupposes that those who are thus displaced are in a worse situation than others in Canada who lose their jobs because of business competition, domestic technological change, or, for that matter, from foreign trade competition which evolves without changes in government trade policy. This worse condition remains to be demonstrated. Moreover, the recommendation, if adopted, could lead to a host of demands for special treatment with individuals seeking additional compensation based on some direct or indirect linkage to trade policy. This is because trade policy not only involves initiatives to increase trade, but also to resist protectionist pressures. Does a trade strategy of

*Mrs. Goldenberg and Mr. Dalpé wish to be associated with Mr. Kaplansky's comment.

firmly rejecting additional tariff or non-tariff barriers justify additional special income and other assistance for those who become unemployed? I believe it would be distasteful to most Canadians to have some unemployed, however much in trouble, accorded special treatment over other Canadians equally in trouble just because of a trade-related cause. Moreover, I think it is naive to suggest that the attendant horrendous administrative difficulties of determining who would or would not qualify could be resolved case-by-case by a centrally-located Labour Adjustment Review Board.

Much of the rationale for the recommendation lies in the accompanying assertion that as a general policy "the majority should compensate any group that it insists should make sacrifices for the greater good." As a general proposition this position has some validity, but in practical terms, it breaks down on many fronts. For instance, should smokers be compensated for not smoking, organized labour for not striking, management for observing health and safety practices, and other individual groups for respecting regulations adopted for reasons of the public interest? Universally applied, this principle could mean that there would be virtually no group without some special claim on the resources of the governments. In my view, the numbers of individuals and enterprises enjoying separate and special entitlements is already sapping the individual initiative and sense of self-reliance that has built this country; and just as in an earlier recommendation, the Council calls for a re-examination of various industry assistance programs with the view to achieving greater uniformity and simplification, so I believe it should assert the use of unemployment insurance and other existing assistance programs, modified if necessary, rather than generating new assistance programs.

Finally, there is the matter of cost. We are on the point of coming out of the worst recession in half a century, with its tremendous financial pressure on governments. The argument supporting Recommendation 19 suggests that, if implemented, the additional costs would be relatively trivial. But given that the recommendation includes not just those displaced by trade policy, however interpreted, but all those who "cannot find work within a reasonably short time," the cost implications for governments are not trivial. Each month, for instance, over 50,000 unemployment insurance recipients exhaust their benefits and each year about half a million Canadians are unemployed for more than 6 months. Without gainsaying the difficulties confronting these people, and their need for assistance, we would be ill served to believe that the remedial costs would be light.

Dissent by Mr. Lortie

The issues raised in this Council's report are both timely and important for Canada. One cannot stress too much the need to restore productivity growth in order to improve the living standards of Canadians. This country has a remarkable track record of caring and sharing; however, one must face the fact that the pursuit of such policies encounters increasing resistance when the size of the pie remains static. Thus, dedication to the goal of restored productivity growth is in the best interest of all Canadians.

The evidence presented in Chapters 1 and 2 on the slowdown of productivity growth in Canada during the last decade illustrates the severity of the problem confronting us. The fact that so much of this slowdown remains unexplained is perplexing. The discussion of the plausible explanations put forward illustrates the complexity of advanced economics.

In the section analysing productivity growth, the report limits its discussion of taxation and welfare programs to the question of the effects of personal taxation and welfare programs on the worker ethic. With respect to this narrow question, many disagree, and I myself suspect that the effects are more significant than suggested. More importantly, however, it is necessary, in my view, to look broadly at the relationships between taxation, welfare programs, and total factor productivity growth. There are many direct and indirect ways in which taxation and welfare programs may affect productivity growth. I note that the Economic Council is now engaged in a study of taxation and the treatment of capital income. There is no doubt in my mind that these issues are most worthy of further investigation and that they are relevant to future productivity and income growth.

To illustrate the importance of a broader approach, let me raise some specific issues concerning these relationships. The report indicates that once an individual is at the workplace, he or she will not be more or less dedicated in the accomplishment of his or her task because of the rate of taxation. This is fine and good, but the fact remains that first, the individual must show up at work, and second, such work must exist. Earlier work by the Council shows quite conclusively that differentials in personal tax rates, support programs, and the level of government services influence migration in this country. Observation of a substantial displacement of mobile business activities between certain large centres in Canada in response to tax differentials also bears upon this point. And what about the generation of funds for risky ventures and the launching of new firms, which depend on the amount of funds available and the net-of-tax rewards derived from such activities?

As a member of the Council, I was very pleased to learn that the Council would publish a report on the subject of technology. Certain findings of this report are very useful, and they provide a good basis for some policy initiatives. In particular, I would stress the importance of the following:

- Govenment policies should place considerably more emphasis than in the past on the transfer, diffusion and adaptation of new ideas, products, and processes, wherever they originate.

- There exists an urgent need to increase the rate of innovation in the non-market sectors of our economy. Given the relative tranquility of such sectors, shielded as they are from competition, vigorous policies should be pursued to ensure that productivity within them will increase in tandem with that in other sectors of our economy.

- Multinational firms are responsible for a substantial amount of the transfer of new technologies occurring worldwide. This fact has heretofore not been given sufficient recognition in Canadian policies concerning foreign investments.

On this latter point, I believe the report does not go far enough. Since the second World War, Canada has played a major role in the development of the present international trade environment and institutional setting. Our earlier liberal policies with respect to trade are contrasted, however, with a relatively recent restrictive stance towards foreign investments. Yet, in this day and age both trade and foreign investment are but two faces of the same coin. The fact that over 50 per cent of Canada's trade in manufactured products with the United States is intra-firm furnishes ample evidence of the significance of this phenomenon. Such considerations and the results of the research call for a serious reevaluation of the premises which underpin the now ten-year old policy concerning foreign investment in Canada. Thus, I do not think recommendation 6 and other related analysis suggest the appropriate course for future action. In my view, the Council should have been more sanguine about the importance of foreign investment in Canada, as well as critical of the appropriateness of the Foreign Investment Review Agency.

The report makes some valuable points and provides useful evidence about certain aspects of the generation and diffusion of technology in Canada. Regrettably, it suffers from shortcomings, and consequently, it does not constitute a balanced contribution to an understanding of the innovation process in Canada. There pervades throughout the text, notably in Chapters 4, 6 and 7, an obvious bias. In my opinion, Canada would be worse off if several of the policies on technology put forward in this report were adopted.

These shortcomings of the report stem, in my view, from a failure to provide, or to rely on, a good conceptual model of the innovation process and, second, from a lack of understanding of the working of firms and technological markets. For instance, Chapter 4, "The Generation of New Technology," is primarily organized around Schumpeter's work. In my opinion, especially promising insights into the innovation process come from more recent work, that of W. J. Abernathy and J. M. Utterback, for example.

These two authors have developed a descriptive paradigm of the dynamics of the innovation process in order to explain differences in outcomes at the level of the firm or of industries. They distinguish "between product and process changes, and between innovations which require change in many facets of the firm and those which require only modest change."[1] A major characteristic of their model is that it conforms to one's experience of the innovation process in the business world and to the behaviour of firms. Their findings lead to the conclusion that, given the dynamic nature of technological innovation, governments will have different effects on innovation, depending upon the particular stage at which a firm or an industry is in its development. As a result, their conceptual model identifies many different kinds of government policies required to cover the total spectrum of innovation activities. In my view, relying on such a broad model would lead to a more comprehensive guide to future policy actions.

Admittedly, the report acknowledges in Chapter 4, that "other factors influencing the generation and use of new technology" have been the subject of substantial research in other countries. It is unfortunate that after three years of study on technology the Council was unable to incorporate the conclusions of this work into its own analysis and policy prescriptions. The irony is that the Council is publishing a report promoting the virtues of diffusion of technology and knowledge from whatever source, while it fails to live up to this requirement!

Other shortcomings in the report concern the section on contracting-out policies. The section in Chapter 4 entitled "The Federal Contracting-Out Policy" is based on a study by A. B. Supanol and D. G. McFetridge called "An Analysis of the Federal Make-or-Buy Policy." The study provides a good quantitative evaluation of the behaviour of various

1 W. J. Abernathy and J. M. Utterback, *Technological Innovation in a Dynamic Economy* (New York: Pergamon Press), 1979.

federal government departments in response to the adoption of the make-or-buy policy. However, in my opinion, the study cannot be used to make a judgment about the impact of the policy on the diffusion of innovation in the Canadian economy, for the reason that such an evaluation was not done. The policy implications are not substantiated by evidence. For example, one need only look at the impact of the buy policy of Hydro-Quebec on the structuring and emergence of Quebec-based engineering consulting firms, which are competitive and have a strong presence in world-wide markets. Also, a causal link between contracting-out in the United States in the 1950s and 1960s and the start-up of new technological firms (such as those in the Boston or Palo Alto areas) is well documented. Moreoever, the notion that a make-or-buy policy might have a "structuring" or "de-structuring" effect on a particular industry was not considered. A better understanding of the dynamics of firms and industries in technological markets would have led to recommendations taking into account the benefits derived from an active make-or-buy policy. Regrettably, this was not the case. Consequently, I reject recommendation 14 since it does not rest on a fully informed assessment of the impact of a more rigorous contracting-out policy.

In addition, I cannot support recommendations 9, 10, 11, 12 and 13. These are derived from the analysis contained in "Government Assistance to Technical Advance" in Chapter 6. This analysis leads to Byzantine conclusions and recommendations.

The report attempts to establish the rationale for government support to R & D activities. This is a legitimate issue. The consensus is that government support is warranted because part of the benefits of innovations and advances in knowledge will occur generally in society and the original performer will not reap the total return from its activities. The amount of R & D that will be performed when relying solely on the market mechanisms will be below the socially optimal level. Government support is required to push the level of R & D activity closer to the optimum.

The report accepts this rationale for government support. However, it adds a new twist to the argument by contending that this wedge between the private and social optimum can, and must, be ascertained precisely for each project. Building on this premise, it goes on to evaluate each government subsidization program against that benchmark and suggests that programs should be administered accordingly. In my opinion, the logical conclusion of the analysis in Chapter 6 is the termination of government subsidy programs supporting R & D activities. Government assistance to R & D can be delivered through other mechanisms, including tax incentives. Such a conclusion is not offered as a palatable alternative in the report. Instead, the recommendations embody an approach which, in the final analysis, would obstruct the management of the innovative process in firms, as well as the delivery of these subsidies by governments. One cannot but despair that such "Alice-in-Wonderland" thinking would rapidly lead to a nightmare of bureaucratic hurdles, as well as to a web of requirements quickly defeating the very purpose of the programs. Moreover, I believe the analysis is too narrow in scope to provide a basis for policy prescriptions.

First, the assessment of the various programs does not include consideration of an evaluation by their users. It is noteworthy that an independent survey has shown that programs judged to be successful in the report fare very poorly when evaluated by the potential target firms, and vice versa.[2] A serious evaluation would have attempted to understand the reasons for such discrepancies.

Second, a better understanding of the realities faced by firms and of the innovation process would have recognized that a subsidy is equivalent to an infusion of equity capital. In *Intervention and Efficiency*, the Council said that there exists an imbalance in the capital structure of small and medium-size firms in Canada. Yet, small new ventures appear to introduce a disproportionate share of product innovations that create major threats to existing markets. The relevant policy question is: How do we nurture and accelerate this process in Canada? Japan has the most complete set of government programs to aid individual inventors, entrepreneurs, and new-high technology firms. One of the most important characteristics of these programs is the variety of ways in which new small firms are offered assistance for the start-up phases of new ventures. This should have been taken into account in the report.

Third, thought has not been given in the report to venture capital, as well as to the financing of R & D activities and of new innovative firms in Canadian capital markets.

Fourth, serious discussion has not been made of tax incentives for R & D activities and, more generally, of the taxation of start-up and risky ventures. For instance, a major factor influencing the survival of small firms is the tax treatment of the losses incurred in their early years. The Council has already made a recommendation on the subject in *Intervention and Efficiency*, which was substantially adopted by the

2 Pierre Lortie et Roger Miller, *Le défi technologique*, Ordre des ingénieurs, Montréal, 1979.

government in its last budget. This report does not take into account such down-to-earth considerations as the balance sheet of the innovative firm. In this respect, the April 1983 Paper for Consultation entitled "Research and Development Tax Policies" holds much greater promise for the future performance of the Canadian economy.

Finally, the value of this report would have been enhanced by other, more practical suggestions. For example, the report demonstrates convincingly that there exists a serious lag in the diffusion of innovations across the country. The pattern appears to be consistent and largely independent of a particular innovation. Why is this? To what extent does the relative weakness of truly national trade associations in Canada account for such delays in the adoption process? Canada is a very large country. The costs to a business person located in the Atlantic Provinces of attending seminars, meetings in Central Canada are substantial. To what extent do such factors account for our problems? What policies could be adopted to bridge this "fractionalization" or "segmentation" of the Canadian economy and thereby substantially increase the flow of technical information within various business sectors?

No new government bureaucracy is required to accomplish such objectives. In this respect, France has reaped significant success with its cooperative research institute program, launched several years ago. Funds are generally applicable to the industrial sector and to transfer information and knowledge to firms. Some of these cooperative institutes have taken up the role of "gatekeepers" for the firms in their trade association, alerting these firms to new developments from around the world that may be of use to them. Apart from such a model, given the particularities of Canada, the desirability of attending trade or technical seminars would be enhanced by better treatment for tax purposes. Consequently, recommendations 4 and 5 should not be limited to the service sector.

Another shortcoming is provided by the analysis of the Patent System and recommendation 7. Clearly, some of the points raised in the discussion are well made. However, one would be more convinced about the adequacy of the "solution" put forward if the evaluation of the Technical Information Service were more vigorous and less self-serving. Moreover, what about the fact that the majority of engineering and science students do not even know how to conduct a patent search! Could it be that a significant step forward would simply consist of making the acquisition of such a skill mandatory in scientific and technical disciplines?

In summary, this report presents new evidence and puts forward some interesting points concerning technology that should be integrated into government policies. Regrettably, these positive notes are much too few. In the areas mentioned above, I do not believe this report offers correct advice to governments on how to improve the innovative process in Canada.

Recommendations

1 We recommend that federal and provincial policy towards technical change put greater emphasis on a) the adaptation of new ideas, products, and processes already in use abroad but not in Canada, and b) the diffusion of new ideas, products, and processes, wherever they originate, to other firms and regions in the country subsequent to their first successful application.

2 We recommend that provincial governments allocate funds to provide information that would speed up the efficient adaptation of new techniques of operation, whatever their country of origin, as well as the diffusion of existing best-practice techniques of operation within Canada, in the nonmarket industries that fall within provincial or municipal jurisdiction – mainly the hospital and medical-care, education, and public-administration sectors.

3 We recommend that the federal Treasury Board reinstate previous requirements for departments to provide productivity comparisons within federal government operations across the country and that it use this information, as well as information gathered from abroad, in a renewed effort to spread best-practice administrative techniques for the federal government across the nation.

4 We recommend that trade associations in the service sector adopt as one of their primary responsibilities the collection and dissemination to member firms of information on new ideas and best-practice technology and management methods in use in Canada and abroad.

5 We recommend that government financial assistance be provided to service trade associations specifically for the purpose of spreading and diffusing to their members information on best-practice technology and management methods, whether found in Canada or abroad and whether resulting from R & D or not.

6 We recommend that the Foreign Investment Review Agency give considerably greater importance to the introduction of new technology and the enhancement of productivity, when considering applications for new investment by foreign corporations.

7 We recommend that the Patent Act be amended in order to give the Patent Office a mandate to establish and operate a patent technical-information service to promote innovation in Canada.

8 We endorse the federal government's target of raising R & D spending to 1.5 per cent of GNP by 1985, considering this a minimum requirement; and we recommend that the target be disaggregated by industry.

9 We recommend that subsidies be awarded to technical innovation projects only when two conditions are met:

a) the projects must be worthwhile to the country; and

b) the subsidies must be necessary, in the sense that the projects would not provide a reasonable profit without them.

10 We recommend that subsidy program administrators ascertain that subsidized projects are incremental not only to the firm but also to the industry to which the firm belongs.

11 We recommend that greater care be taken, when assessing the benefits of projects that are actual or potential recipients of R & D subsidies, to evaluate the incrementality of the jobs created.

12 We recommend that there be two categories of subsidies in the Defence Industry Productivity Program. The smaller category should include subsidies for specific projects that meet the two conditions that apply to innovation projects subsidized under other programs. The larger category of subsidies should be aimed at keeping in the defence production field certain firms that are deemed essential but that might otherwise wish to leave it because of insufficient profits. The subsidies should be calculated to offset this insufficiency.

13 We recommend that where the object of a Defence Industry Productivity Program subsidy is to ensure that the recipient firm will remain in the defence production industry, an appropriate board, responsible to Parliament, be created to oversee the relationship between the firm and the subsidy program.

14 We recommend that enforcement of the federal contracting-out policy be confined to those departments and projects where contracting out can be expected to bring net benefits.

15 We recommend that the practice of setting performance standards rather than material specifications

be more widespread. Federal departments, whenever possible, should define the ends and leave the technical means by which performance standards are met up to the firm(s) involved in the project. The extent to which this is possible will be constrained by the need for co-ordination when more than one firm is involved in a project.

16 We recommend that the Program for Industry/Laboratory Projects of the National Research Council be broadened explicitly to include transfers of know-how from the universities to industry.

17 We recommend that government assistance to exports, insofar as it is permitted under Canada's international trading obligations, not discriminate among exports according to whether or not they involve manufactured products. This does not exclude other reasons for assistance, such as the desire to develop infant industries.

18 We recommend that the wide variety of existing programs for assistance to industry continue to be re-examined, with a view to further reconciling their objectives and simplifying eligibility conditions and provisions for assistance. This review should also focus on the degree to which there remains a need for further increasing assistance to business firms as the country moves towards freer trade – for such positive adjustment purposes as the expansion of distribution networks for exports and the financing of shifts to new product lines, new facilities, and new locations.

19 We recommend that, in addition to the assistance presently available, special assistance in the form of both direct income payments and help in obtaining new work be given to those of any age, in any industry or location, who, after losing their job for reasons among which policy-induced competition from imports played a significant role, cannot find work within a reasonably short time.

20 We recommend that the federal government remain committed, for the time being, to present plans for reducing trade barriers under GATT and that it resist the temptation to create any new nontariff barriers.

21 We recommend that as soon as clear evidence exists that the current recession has ended, consideration be given to accelerating the process of reduction of both Canadian and foreign tariffs and nontariff barriers.

Appendixes

A Tables to Chapter 6

Table A-1

Program for the Advancement of Industrial Technology: Summary Data on Subsidies, by Recipient Industry Group, 31 March 1975

	Estimated total cost of projects	PAIT commitments		PAIT expenditures	Projects		Average PAIT commitment
		Amount	Distribution		Number	Distribution	
	($ Thousands)		(Per cent)	($ Thousands)		(Per cent)	($ Thousands)
Mines	27,254	13,628	5.8	7,909	23	2.6	593
Gas and oil wells	12,818	6,409	2.7	5,343	6	0.7	1,068
Food and beverages	9,185	4,564	1.9	2,337	53	6.1	86
Rubber	1,076	538	0.2	300	9	1.0	60
Textiles	6,289	3,274	1.4	2,114	18	2.1	182
Wood	2,463	1,232	0.5	972	10	1.1	123
Furniture	350	175	0.1	144	2	0.2	88
Paper	11,751	5,853	2.4	3,328	26	3.0	225
Primary metals (ferrous)	13,222	6,612	2.7	3,880	18	2.1	367
Primary metals (nonferrous)	5,035	2,516	1.1	1,289	9	1.0	280
Metal fabricating	16,429	8,133	3.4	4,712	61	7.0	133
Machinery	99,086	49,522	20.9	18,897	140	16.1	354
Aircraft and parts	26,213	13,883	5.8	11,973	15	1.7	926
Other transportation equipment	26,650	13,189	5.5	7,495	52	5.9	254
Electrical products	119,794	60,757	25.7	43,417	139	16.0	437
Mineral products	6,005	3,002	1.3	1,760	19	2.2	158
Petroleum products	2,582	1,292	0.5	862	4	0.5	323
Drugs and medicines	5,313	2,657	1.1	615	14	1.6	190
Other chemical products	36,122	17,494	7.4	8,868	70	8.0	250
Scientific instruments	11,317	5,833	2.4	4,711	47	5.4	124
Other manufacturing	9,863	4,947	2.1	3,175	67	7.7	74
Utilities	8,732	1,842	0.8	1,173	13	1.5	142
Nonmanufacturing	17,066	10,278	4.3	7,781	57	6.5	180
Total	474,615	237,630	100.0	143,055	872	100.0	273

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table A-2

Program for the Advancement of Industrial Technology: Summary Data on Subsidies, by Province, 31 March 1975

	Estimated total cost of projects	PAIT commitments		PAIT expenditures[1]	Projects		Average PAIT commitment
		Amount	Distribution		Number	Distribution	
	($ Thousands)		(Per cent)	($ Thousands)		(Per cent)	($ Thousands)
Newfoundland	–	–	–	–	–	–	–
Nova Scotia	2,606	1,304	0.5	293	11	1.3	118
New Brunswick	831	415	0.2	257	4	0.4	104
Prince Edward Island	391	195	0.1	47	3	0.3	65
Quebec	138,428	68,866	29.0	35,492	231	26.5	298
Ontario	263,779	131,126	55.2	81,731	462	53.0	284
Manitoba	3,771	1,885	0.8	1,384	15	1.7	126
Saskatchewan	1,105	552	0.2	409	6	0.7	92
Alberta	16,369	8,092	3.4	5,883	46	5.3	176
British Columbia	47,335	25,192	10.6	17,462	94	10.8	268
Total	474,615	237,627	100.0	143,055*	872	100.0	273

1 There is an error of negligible proportion in the data prepared by the Department for one province (unindentified), so that the sum of the figures in this column does not equal the total.

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table A-3

Enterprise Development Program: Contribution Project Approvals, by Industry Group, 1980-82

	1980/81			1981/82		
	Number of projects	Project cost	Amount authorized	Number of projects	Project cost	Amount authorized
		($ Thousands)			($ Thousands)	
Gas and oil wells	1	2,140	1,070	–	–	–
Food and beverages	28	6,321	4,303	22	2,774	1,461
Rubber and plastics	32	4,497	2,786	10	651	458
Textiles	9	383	280	11	543	381
Clothing	38	1,449	1,031	22	646	475
Footwear	22	909	712	1	25	18
Wood	12	473	355	22	1,373	1,030
Furniture	30	1,303	977	33	1,050	805
Paper	6	799	455	4	114	86
Primary metals (ferrous)	6	573	198	–	–	–
Primary metals (nonferrous)	2	236	177	2	327	229
Metal fabricating	38	3,390	2,436	30	3,506	2,388
Machinery	103	13,714	9,577	123	81,044	39,684
Aircraft and parts	3	455	341	4	265	209
Other transportation equipment	32	73,976	38,302	30	7,009	4,420
Electrical products	109	39,907	26,060	153	173,755	56,086
Mineral products	8	947	624	11	2,475	1,823
Petroleum products	–	–	–	2	272	185
Drugs and medicines	2	286	215	5	1,038	779
Other chemical products	13	5,135	2,669	15	5,290	3,007
Scientific instruments	13	6,822	3,616	5	2,040	1,205
Other manufacturing	40	2,494	1,871	69	5,515	4,067
Nonmanufacturing	2	194	145	2	482	362
Total	549	166,403	98,200	576	290,198	119,158

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table A-4

Enterprise Development Program: Contribution Project Approvals, by Province of Location of Head Office, 1977-82

	1977/78				1978/79				1979/80				1980/81				1981/82			
	Number of approvals	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Number of approvals	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Number of approvals	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Number of approvals	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Number of approvals	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)
Newfoundland	2	1.0	22	0.1	6	2.1	301	0.7	8	1.8	617	0.7	2	0.4	50	0.1	3	0.5	517	0.4
Nova Scotia	2	1.0	15	0.1	5	1.8	90	0.2	15	3.4	1,332	1.6	15	2.7	1,107	1.1	15	2.6	679	0.6
New Brunswick	2	1.0	55	0.3	9	3.2	468	1.1	7	1.6	106	0.1	6	1.1	305	0.3	4	0.7	352	0.3
Prince Edward Island	2	1.0	95	0.5	5	1.8	167	0.4	7	1.6	422	0.5	6	1.1	387	0.4	4	0.7	421	0.4
Quebec	67	34.4	3,221	17.9	92	32.3	4,688	10.8	176	39.7	13,697	16.2	250	45.5	47,943	48.8	306	53.1	35,262	29.6
Ontario	68	35.9	12,143	67.5	105	36.8	21,689	49.8	120	27.1	60,204	71.1	154	28.1	36,850	37.5	135	23.4	62,662	52.6
Manitoba	13	6.7	587	3.3	14	4.9	942	2.2	29	6.5	1,420	1.7	25	4.6	1,998	2.0	33	5.7	9,534	8.0
Saskatchewan	5	2.6	180	1.0	11	3.9	495	1.1	13	2.9	1,096	1.3	18	3.3	1,106	1.1	10	1.7	1,320	1.1
Alberta	15	7.7	560	3.1	20	7.0	1,815	4.2	34	7.7	1,727	2.0	34	6.2	3,115	3.2	32	5.6	3,685	3.1
British Columbia	19	9.7	1,122	6.2	18	6.3	12,933	29.7	34	7.7	3,997	4.7	39	7.1	5,339	5.4	34	5.9	4,725	4.0
Total	195	100.0	18,000	100.0	285	100.0	43,589	100.0	443	100.0	84,618	100.0	549	100.0	98,200	100.0	576	100.0	119,158	100.0

SOURCE: Based on data from the Department of Industry, Trade and Commerce.

Table A-5

Enterprise Development Program: Contribution Project Approvals, by Firm Size, 1977-82

	1977/78		1978/79		1979/80		1980/81		1981/82	
	Number	Amount	Number	Amount	Number	Amount	Number	Amount	Number	Amount
		($ Thousands)		($ Thousands)		($ Thousands)		($ Thousands)		($ Thousands)
Sales:										
Less than $5,000,000	162	9,122	221	17,654	385	50,476	489	50,450	506	48,823
$5,000,000 to $25,000,000	28	2,369	55	19,739	48	29,844	51	16,949	41	32,644
Over $25,000,000	5	6,509	9	6,196	10	4,298	9	30,801	29	42,691
Total	195	18,000	285	43,589	443	84,618	549	98,200	576	119,158

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table A-6

Enterprise Development Program: Contribution Project Approvals, by Nationality of Majority Ownership, 1977-82

	1977/78		1978/79		1979/80		1980/81		1981/82	
	Number	Amount	Number	Amount	Number	Amount	Number	Amount	Number	Amount
		($ Thousands)		($ Thousands)		($ Thousands)		($ Thousands)		($ Thousands)
Nationality of majority ownership:										
Canadian	188	10,573	273	41,621	425	76,403	534	89,062	558	80,369
U.S.	6	6,667	9	1,683	11	2,685	13	7,947	12	24,365
Other foreign	1	750	3	285	7	5,529	2	1,191	6	14,424
Total	195	18,000	285	43,589	443	84,617	549	98,200	576	119,158

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table A-7

Defence Industry Productivity Program:
Expenditures, by Program Component, 1969-79

	Projects		Expenditures		
	Number	Distribution	Amount	Distribution	Average value
		(Per cent)	($ Millions)	(Per cent)	($ Thousands)
Program component:					
Research and development	199	32.9	292.8	69.0	1,471
Capital assistance	291	48.2	52.0	12.3	179
Source establishment	114	18.9	79.5	18.7	697
Total	604	100.0	424.3	100.0	702

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table A-8

Defence Industry Productivity Program Expenditures, by Program Component and by Industry Group, 1969-79

	Capital assistance		Source establishment		R&D		Total	
	Number of projects	Total subsidies	Number of projects	Total subsidies	Number of projects	Total subsidies	Number of projects	Total subsidies
		($ Thousands)		($ Thousands)		($ Thousands)		($ Thousands)
Industry group								
Chemicals	8	878	3	7,692	–	–	11	8,570
Electrical and electronics	74	12,620	42	8,251	131	96,104	247	116,975
Machinery	33	4,438	5	241	3	3,194	41	7,873
Resource industries	9	1,248	4	386	1	627	14	2,261
Transportation industries[1]	163	32,552	59	62,780	62	190,978	284	286,310
Textile and consumer products	4	312	–	–	–	–	4	312
Defence programs	–	–	–	–	1	829	1	829
Indeterminate	–	–	1	109	1	1,029	2	1,138
All groups	291	52,049	114	79,459	199	292,762	604	424,270
				(Per cent)				
Distribution:								
Chemicals	72.7	10.2	27.3	89.8	–	–	100.0	100.0
Electrical and electronics	30.0	10.8	17.0	7.1	53.0	82.2	100.0	100.0
Machinery	80.5	56.4	12.2	3.1	7.3	40.6	100.0	100.0
Resource industries	64.3	55.2	28.6	17.1	7.1	27.7	100.0	100.0
Transportation industries[1]	57.4	11.4	20.8	21.9	21.8	66.7	100.0	100.0
Textile and consumer products	100.0	100.0	–	–	–	–	100.0	100.0
Defence programs	–	–	–	–	100.0	100.0	100.0	100.0
Indeterminate	–	–	50.0	9.6	50.0	90.4	100.0	100.0
All groups	48.2	12.3	18.9	18.7	32.9	69.0	100.0	100.0

1 Primarily, but not exclusively, aerospace.

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table A-9

Industrial Research Assistance Program: Expenditures, by Industry, 1974-82

	1974/75		1975/76		1976/77		1977/78		1978/79		1979/80		1980/81		1981/82	
	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution
	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)
Food	1,883	13.7	2,542	18.0	2,806	19.3	3,201	20.8	3,955	22.0	4,696	24.0	4,648	22.5	5,158	21.5
Rubber	458	3.3	372	2.6	469	3.2	440	2.9	627	3.5	619	3.2	501	2.4	573	2.4
Textiles	97	0.7	61	0.4	60	0.4	65	0.4	71	0.4	42	0.2	47	0.2	115	0.5
Wood	128	0.9	142	1.0	80	0.6	–	–	18	0.1	70	0.4	59	0.3	39	0.2
Paper	992	7.2	714	5.1	743	5.1	786	5.1	765	4.3	777	4.0	898	4.3	710	3.0
Primary metals	1,065	7.7	1,205	8.6	1,385	9.5	989	6.4	748	4.2	649	3.3	642	3.1	637	2.7
Metal fabricating	208	1.5	237	1.7	185	1.3	236	1.5	411	2.3	617	3.2	974	4.7	1,298	5.4
Machinery	635	4.6	801	5.7	945	6.5	1,185	7.7	1,365	7.6	1,458	7.5	1,247	6.0	1,931	8.1
Transportation	271	2.0	260	1.9	268	1.9	341	2.2	454	2.5	553	2.7	489	2.4	671	2.8
Electronics	3,255	23.6	3,166	22.5	3,371	23.2	3,930	25.5	5,072	28.2	5,073	25.9	5,796	28.0	6,969	29.0
Nonmetal mining	280	2.0	308	2.2	277	1.9	190	1.2	341	1.9	369	1.9	302	1.5	343	1.4
Petroleum	437	3.2	399	2.8	253	1.7	258	1.7	152	0.8	67	0.3	12	0.1	3	--
Chemicals	2,055	14.9	1,768	12.5	1,566	10.8	1,650	10.7	1,666	9.3	1,968	10.1	2,489	12.0	2,479	10.4
Pharmaceuticals	893	6.5	879	6.2	875	6.0	870	5.7	846	4.7	1,327	6.8	1,330	6.4	1,311	5.5
Other	1,130	8.2	1,238	8.8	1,235	8.5	1,253	8.1	1,487	8.3	1,260	6.5	1,255	6.1	1,699	7.1
Total	13,787	100.0	14,093	100.0	14,518	100.0	15,394	100.0	17,977	100.0	19,515	100.0	20,691	100.0	23,935	100.0

SOURCE Based on data from the National Research Council of Canada.

Table A-10

Industrial Research Assistance Program: Expenditures, by Nationality of Firm Ownership and by Firm Size, 1974-82

	1974/75		1975/76		1976/77		1977/78		1978/79		1979/80		1980/81		1981/82	
	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution
	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)
Nationality of firm ownership:																
Canadian	9,774	70.9	10,009	71.0	9,728	67.0	10,600	68.9	12,921	71.9	14,464	74.1	15,947	77.1	18,274	76.3
Foreign	4,012	29.1	4,084	29.0	4,790	33.0	4,795	31.1	5,056	28.1	5,051	25.9	4,744	22.9	5,661	23.7
Firm size:																
Small	5,483	39.8	5,133	36.4	5,271	36.3	6,615	43.0	8,983	50.0	9,945	51.0	11,288	54.6	13,285	55.5
Medium	1,982	14.4	2,284	16.2	2,499	17.2	2,598	16.9	2,551	14.2	3,082	15.8	3,062	14.8	4,077	17.0
Large	5,533	40.1	5,951	42.2	6,118	42.1	5,652	36.7	5,833	32.4	5,865	30.1	5,690	27.5	6,136	25.6
Associations	788	5.7	725	5.1	630	4.3	529	3.4	610	3.4	623	3.2	641	3.1	437	1.8
Total	13,786	100.0	14,093	100.0	14,518	100.0	15,394	100.0	17,977	100.0	19,515	100.0	20,691	100.0	23,935	100.0

SOURCE Based on data from the National Research Council of Canada.

Table A-11

Program for Industry/Laboratory Projects: Expenditures, 1975-82

	($ Thousands)
1975/76	770
1976/77	2,084
1977/78	4,438
1978/79	5,988
1979/80	6,003
1980/81	8,882
1981/82	15,000

SOURCE Data provided by the National Research Council of Canada.

Table A-12

Technical Information Service: Budget Allocations, 1977-80

	1977/78	1978/79	1979/80
		($ Thousands)	
Paylist	1,308	1,404	1,502
Nonpaylist[1]	852	1,080	1,155
Total	2,160	2,484	2,657
Contributions[2]	-	250[3]	750
Total	2,160	2,734	3,407
Minor capital	10	10	10
Person-years	55	55	55

1 Includes the cost of contracts with provincial research organizations to provide TIS assistance in six provinces, and a research contract with the Saskatchewan Research Council.

2 Contributions under the Science and Engineering Student Program (SESP) extend TIS assistance to senior students undertaking short-term projects in industry.

3 SESP got under way in October 1978; because students were unavailable or already committed under co-op programs, only about half of the 1978/79 allocation was spent, leaving a balance of about $123,000.

SOURCE Data provided by the National Research Council of Canada.

B The Estimation of Inappropriable Benefits

We wish to illustrate, in a schematic fashion, how the inappropriable benefits generated by a given subsidized innovative project could be estimated. Although the innovation described below is hypothetical, it resembles one actually subsidized a few years ago under the Enterprise Development Program. As explained in Chapter 6, EDP has not heretofore been administered on the basis of decision rules that would be appropriate for programs of this type. Consequently, certain essential questions have not been put to the applicant firm (in this case or in any other) nor have most of the associated projections been made. These questions are specified below, and the information necessary to answer them is provided. Then, hypothetical numbers are used to illustrate how the inappropriable benefits that could reasonably be expected from such a project are calculated. It will be seen that the requisite data would not usually be unduly difficult to obtain.

The proposed project involves the development of an improved method of producing a certain automotive engine component. The basic questions that program administrators must be able to answer before deciding whether a subsidy should be awarded to the applicant firm are as follows:

1) Does the firm really need a subsidy in order to undertake this project? If so, what would be an appropriate amount?

2) Are there reasonable grounds for believing that this project will not pre-empt an analogous project that is being carried on currently by some competitor of the applicant firm?

3) If a subsidy in the amount determined is really needed, is the project likely to leave Canadians better off than they would otherwise be?

An affirmative answer to the first question requires evidence that, without a subsidy, the project's net return to the applicant firm would be negative. The estimation of this net private return requires risk-adjusted projections of the project's future flows of revenues and costs. These projections are identical in nature to those which firms make routinely when contemplating any significant investment activity. The information required includes estimates of the total cost of the project and of its implementation, of the cost of producing its intended product, and of its annual domestic sales volume over the years during which significant sales can realistically be anticipated. That implies that if the project's intended product serves as an input into the production of some other product, projections of that product's future domestic sales are also needed. These future flows are then discounted, on the basis of a discount rate appropriate to the firm, and the resulting present values give the firm's *net* private return from the project. A negative net private return would, in this instance, imply that a subsidy was needed in order to induce the firm to proceed with the project and would indicate the required amount of that subsidy. The latter should be just sufficient to enable the firm to earn its normal rate of return, as indicated by its past performance. Few of the necessary projections were made in the case of the actual project that resembles this example, but they clearly could have been. Let it be assumed that, if they had been made, a subsidy of X dollars would have been indicated.

The answer to the second question requires some knowledge of the main R & D activities conducted by the applicant firm's competitors. In the actual case, there was enough knowledge of the relevant industry to permit the belief that no analogous project was under way within it. There is evidence to suggest that in many, if not most, Canadian industries, firms engaged in substantial R & D activity usually have quite a good idea of the general nature of the R & D activities that are being carried on by their rivals.

The third question, which is the critical one for our purpose here, involves the project's inappropriable benefits. Technically, the per-year inappropriable benefits generated by this innovation may be defined as

$$(P_1 - P_2)Q(1 - \tfrac{1}{2}Kn)$$

where

P_1 = the average price of a Canadian-produced vehicle prior to implementation of the innovation by the industry;
P_2 = the average price of a Canadian-produced vehicle after implementation of the innovation by the industry;
Q = the number of vehicles produced and sold in Canada;
K = $(P_1 - P_2)/P_1$; and
n = the price elasticity of demand for Canadian-produced vehicles.

There exists persuasive evidence, however, to suggest that, for the types of innovations usually subsidized by the programs reviewed, Kn will generally be very small. Hence the rather difficult exercise of estimating n is unnecessary, and reliable estimates of the benefits per year can be derived by calculating only $(P_1 - P_2)Q$. Because the concept of such benefits has not entered into either the rationale or the administrative procedures of EDP or of any of the other programs reviewed, the information needed to calculate them was not gathered, although it should have been. Purely hypothetical numbers and other circumstances are therefore assumed below. The necessary information consists, as was just indicated, of the expected price reduction of the product from using the innovation and of the expected annual sales volume of that product. Much of this information is already implicit in that used to estimate the innovation's private benefits and need not be gathered anew. Since here, too, flows are involved, an estimate – admittedly arbitrary – must be made of the time interval that would probably elapse before a similar innovation would appear if the present project did not go forward.

One year after the start of the project, products produced by the new method will start to be delivered to one Canadian automobile manufacturer with whom the applicant firm has an arrangement. It is expected, however, that within a few months all Canadian automobile manufacturers will be able to obtain similarly produced versions of the product from their respective suppliers, who will be able effectively to duplicate the new production method. It has been estimated that by going ahead with this project the applicant firm will succeed in expediting by two years the implementation of the new production method. The following additional estimates have also been made:

1) The average price of a vehicle produced and sold in Canada will fall, as a result of this innovation, by $5;

2) Approximately 300,000 vehicles will be sold annually during the year after next and during the following year; and

3) the appropriate discount rate is 4 per cent per year.

Thus the present value of the above flow of inappropriable benefits, amounting to $1.5 million annually for two years, which will start after one year and continue for another year thereafter, is

$$\frac{\$1.5 \text{ million}}{(1.04)^2} + \frac{\$1.5 \text{ million}}{(1.04)^3} = \$2{,}720{,}329$$

If this amount proves to be greater than the sum of the subsidy ($X) and the various costs that arise from delivering it, then the proposed project should be regarded as serving Canada's interests, and the subsidy is warranted.

C Table to Chapter 8

Table C-1

Performance of Canadian Manufacturing Industries with Respect to the Ratios of Shipments to Apparent Domestic Availability (ADA), Exports to Shipments, and Imports to ADA, 1966-80

	Shipments/ADA	Exports/shipments	Imports/ADA
All manufacturing industries	-	Up	Up
Food and beverage industries	-	Up	Up
Meat and poultry product industries	-	-	-
Slaughtering and meat processors	-	Up	-
Poultry processors	-	-	-
Fish product industry	-	Up	Up
Fruit and vegetable processing industries	-	Up	Up
Dairy products industry	-	-	-
Flour and breakfast cereal product industries	-	-	-
Feed industry	-	-	-
Bakery product industry	-	-	-
Biscuit manufacturers	-	-	-
Bakeries	-	Up	Up
Miscellaneous food industries	-	-	-
Confectionery manufacturers	-	Up	Up
Cane and beet sugar processors	-	-	-
Vegetable oil mills	-	-	-
Miscellaneous food processors, n.e.s.	Down	-	Up
Beverage industries	Down	-	Up
Soft drink manufacturers	-	-	-
Distilleries	Down	-	Up
Breweries	-	Up	Up
Wineries	Down	-	Up
Tobacco product industries	-	-	-
Tobacco product manufacturers	-	-	-
Rubber and plastics product industries	-	Up	Up
Rubber products industries	-	Up	Up
Plastic fabricating, industry, n.e.s.	-	-	-
Leather industries	Down	Up	Up
Leather tanneries	Down	-	Up
Shoe factories	Down	Up	Up
Leather glove factories	Down	Down	Up
Luggage, handbag, and small leather goods manufacturers	Down	Up	Up
Boot and shoe findings manufacturers	-	Up	Up
Miscellaneous leather products manufacturers	Down	-	Up
Textile industries	-	Up	Up
Cotton yarn and cloth mills	-	-	-
Wool, yarn, and cloth mills	-	Up	Up
Man-made fibre, yarn, and cloth mills	Down	Up	Up
Cordage and twine industry	Down	Down	Up
Felt and fibre processing mills	-	-	-
Fibre processing mills	-	-	-
Pressed and punched felt mills	-	-	-
Carpet, mat, and rug industry	Up	Up	-
Cotton and jute bag manufacturers	Down	-	Up

Table C-1 (cont'd.)

	Shipments/ADA	Exports/shipments	Imports/ADA
Miscellaneous textile industries	-	-	-
Thread mills	-	-	-
Narrow fabric mills	Down	-	Up
Embroidery, pleating, and hemstitch manufacturers	-	-	-
Miscellaneous textile industries, n.e.s.	Up	-	Down
Knitting mills	Down	-	Up
Hosiery mills	Down	-	Up
Knitting mills (except hosiery mills)	Down	Up	Up
Clothing industries	Down*	Up*	Up
Men's, women's, and children's clothing industries	Down	-	Up
Fur goods industry	Up	Up	Up
Foundation garment industry	Down	Down*	Up
Miscellaneous clothing industry	Down	-	Up
Fabric glove manufacturers	Down	Down	Up
Hat and cap industry	Down	Up	Up
Miscellaneous clothing industries, n.e.s.	Down	Down	-
Wood industries	Up	Up	Up
Sawmills, planing mills, and shingle mills	Up	Up	Up
Veneer and plywood mills	-	-	-
Sash, door, and other millwork plants	Up	Up	-
Sash, door, and other millwork plants, n.e.s.	Up*	Up	Up
Wooden box factories	-	-	-
Coffin and casket industry	Down	-	Up
Miscellaneous wood industries	Up	Up	Up
Furniture and fixture industries	-	Up	Up
Household furniture manufacturers	Down	-	Up
Office furniture manufacturers	Up	Up	Up
Miscellaneous furniture and fixture manufacturers	Up*	Up	Up
Electric lamp and shade manufacturers	-	-	-
Paper and allied industries	Up	Up	Up
Pulp and paper mills	Up	Up	Up
Asphalt roofing manufacturers	Up	Up	-
Paper box and bag manufacturers	-	-	-
Miscellaneous paper converters	Up*	Up	Up
Printing, publishing, and allied industries	-	Up	Up
Commercial printing	-	Up	Up
Primary metal industries	-	-	-
Iron and steel mills	-	-	-
Steel pipe and tube mills	-	Up	Up
Iron foundries	Up*	Up*	Up*
Smelting and refining	-	-	-
Aluminum rolling, casting, and extruding	-	-	-
Copper and copper alloy rolling, casting, and extruding	Down	-	Up
Metal rolling, casting, and extruding, n.e.s.	-	-	-
Metal fabricating industries (except machinery and transportation equipment industries)	-	Up	Up
Boiler and plate works	-	-	-
Fabricated structural, ornamental, and architectural metal industry	-	-	-
Metal stamping, pressing, and coating industry	-	-	-
Wire and wire product manufacturers	Up	Up	Up
Hardware, tool, and cutlery manufacturers	-	Up	Up
Heating equipment manufacturers	-	-	-
Miscellaneous metal fabricating industries	-	Up	Up
Machinery industries (excluding electrical)	-	Up	Up
Agricultural implement industry	-	-	-
Miscellaneous machinery and equipment manufacturers	-	Up	Up
Commercial refrigeration and air conditioning equipment manufacturers	-	-	-
Office and store machinery manufacturers	-	Up	Up
Transportation equipment industries	-	Up	Up
Aircraft and aircraft parts manufacturers	-	-	-
Motor vehicle manufacturers	-	Up	Up
Truck body and trailer manufacturers	Up	-	Down
Motor vehicle parts and accessories manufacturers	-	Up	Up
Railroad rolling stock industry	-	Up	Up
Shipbuilding and repair	Up	Up	Up

Table C-1 (concl'd.)

	Shipments/ADA	Exports/shipments	Imports/ADA
Boatbuilding and repair	-	-	-
Miscellaneous vehicle manufacturers	-	Up	Up
Electrical product industries	Down	Up	Up
Manufacturers of small electrical appliances	Down	Up	Up
Manufacturers of major appliances (electric and nonelectric)	-	Up	Up
Manufacturers of household radio and television receivers	Down	Up	Up
Communications equipment manufacturers	Down*	Up	Up
Manufacturers of electrical industrial equipment	Down*	Up	Up
Manufacturers of electric wire and cable	Down	-	Up
Manufacturers of miscellaneous electrical products	Down	Up	Up
Battery manufacturers	Down	Up	Up
Manufacturers of miscellaneous electrical products, n.e.s.	Down	Up	Up
Nonmetallic mineral product industries	-	Up	Up
Clay product manufacturers	Down	-	Up
Cement manufacturers	Up	Up	Up
Stone product manufacturers	-	-	-
Concrete product manufacturers	Up	Up	-
Glass and glass product manufacturers	-	Up	-
Glass manufacturers	-	-	-
Glass product manufacturers	-	Up	Up
Abrasives manufacturers	Down	-	Up
Lime manufacturers	Up	Up	-
Miscellaneous nonmetallic mineral product industries	Up	-	Down
Refractories manufacturers	-	Up*	-
Miscellaneous nonmetallic mineral product industries, n.e.s.	Up	-	Down
Petroleum and coal product industries	Up	Up	Down
Petroleum refineries	Up	Up	Down
Petroleum refining	Up	Up	Down
Manufacturers of lubricating oils and greases	Up	-	Down
Miscellaneous petroleum and coal product industries	Up	Up	Up
Chemical and chemical product industries	-	Up	Up
Manufacturers of mixed fertilizers	Up	Up	Up
Manufacturers of plastics and synthetic resins	Up	Up	-
Manufacturers of pharmaceuticals and medicines	-	-	-
Paint and varnish manufacturers	Down	-	Up
Manufacturers of soap and cleaning compounds	-	Up	Up
Manufacturers of toilet preparations	Down	Up	Up
Manufacturers of industrial chemicals	Up	Up	Up
Miscellaneous chemical industries	Down	Up*	Up
Miscellaneous manufacturing industries	Down	-	Up
Scientific and professional equipment industries	Down	-	Up*
Instrument and related product manufacturers	Down	Down	-
Clock and watch manufacturers	Down	Up*	Up
Orthopaedic and surgical appliance manufacturers	Down	Up	Up
Ophthalmic goods manufacturers	Down	Up	Up
Jewellery and silverware industry	-	-	-
Sporting goods and toy manufacturers	-	Up	Up
Sporting goods manufacturers	-	Up	Up
Toy and game manufacturers	Down	-	Up
Signs and display industry	Up	Up	Down
Miscellaneous manufacturing industries, n.e.s.	-	Up	Up
Broom, brush, and mop manufacturers	Down	-	Up
Button, buckle, and fastener manufacturers	-	-	-
Floor tile, linoleum, and coated fabrics manufacturers	-	-	-
Sound recording and musical instrument manufacturers	-	Up	Up
Pen and pencil manufacturers	Down	-	Up
Fur dressing and dyeing	-	Up	Up
Other miscellaneous manufacturing industries	-	-	-

*Cases where the trend is not certain because of wide fluctuations over the period.

SOURCE Analysis by the Economic Council of Canada, based on Department of Industry, Trade and Commerce, Economic Intelligence Branch, Economic Policy and Analysis, "Manufacturing Trade & Measures, 1966-1980: Tabulations of Trade, Output, Canadian Market, Total Demand and Related Measures for Manufacturing Industrial Sectors," Ottawa, 1981.

Notes

CHAPTER 1

1 Economic Council of Canada, *In Short Supply: Jobs and Skills in the 1980s* (Ottawa: Supply and Services Canada, 1982).

2 Economic Council of Canada, *Lean Times – Policies and Constraints: Nineteenth Annual Review* (Ottawa: Supply and Services Canada, 1982).

CHAPTER 2

1 The data sources for output per person-hour worked are less reliable than those for output per person employed, however. Some new ideas concerning an extended version of the latter are discussed later.

2 E. F. Denison, *The Sources of Economic Growth in the United States and the Alternatives Before Us* (New York: Committee for Economic Development, 1962).

3 Alternative definitions of productivity can be useful in other contexts. One could define capital productivity as output per unit of capital equipment used; labour productivity could be obtained by dividing output by the number of person-hours worked rather than by the number of persons employed. Another option, often used in the technical analysis of productivity, is to divide output by a weighted average of all the inputs used, to obtain an actual measure of the efficiency with which all inputs are combined to produce output – a measure of the concept defined earlier as "total factor productivity." This measure can be calculated for the economy as a whole or for any one industry or firm. Another potentially useful measure of productivity can be derived by using a technique known as "input-output analysis," discussed later in this chapter.

4 See, especially, R. Stone, "Denison's Accounting for Slower Economic Growth: A Review Article," *Journal of Economic Literature* 18, no. 4 (December 1980), Table 1.

5 See Economic Council of Canada, *A Climate of Uncertainty: Seventeenth Annual Review* (Ottawa: Supply and Services Canada, 1980).

6 D. J. Daly, B. A. Keys, and E. J. Spence, *Scale and Specialization in Canadian Manufacturing*, Economic Council of Canada, Staff Study 21 (Ottawa: Queen's Printer, 1968); Economic Council of Canada, *The Canadian Economy from the 1960s to the 1970s: Fourth Annual Review* (Ottawa: Queen's Printer, 1968); Economic Council of Canada, *Looking Outward: A New Trade Strategy for Canada* (Ottawa: Information Canada, 1975); H. C. Eastman and S. Stykolt, *The Tariff and Competition in Canada* (Toronto: Macmillan, 1967); and Royal Commission on Corporate Concentration, *Final Report* (Ottawa: Supply and Services Canada, 1978).

7 Organisation for Economic Co-operation and Development, *Information Activities, Electronics and Telecommunications Technologies*, Vol. I, Study No. 6 of Information, Computer, Communications Policy (Paris: OECD, 1981).

8 This topic is discussed in R. E. Caves, "Corporate Strategy and Structure," *Journal of Economic Literature* 18, no. 1 (March 1980):64-92.

9 J. P. Jarrett and J. G. Selody, "The Productivity-Inflation Nexus in Canada, 1963-1979," Bank of Canada, Technical Report 23, Ottawa, March 1981; reproduced in *Review of Economics and Statistics* 64, no. 3 (August 1982):361-67.

10 This discussion is based on H. H. Postner and L. Wesa, *Canadian Productivity Growth: An Alternative (Input-Output) Analysis*, Economic Council of Canada (forthcoming).

11 Final demand, in our analysis, includes total consumer expenditures, total government net expenditures, and total net fixed capital formation.

12 Amil Nag, "Wheel Spinning: U. S. Car Industry Has Full-Sized Problems in Subcompact Market," *Wall Street Journal* (January 7, 1983), pp. 1-2.

13 Actually, our experimental measure refers mostly to the financial components of the finance, insurance, and real estate industry. We assume that the output adjustment of the financial components (official *vs.* experimental measures) carries through for all other components of the industry as well. Clearly, our results should be regarded as tentative.

CHAPTER 3

1 The Statistics Canada definition of R & D covers three activities: basic research, applied research, and experimental development. We shall refer to the latter two categories as "applied R & D," or just "R & D" if the context makes it clear that basic research is not included. Applied R & D includes both the making of new discoveries and work done to change existing discoveries or to adapt them to Canadian conditions.

The formal definitions are as follows. "Basic research" is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. "Applied research" is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. "Experimental development" is systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed at the production of new materials, products, or devices; the installing of new processes, systems, and services; or substantial improvement in those already produced or installed.

2 Postner and Wesa, *Canadian Productivity Growth*.

3 F. Martin, N. Swan, I. Banks, G. Barker, and R. Beaudry, *The Interregional Diffusion of Innovations in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1979), Chapter 5.

4 An introduction to the geographical approach can be found in L. A. Brown, *Diffusion Processes and Location: A Conceptual Framework and Bibliography* (Philadelphia: Regional Science Institute, 1968). See, also, Martin *et al.*, *Interregional Diffusion*, Chapter 2.

5 Martin *et al.*, *Interregional Diffusion*, p. 21.

6 The data cited in this paragraph are drawn from the *Final Report* of the Royal Commission on Corporate Concentration, pp. 191-92.

7 To be more precise, there is a probability of 0.99 that between 37 and 65 projects will succeed, provided that success or failure in any one project is independent of success or failure in any other.

8 Economic Council of Canada, *Newfoundland: From Dependency to Self-Reliance* (Ottawa: Supply and Services Canada, 1980), Chapter 5.

9 Economic Council of Canada, *Living Together: A Study of Regional Disparities* (Ottawa: Supply and Services Canada, 1977); and Martin *et al.*, *Interregional Diffusion*.

CHAPTER 4

1 E. Mansfield, J. Rapoport, A. Romeo, S. Wagner, and G. Beardsley, "Social and Private Rates of Return from Industrial Innovations," *The Quarterly Journal of Economics* 91, no. 2 (May 1977):221-40.

2 Z. Griliches, "Research Costs and Social Returns: Hybrid Corn and Related Innovations," *Journal of Political Economy* 66, no. 5 (October 1958):419-31; and W. L. Peterson, "Returns to Poultry Research in the United States," *Journal of Farm Economics* 49, no. 3 (August 1967):656-69.

3 B. E. Prentice and G. L. Brinkman, *The Value of Agricultural Research in Ontario*, Ontario Agricultural College, School of Agricultural Economics and Extension Education (Guelph: University of Guelph, 1982).

4 Science Statistics Centre, *R&D Expenditures in Canada, 1963-1982* (Ottawa: Science Statistics Centre, 1982).

5 Ministry of State for Science and Technology, *R&D Policies, Planning and Programming*, Background Paper 13 (Ottawa: MOSST, 1981).

6 Science Statistics Centre, *R&D Expenditures in Canada*.

7 K. S. Palda and B. Pazderka, *Approaches to an International Comparison of Canada's R&D Expenditures*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1982).

8 J.N.H. Britton, and J. M. Gilmour, *The Weakest Link: A Technological Perspective on Canadian Industrial Underdevelopment*, Science Council of Canada, Background Study 43 (Ottawa: Supply and Services Canada, 1978).

9 Britton and Gilmour, *The Weakest Link*; J. Gilmour, "Industrialization and Technological Backwardness: The Canadian Dilemma," *Canadian Public Policy* 4, no. 1 (Winter 1978):20-33; and J.N.H. Britton, "Industrial Dependence and Technological Underdevelopment: Canadian Consequences of Foreign Direct Investment," *Regional Studies* 14, no. 3 (1980):181-99.

10 E. Mansfield and A. Romeo, "Technology Transfer to Overseas Subsidiaries by U.S.-Based Firms," *The Quarterly Journal of Economics* 95, no. 4 (December 1980):737-50.

11 S. Globerman, "Foreign Direct Investment and 'Spillover' Efficiency Benefits in Canadian Manufacturing Industries," *Canadian Journal of Economics* 12, no. 1 (February 1979):42-56; see, also, T. J. Allen, "Transferring Technology to the Firm: A Study of the Diffusion of Technology in Irish Manufacturing Industry," *Irish Journal of Business and Administrative Research* (1980):3-34.

12 J. A. Schumpeter, *Capitalism, Socialism and Democracy*, third edition (New York: Harper and Row, 1950).

13 M. I. Kamien and N. L. Schwartz, "Market Structure and Innovation: A Survey," *Journal of Economic Literature* 13, no. 1 (March 1975):1-37.

14 F. M. Scherer, "Firm Size, Market Structure, Opportunity, and the Output of Patented Inventions," *American Economic Review* 55, no. 5, part 1 (December 1965):1097-1125.

15 J. D. Howe and D. G. McFetridge, "The Determinants of R & D Expenditures," *Canadian Journal of Economics* 9, no. 1 (February 1976):57-71.

16 U.K.R. Chand, "Innovation and Its Environment," *The Canadian Business Review* 7, no. 3 (Autumn 1980):32-36.

17 See H. G. Grabowski, "The Determinants of Industrial Research and Development: A Study of the Chemical, Drug, and Petroleum Industries," *Journal of Political Economy* 76, no. 2 (March-April 1968):292-306; W. S. Comanor, "Market Structure, Product Differentiation, and Industrial Research," *The Quarterly Journal of Economics* 81, no. 4 (November 1967):639-57; T. M.

Kelly, "The Influences of Firm Size and Market Structure on the Research Efforts of Large Multiple-Product Firms," Oklahoma State University, Ph.D. dissertation, 1970; and Scherer, "Firm Size."

18 A. E. Safarian, *Foreign Ownership of Canadian Industry* (Toronto: McGraw-Hill, 1966). Rugman, using data for 1977, reached similar conclusions, although his results were more ambiguous than Safarian's; see A. M. Rugman, "Research and Development by Multinational and Domestic Firms in Canada," *Canadian Public Policy* 7, no. 4 (Autumn 1981):604-16.

19 S. Globerman, "Market Structure and R&D in Canadian Manufacturing Industries," *Quarterly Review of Economics and Business* 13, no. 2 (Summer 1973):59-67; see also, R. E. Caves, "International Corporations: The Industrial Economics of Foreign Investment," *Economica* 38 (February 1971): 1-27.

20 H. P. Bones, "Are Foreign Subsidiaries More Innovative?," *Foreign Investment Review* 3, no. 2 (Spring 1980):20-23.

21 B. Branch, "Research and Development Activity and Profitability: A Distributed Lag Analysis," *Journal of Political Economy* 82, no. 5 (September-October 1974):999-1011; and Grabowski, "Determinants of Industrial Research and Development."

22 Howe and McFetridge, "Determinants of R&D Expenditures."

23 Scherer, "Firm Size."

24 Globerman, "Market Structure and R&D"; see, also, Howe and McFetridge, "Determinants of R&D Expenditures."

25 Schumpeter, *Capitalism*.

26 See Scherer, "Firm Size"; Comanor, "Market Structure"; F. M. Scherer, "Research and Development Resource Allocation under Rivalry," *The Quarterly Journal of Economics* 81, no. 3 (August 1967):359-94; Globerman, "Market Structure and R&D"; and P. Dasgupta and J. Stiglitz, "Industrial Structure and the Nature of Innovative Activity," *Economic Journal* 90 (June 1980):266-93.

27 See Z. Griliches and J. Schmookler, "Inventing and Maximizing," *American Economic Review* 53, no. 4 (September 1963):725-29; and J. Schmookler, *Invention and Economic Growth* (Cambridge, Mass.: Harvard University Press, 1966).

28 N. Rosenberg, "Factors Affecting the Diffusion of Technology," *Explorations in Economic History* 10, no. 1 (Fall 1972):3-33; and D. Mowery and N. Rosenberg, "The Influence of Market Demand Upon Innovation: A Critical Review of Some Recent Empirical Studies," *Research Policy* 8, no. 2 (April 1979): 102-53.

29 See S. Peltzman, *The Regulation of Pharmaceutical Innovation: The 1962 Amendments* (Washington, D.C.: American Enterprise Institute for Public Policy Research, 1974); M. N. Baily "Research and Development Costs and Returns: The U.S. Pharmaceutical Industry," *Journal of Political Economy* 80, no. 1 (January-February 1972):70-85; D. Schwartzman, *Innovation in the Pharmaceutical Industry* (Baltimore: The Johns Hopkins University Press, 1976); and H. G. Grabowski, J. M. Vernon, and L. C. Thomas, "Estimating the Effects of Regulation on Innovation: An International Comparative Analysis of the Pharmaceutical Industry," *Journal of Law and Economics* 21, no. 1 (April 1978): 133-63.

30 The Economic Council is currently involved in an interdepartmental committee – along with Statistics Canada, the Department of Finance, and the Bank of Canada – charged with investigating the feasibility of a capital stock survey that would be conducted every five years. Among other things, the survey would be used to determine the impact of environmental and pollution control legislation on capital stock, including investment in new equipment and new processes.

31 See A. Gillman, "Surface Freight Transportation," in W. M. Capron, ed., *Technological Change in Regulated Industries* (Washington, D.C.: The Brookings Institution, 1971); and P. MacAvoy and J. Gloss, *Regulation of Transport Innovation: The ICC and Unit Coal Trains to the East Coast* (New York: Random House, 1967).

32 W. G. Shepherd, "The Competitive Margin in Communications," in *Technological Change in Regulated Industries*, pp. 86-122.

33 D. G. McFetridge and J. P. Warda, *Canadian R&D Incentives: Their Adequacy and Their Impact* (Toronto: Canadian Tax Foundation, 1983).

34 Howe and McFetridge, "Determinants of R&D Expenditures."

35 M. I. Nadiri, "Contributions and Determinants of Research and Development Expenditures in the U.S. Manufacturing Industries," National Bureau of Economic Research, Working Paper 360, Cambridge, Mass., 1979.

36 Senate Special Committee on Science Policy, *A Science Policy for Canada*, vol. 2 (Ottawa: Information Canada, 1972).

37 The mission-oriented science and technology requirements of government are those pertaining to the performance of scientific activities that support departmental missions. An example of a departmental mission is the promotion of the more effective use of land. The corresponding science and technology requirement in support of this mission is satellite surveying of tracts of land, using infra-red technology.

CHAPTER 5

1 National Research Council, *The Urgent Investment: A Long Range Plan for the National Research Council of Canada* (Ottawa: NRC, 1980), p. 68.

2 The dates of first commercialization by other firms have been estimated by the reporting firms. As a result, they are subject to an unknown level of inaccuracy, introduced by human error in recall or awareness of the true first date of innovation commercialization. Because of the large number of discrete innovations included in the database, an independent check of the accuracy of the first date reported was not possible. This problem is one that affects all

diffusion research, since it is argued that new technology is part of an evolutionary process whereby previously acquired knowledge is applied to the solving of technical problems. Since the essence of innovation is the integration of knowledge in novel ways and since most new knowledge consists of the addition of some novel insight to a wealth of older knowledge, the precise pinpointing of the date of a given innovation is actually rather vague.

3 Martin *et al.*, *Interregional Diffusion*.

4 Martin *et al.*, *Interregional Diffusion*.

5 E. Mansfield, *Industrial Research and Technological Innovation* (New York: Norton, 1968); see, also, I. Bernhardt, "Diffusion of Catalytic Techniques through a Population of Medium Size Petroleum Refining Firms," *Journal of Industrial Economics* 19, no. 1 (November 1970):50-65; S. Davies, *The Diffusion of Process Innovations* (Cambridge: Cambridge University Press, 1979); and J. E. Tilton, *International Diffusion of Technology: The Case of Semi-Conductors* (Washington, D.C.: The Brookings Institution, 1971).

6 L. Nabseth and G. F. Ray, *The Diffusion of New Industrial Processes* (Cambridge: Cambridge University Press, 1974).

7 K. Norris and J. Vaizey, *The Economics of Research and Technology* (London: Allen and Unwin, 1973).

8 S. Globerman, *Technological Diffusion in Canadian Manufacturing Industries*, Department of Industry, Trade and Commerce, Technological Innovation Studies Program, Research Report 17 (Ottawa: IT & C, 1974).

9 Nabseth and Ray, *Diffusion of New Industrial Processes*; and Globerman, *Technological Diffusion*.

10 E. von Hippel, *The Role of the Initial User in the Industrial Good Innovation Process* (Cambridge, Mass.: Sloan School of Management, MIT, 1978).

11 For example, Globerman, in *Technological Diffusion*, pointed out that the diffusion of carpet tufting equipment in the United States earlier than in Canada was partially due to the fact that the equipment was produced and marketed by U.S.-based firms.

12 Rosenberg, "Diffusion of Technology"; and Mowery and Rosenberg, "Market Demand."

13 R. Vernon and W. H. Davidson, "Foreign Production of Technology-Intensive Products by U.S.-Based Multinational Enterprises," a study funded by the National Science Foundation, Boston, Mass., 1979.

14 Bones, "Are Foreign Subsidiaries More Innovative?"

15 M. J. Gordon and D. J. Fowler, *The Drug Industry: A Case Study of the Effects of Foreign Control on the Canadian Economy* (Ottawa: Canadian Institute for Economic Policy, 1981).

16 Globerman, *Technological Diffusion*.

17 W. Adams and J. B. Dirlam, "Big Steel: Invention and Innovation," *The Quarterly Journal of Economics* 80, no. 2 (May 1966):167-89.

18 H. G. Baumann, "The Diffusion of the Basic Oxygen Process in the U.S. and Canadian Steel Industries, 1955-69," University of Western Ontario, Department of Economics, Research Report 7303, London, Ont., 1973.

19 K. McMullen, "A Model of Lag Lengths for Innovation Adoption by Canadian Firms," Economic Council of Canada, Discussion Paper 216, Ottawa, May 1982.

20 Howe and McFetridge, "Determinants of R & D Expenditures."

21 S. Globerman, *The Adoption of Computer Technology in Selected Canadian Service Industries*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1981).

22 See Globerman, *Computer Technology in Service Industries*, p. 42. Indivisibility refers to the fact that some innovations cannot be broken down into smaller units – for example, to allow smaller-scale trials.

23 S. Globerman, "The Adoption of Computer Technology by Insurance Companies," a paper prepared for the Economic Council of Canada, 1983.

24 Similar patterns have been observed in the automation of the banking industry; see D. McQueen and J. R. Savary, "Economic Significance of the Computerization of Deposit-Taking Institutions in Canada," Economic Council of Canada, Discussion Paper 87, Ottawa, April 1977.

25 For a description of the project (including organization, marketing strategy, methodology, and evaluation of results), see E. C. Burns, "Patent Technical Information Services Project," Department of Consumer and Corporate Affairs, Ottawa, 1981.

CHAPTER 6

1 Economic Council of Canada, *Intervention and Efficiency: A Study of Government Credit and Credit Guarantees in the Private Sector* (Ottawa: Supply and Services Canada, 1982).

2 These programs, together with the issues discussed in this chapter, are examined in detail in A. Tarasofsky, "The Subsidization of Specific Innovation Projects by the Government of Canada," a paper in preparation for the Economic Council of Canada. Note that smaller programs, roughly analogous to the federal government's, also exist in various provinces.

3 See K. E. Boulding, "The Concept of Economic Surplus," *American Economic Review* 35, no. 5 (December 1945). A comprehensive review of the relevant literature appears in J. M. Currie, J. A. Murphy, and A. Schmitz, "The Concept of Economic Surplus and Its Use in Economic Analysis," *Economic Journal* 81, no. 324 (December 1971):741-99.

4 This argument implicitly assumes that financial markets are efficient – a question that we explored in *Intervention and Efficiency*. It is important to note, however, that even if financial markets are not efficient, this does not constitute adequate justification for paying subsidies to innovative firms. What it does imply is the existence of a case for other types of government action, such as providing loans, loan guarantees, and the like.

5 Examples include the Automotive Manufacturing Assistance Program (AMAP), the Footwear and Tanning Industries Adjustment Program (FTIAP), and Pharmaceutical Industry Development Assistance (PIDA).

6 The same could also be said of such indicators as the Canadian-content/PAIT-subsidy and export-sales/PAIT-subsidy ratios, which appear in some annual reviews of the PAIT's performance.

7 See Department of Industry, Trade and Commerce, "The Enterprise Development Program: First Annual Review, for the Period April 1, 1977 to March 31, 1979," Ottawa, June 1979, p. 9.

8 For example, a firm with a tangible net worth of $2.5 million or less is classified as small. If the project is classified as high-risk, its cost should approximate 10 per cent of the firm's tangible net worth, 25 per cent of last year's cash flow, and 15 per cent of the average cash flow of the last three years.

9 The information that applicant firms are required to provide is specified in a document called "Contribution Submission." This document has two sections, of which the second (Section B) is the more detailed. Three-year projections are called for, pertaining to the firm's overall operations and to the project's sales, expenses, cost savings, and profits. Nowhere in the submission is it explicitly recognized that the project might, if successful, generate benefits that the firm could not appropriate. A review of the files of several large projects subsidized under the EDP has produced no evidence that the subject of inappropriated social benefits receives conscious attention at any stage in the decision-making process; see Tarasofsky, "Subsidization."

10 In spite of the requirements set forth in the Contribution Submission, it is not uncommon for the projections to refer only to the firm as a whole and not to the project. In the case of a small firm, where the project may represent a decisive proportion of its activities over the projected period, this is perhaps not a serious problem, although it is clearly a second-best situation. But this saving grace does not exist where the project, however large it may be in absolute terms, does not dominate the firm's overall activities.

11 Department of Industry, Trade and Commerce, "Defense Industry Productivity Program: Administrative Directive," Ottawa, June 1977, p. 1.

12 IT & C, "Administrative Directive," p. 3.

13 This view is advanced in spite of the argument developed, for example, by G. P. Jenkins, in "Theory and Estimation of the Social Cost of Foreign Exchange Using a General Equilibrium Model with Distortions in All Markets," Harvard University, Development Discussion Paper 28, Cambridge, Mass., May 1977. Jenkins estimated that the social value of foreign exchange earned by Canada is approximately 115 per cent of its market value. This could be taken to imply that exports bring an inherent benefit, and imports an inherent cost; and this, in turn, could serve as a broad rationale for subsidizing exports. It seems fair to say, without prejudice to an excellent and intriguing study, that much more research is necessary before the analytical model used by Jenkins can be accepted as having sufficient applicability to Canada's present and future position in the international marketplace to serve as a basis for broad policies.

14 National Research Council, "Industrial Research Assistance Program: Information for Applicants," Ottawa, March 1981.

15 See NRC, *The Urgent Investment*, pp. 86-87, for a more complete expression of these views. It is possible that some concept of incrementality entered into the making of these judgments; if it did, it does not appear to resemble the concept described here.

16 This, needless to say, follows not from any notion that businessmen are less inclined to be forthright than other recipients of subsidies, but from the principle that those who are entrusted with the responsibility of allocating subsidies must also assume responsibility for the calculations upon which their allocations are based.

17 The federal Make-or-Buy Program and the Unsolicited Proposals Program, both administered by Supply and Services Canada, are examples of such procurement activities.

18 National Research Council, "Key Facts on PILP – Program for Industry/Laboratory Projects," Ottawa, undated.

19 NRC, "Key Facts on PILP."

20 This problem is discussed in K. Pavitt and W. Walker, "Government Policies Towards Industrial Innovation: A Review," *Research Policy* (May 1976).

21 G. Kirouac, "Information and Assistance Service to the Manufacturing Industry in Canada," a paper presented to a conference on Information and Industry, Advisory Group for Aerospace Research and Development, Neuilly-sur-Seine, France [*circa* 1978].

22 See Tarasofsky, "Subsidization"; and D. Usher, "The Benefits and Costs of Firm-Specific Investment Grants: A Study of Five Federal Programs," a paper prepared for the Economic Council of Canada, 1982.

CHAPTER 7

1 Examples of the kinds of changes that sound plausible but are beyond our competence to assess properly are: the provision of a legal basis for the PEMS system; the payment of bonuses for lapsed funds; an emphasis on dollars rather than person-years in budget allocations; and systematic and periodic re-evaluations of the functions of, and necessity for, departments and agencies ("sunset" provisions).

2 P. Morici, A.J.R. Smith, and S. Lea, "Canadian Industrial Policy," National Planning Association, Washington, 1981, Table 10, p. 87.

3 A more technically precise specification of what we have in mind would be that, in general, program administrators should award subsidies only to projects that are expected to meet both of the following conditions: 1) the present (discounted) value of the project's benefits to the innovative firm is less than the

present value of its costs; and 2) the present value of the project's benefits that the firm cannot appropriate exceeds that of its benefits to the firm by an amount that is at least equal to the present value of the sum of the firm's expected deficit and the cost of delivering the subsidy. Once these conditions are met, the subsidy should be equal to the present value of the firm's expected deficit.

CHAPTER 8

1 P.-P. Proulx, "North American Trade in a Changing International Trade Context: The Role of the World Product Mandates," Toronto, 1981; Proulx used data derived from U.S. Department of Commerce, "Foreign Trade Imports: Related/Nonrelated," unpublished annual series IQ246.

2 Department of Industry, Trade and Commerce, "Multilateral Trade Negotiations, 1973-1979," Ottawa, 1979. Similarly calculated declines in the tariff barriers imposed against Canada by the European Economic Community, Japan, and most other developed nations amount to about 30 per cent.

3 M. Sharp, "Canada-U.S. Relations: Options for the Future," *International Perspectives* (Autumn 1972).

4 For example, Department of Industry, Trade and Commerce, *Canada's Export Development Plan for Australia* (Ottawa: IT & C, October 1981); and Department of External Affairs, *Canada's Export Development Plan for Brazil* (Ottawa: IT & C, May 1982).

5 S. Stykolt and H. C. Eastman, "A Model for the Study of Protected Oligopolies," *Economic Journal* 70 (June 1960):336-47.

6 There are a number of different methods for calculating average tariffs, and another estimate has the Canadian post-Tokyo Round rate at 9 to 10 per cent. However, this slight difference does not affect the points made.

7 F. M. Scherer *et al.*, *The Economics of Multi-Plant Operation* (Cambridge, Mass.: Harvard University Press, 1975), pp. 80, 85, and 94.

8 Ministry of State for Science and Technology, *Canadian Trade in Technology-Intensive Manufactures, 1964-76* (Ottawa: MOSST, 1978).

9 The most forceful presentation of these advantages has come from the Science Council of Canada; see, for example, *Forging the Links: A Technology Policy for Canada* (Ottawa: Supply and Services Canada, February 1979); and Britton and Gilmour, *The Weakest Link*.

10 D. P. De Melto, K. E. McMullen, and R. M. Wills, "Preliminary Report: Innovation and Technological Change in Five Canadian Industries," Economic Council of Canada, Discussion Paper 176, Ottawa, October 1980.

11 P. Hanel and K. Palda, "Innovation and Export Performance in Canadian Manufacturing," Economic Council of Canada, Discussion Paper 209, Ottawa, December 1981.

CHAPTER 9

1 Senate Standing Committee on Foreign Affairs, *Canada-United States Relations*, vol. II: "Canada's Trade Relations with the United States" (Ottawa: Queen's Printer, 1978), p. 11. Note that when automobiles are excluded, the percentage falls to 44.

2 For details, see K. Stegemann, *Canadian Non-Tariff Barriers to Trade* (Montreal: Private Planning Association of Canada, 1973); and J. Quinn and P. Slayton, eds., *Non-Tariff Barriers after the Tokyo Round* (Montreal: Institute for Research on Public Policy, 1982).

3 The traded-goods sectors are agriculture; forestry; fishing and trapping; mines, quarries and oil wells; and manufacturing. The percentages in the text are taken from Statistics Canada, *System of National Accounts, National Income and Expenditures Accounts, 1964-1978* (Ottawa: Statistics Canada, 1979), Table 28, pp. 36-37.

4 See, for example, Economic Council of Canada, *Efficiency and Regulation: A Study of Deposit Institutions* (Ottawa: Supply and Services Canada, 1976).

5 See Economic Council of Canada, *Looking Outward: A New Trade Strategy for Canada* (Ottawa: Information Canada, 1975), Table 2-4, p. 15.

6 Economic Council of Canada, *Reforming Regulation* (Ottawa: Supply and Services Canada, 1981).

7 If, on the other hand, inputs and components receive higher nominal-tariff protection than the output, then, assuming that they are priced up to the tariff, the value-added of the industry output will fall, compared with a no-tariff situation.

8 On this question, see T. Horst, "The Industrial Composition of U.S. Exports and Subsidiary Sales to the Canadian Market," *American Economic Review* 62, no. 1 (March 1972):37-45; D. Orr, "The Industrial Composition of U.S. Exports and Subsidiary Sales to the Canadian Market: Comment," *American Economic Review* 65, no. 1 (March 1975):230-34; and Horst's "Reply," p. 235.

9 See, for example, R. Saunders, "The Determinants of Productivity in Canadian Manufacturing Industries," *Journal of Industrial Economics* 29, no. 2 (December 1980):167-84; and R. E. Caves, M. E. Porter, and A. M. Spence, with J. T. Scott, *Competition in the Open Economy: A Model Applied to Canada* (Cambridge, Mass.: Harvard University Press, 1980), pp. 257-70.

10 See I.L.A. Connidis, "The Canadian Motor Vehicle Assembly Industry: A Study of Protection and Productivity under the Auto Pact," unpublished Ph.D. thesis, Queen's University, Kingston, Ontario, 1978.

11 Technically speaking, the major group is at the two-digit level of aggregation, and the first subgroup is at the four-digit level. There are 167 four-digit manufacturing industries. In all cases, the 1970 Standard Industrial Classification is used.

12 The years displayed for tariffs differ somewhat from those in Tables 9-1 and 9-3, because the latest year for which tariff data were available was 1978; in addition, 1966 is included so that the impact of the

Kennedy Round tariff reductions, implemented over the 1966-70 period, can be better observed.

13 This explanation is taken from B. W. Wilkinson and K. Norrie, *Effective Protection and Return to Capital*, Economic Council of Canada (Ottawa: Information Canada, 1975), p. 37.

14 The effective tariffs presented in Table 9-2 are the simple rates. It is possible to adjust them to take into account such factors as exports, taxes, and subsidies. Although differences do occur between the two measures, they give roughly similar findings, with some exceptions.

15 See Caves *et al.*, *Competition*, pp. 67-74; preliminary results obtained in work conducted for the Economic Council are consistent with their findings.

16 See, also, Department of Finance, *Economic Review: A Perspective on the Decade* (Ottawa: 1980), pp. 8-9 and 97-102; and Economic Council of Canada, *Room for Manoeuvre: Eighteenth Annual Review* (Ottawa: Supply and Services Canada, 1981), pp. 25-30.

17 The discussion that follows is based upon J. Baldwin and P. Gorecki, with J. McVey and J. Crysdale, "Entry and Exit to the Canadian Manufacturing Sector: 1970-1979," Economic Council of Canada, Discussion Paper No. 225, Ottawa, February 1983.

18 D. L. Birch, "Who Creates Jobs?", *The Public Interest*, no. 65 (Fall 1981):3-14.

19 For details, see Department of Industry, Trade and Commerce, *A Report on the Labour Force Tracking Project/Costs of Labour Adjustment Study* (Ottawa: IT & C, 1979).

20 T. Hazledine, *The Costs of Protecting Jobs in 100 Canadian Manufacturing Industries*, Employment and Immigration Canada, Task Force on Labour Market Development, Technical Study 16 (Ottawa: Supply and Services Canada, 1981), p. 3.

21 Reliable figures on permanent layoffs are not available to compare with the figure of 40,000. One estimate of major shutdowns and layoffs that occurred across the entire economy suggests that at least 28,000 workers were displaced during the 1974-78 period; see Employment and Immigration Canada, Task Force on Labour Market Development, *Labour Market Development in the 1980s* (Ottawa: Supply and Services Canada, 1981), p. 195. Major layoffs are defined in this context as involving at least 400 employees. In the period 1974-78, 70 such occurrences were recorded. No doubt the number of layoffs would increase significantly if the threshold were lower.

22 The discussion that follows is based upon a series of background papers prepared for the Economic Council of Canada by J. R. Baldwin and P. K. Gorecki.

23 Daly, Keys, and Spence, *Scale and Specialization*.

24 The more detailed classification system divides the manufacturing sector into 6,126 commodities, compared with 167 manufacturing industries in the four-digit classification.

Chapter 10

1 See R. J. Wonnacott, *Canada's Trade Options*, Economic Council of Canada (Ottawa: Information Canada, 1975); R. J. Wonnacott, *US-Canadian Free Trade: The Potential Impact on the Canadian Economy* (Montreal: Private Planning Association, 1968); and R. J. Wonnacott, and P. Wonnacott, *Free Trade Between the United States and Canada* (Cambridge, Mass.: Harvard University Press, 1967). Work still in progress at the time of writing has reached similar results, using more recent data; see R. Harris, "Tariffs, Industrial Subsidies and the Structure of Manufacturing Industries in Canada," Ontario Economic Council, Toronto, 1982.

2 Economic Council of Canada, *Looking Outward*, p. 174.

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