1984

Technology Transfer and Canada's Competitive Performance

Donald J. Daly

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WORKING PAPER NO. 8442C

TECHNOLOGY TRANSFER AND CANADA'S
COMPETITIVE PERFORMANCE

Donald J. Daly

This paper contains preliminary findings from research work still in progress and should not be quoted without prior approval of the author.

DEPARTMENT OF ECONOMICS
UNIVERSITY OF WESTERN ONTARIO
LONDON, CANADA
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CURRENT ISSUES IN TRADE AND INVESTMENT
IN SERVICE INDUSTRIES:
U.S.-CANADIAN BILATERAL AND MULTILATERAL PERSPECTIVES

THE THIRD ANNUAL WORKSHOP ON U.S.-CANADIAN RELATIONS

Sponsored by the Institute of Public Policy Studies of The University of Michigan and the Centre for the Study of International Economic Relations of the University of Western Ontario, with financial support from the Ford Foundation, Donner Foundation, National Science Foundation, Ontario Economic Council, Bank of Montreal, IBM Canada, and The Fishman-Davidson Center of the University of Pennsylvania.

October 19-20, 1984
Ann Arbor, Michigan

Donald J. Daly
York University

Technology Transfer and Canada's Competitive Performance
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For Third Annual Workshop
on U.S. - Canadian Relations
October 19-20, 1984
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Although the major emphasis of this workshop is on trade and investment in the service sector, the transfer of technology and its importance in the trade, investment and employment performance of Canadian manufacturing in a North American context continues to be an important and controversial area in analysis and policy. The payments for these transfers of technologies (by both Canadian owned companies and subsidiaries) are an element in the deficit on service transactions that Canada has with the United States and in aggregate.

After a brief introduction, this survey will examine five topics, starting with a more aggregative picture and moving down to narrower topics, an approach in line with the current emphasis in management and corporate strategy of putting the issues of the firm and industry into a broader environmental perspective. The first major part will summarize recent data on Canada's productivity, cost and real wage performance in an international perspective for manufacturing. A second section will review the evidence on ownership and performance within Canadian manufacturing. The third section will discuss the various dimensions of technology and its relationship to performance drawing on new perspectives on these issues, and the options open to the firm of "making" or "buying" technologies that may be of potential relevance. The fourth section reviews the Canadian business practice, and the potential benefits and costs from those prevailing business practices. The last section will discuss the implications for Canadian government policy.

Introduction

A long discussion of Canadian manufacturing is not necessary for the audience this paper is designed for, but five points are important to bear in mind in this area.
Canada continues to be a high cost, low productivity producer of manufactured products in relation to other countries, in spite of the increases in plant size and production runs that have occurred in the 1970's. The increases in output per hour in 1983 after the severe 1981-82 recession does not modify that picture. Although there are a growing number of firms and industries who have become successful exporters, there are still a large number of plants and firms for whom this is not yet true. Manufacturing is not generally an area of comparative advantage for Canada in a broader international perspective.

Manufacturing continues to be fairly important in terms of output and employment. Manufacturing was about 21 per cent of gross domestic product at factor cost in 1981, down slightly from earlier decades, but both exports and imports of manufactured products are large and growing in relation to domestic production. For example, exports of manufactured products had grown from less than 20 per cent of domestic shipments in the mid 1960's to over 30 per cent in the late 1970's and early 1980's.

Trade in manufactured products has been the most rapidly growing sector in world trade since the second world war, with international trade tending to grow more rapidly than either domestic production or domestic consumption of manufactured products in most countries and trading regions. To an important degree this reflects the increased amount of intra-industry trade that has been developing in many industry and commodity groups and in many countries. However, when Canada tends to be a high cost producer of manufactured products, one should not be surprised if the Canadian share of the world market for many product groups has fallen.

A further important point is the high and increased interdependence between the Canadian and U.S. economies. This is reflected in the dominant share of trade with the United States in exports and imports, both for merchandise trade
and trade in services. Beyond such basic statistics lies the fundamental fact that North America is a common economic entity, and the two economies basically move together in terms of macro performance. If there are differences, the task of the analyst is to explain why such differences occur.

There is also a significant amount of U.S. ownership of Canadian industry, a fact that is widely recognized. However, there are several other developments over the last decade that are less widely known. One is that the Canadian share of U.S. direct investment has been declining for many years, partly with the more rapid growth in the European market. In 1967, more than 25 per cent of the stock of direct investment in the developed market economies was in Canada, but by the late 1970's, the Canadian share of inward direct investment flows to the developed market economies had dropped to about 3 per cent. U.S. direct investment has also been falling slightly as a share of the Canadian market. An even more striking development is the rapid growth in Canadian direct investment in the United States, amounting to a growth rate of over 25 per cent at an annual rate from 1975 to 1980. Our interest in this paper, however, is more on the effects of foreign direct investment in Canada on performance and technology transfer.

Canada's International Cost Competitiveness

It has been clear for more than a decade and a half that the levels of output per hour in a wide range of individual manufacturing industries are lower than the comparable industries in the United States. The last fairly comprehensive survey was done by staff of the Conference Board in Canada was for 1974 and this showed a fair amount of variation around the mean for the manufacturing in total, a pattern that was similar for similar studies for fifteen pairs of country comparisons. For 1974, the average level of real net output per employee was about 23 per cent below the United States, a narrower gap than in earlier decades. From 1974 to 1983, however, the rate of increase in output per hour in Canada has been slower
than in the United States so the gap for total manufacturing appears to have
widened to about 28 per cent. During the 1970's there has been increase in both
average plant size and the size of production run in Canada and an increase in
output in relation to both labor and capital inputs in Canada. There has also
been an increase in both exports and imports of a wide range of manufactured
products, reflecting the increased importance of intra-industry trade. However,
important increases have taken place simultaneously in the United States. The
levels of output per hour dropped during the recession in both the United States
and Canada, but the increases in 1983 were dramatic in both countries (especially
in Canada), but the longer-term gap continues to persist as it has since the
1930's.

One can also make a comparison of labor costs per unit of output between
Canada and the United States. For example, total compensation per hour (including
fringe benefits) in Canada for production workers was about 7 per cent below the
United States at the average 1983 exchange rate. The relative difference of the
compensation per hour to the difference in output per hour suggests that the level
of labor cost in Canada was about 29 per cent higher than in the United States - a
dramatic indication of the order of magnitude of the problems of cost
competitiveness in relation to our major market and supplier.

This research has emphasized labor costs, as it is the most important element
in costs for total manufacturing. For 1981, for example, total labour income was
almost two-thirds of gross domestic product in manufacturing. (Labor income for
an individual firm or industry is normally a much smaller proportion of company or
industry costs as purchased materials and services includes an important element
of labor costs indirectly that are eliminated when the large and growing role of
inter-industry trade is eliminated). Depreciation is another cost factor in gross
domestic product at factor cost, and this is a larger component of factor cost in
Canada than in the United States. In other words, an estimate of total factor
cost per unit of output for Canada would be even more above the U.S. than the 29 per cent higher level of labor cost referred to in the previous paragraph.

A wide variety of factors have been put forth as contributing reasons for this long-standing structural difference, but I doubt if any one factor is an adequate explanation for the differences. The presence of tariffs and non-tariff barriers to trade and the resulting effects on smaller plant sizes and short runs is the most widely researched and accepted interpretation for this difference.\(^3\) It is also widely accepted that the available evidence indicates that new products and new processes are usually first introduced in Canada later than in other countries, and that the diffusion of such new technologies within Canada have been slower than in other countries.\(^4\) This topic will be discussed more fully in a later section.

Although the primary focus of this paper is on Canada-U.S. relations, it may be useful to put the comparative cost position of North America into a broader comparison with some of the other major industrialized countries. This can be seen for unit labor costs for total manufacturing for 1983. Table 1 shows that only the United Kingdom had higher unit labor costs than Canada in 1983, based on the differences then prevailing in total compensation per hour, exchange rates, and real output per hour.
Table 1

Labour Costs per Unit, Manufacturing, Selected Countries, 1983
United States = 100.0

<table>
<thead>
<tr>
<th>Country</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>136.0</td>
</tr>
<tr>
<td>Canada</td>
<td>129.3</td>
</tr>
<tr>
<td>Italy</td>
<td>107.2</td>
</tr>
<tr>
<td>Belgium</td>
<td>106.3</td>
</tr>
<tr>
<td>United States</td>
<td>100.0</td>
</tr>
<tr>
<td>Germany</td>
<td>92.3</td>
</tr>
<tr>
<td>France</td>
<td>86.5</td>
</tr>
<tr>
<td>Sweden</td>
<td>73.3</td>
</tr>
<tr>
<td>Japan</td>
<td>61.2</td>
</tr>
</tbody>
</table>


Japan had the lowest level of unit labor costs, reflecting compensation per hour about half the United States level and output per hour that is now within twenty per cent of U.S. levels. Unit labor costs in Japan were roughly 40 per cent below U.S. levels, and half the level in Canada, a dramatic difference. By 1983, Japan's level of output per hour exceeded Canada and most of the countries in the European Economic Community. The rate of increase in output per hour was so much more rapid than in the other industrialized countries that it had moved from the lowest of the nine countries shown in 1955 to the third highest. Although the rate of increase in Japan has slowed down since 1974, the rate of growth in output per hour has continued to be the most rapid of the countries
shown over the last decade. Furthermore, the rate of increase in real hourly wages in Japan (total compensation per hour divided by the consumer price index) was only about one-fifth the increase in real output per hour. By far the largest part of the increase in output per hour was passed to the buyers of manufactured products domestically and internationally, rather than accruing to workers in manufacturing within Japan.  

The position of the individual European countries varied with France, Germany and Sweden moderately below the United States and Belgium and Italy moderately above. Only the United Kingdom was well out of line above the others. This was a significant change since 1980 when all the European countries were well above the United States, but the marked drop in their exchange rates relative to the U.S. dollar brought their unit labor costs much more in line with the United States than they had been for a decade.

The magnitude of the cost differences between Canada and the United States pose three challenges for business, labor and governments in Canada. How can productivity levels be increased to close the existing gap? What other steps are necessary to sustain continued increases in output per hour more in step with those taking place in the other industrialized countries? In addition, a much larger part of the increases in output per hour must be passed along to the buyers in the form of price reductions for manufactured products, rather than accruing to workers in manufacturing as in the past decade.

By 1983, it would appear that real wages per hour in Canadian manufacturing were about 15 per cent below the United States, while real manufacturing output per hour was almost 30 per cent lower. Such a difference may have been sustainable when Canada had a strong comparative advantage in natural resource products, there was a significant degree of protection for Canadian industry, and there was a pressure of demand against capacity in manufactured products in world
markets. Most of these factors have now gone or are going, and corporate rates of return in manufacturing in Canada had dropped well below returns estimated on a comparable basis in the United States and Japan.

The role of technology transfer in these productivity and cost differences will be examined later in this survey.

Ownership and Performance

The last section emphasized Canada - U.S. differences in performance as measured by data on output per hour and unit labor costs (with some comparisons to put North America into perspective with Japan and some of the major European economies). This section will examine differences within Canadian manufacturing, concentrating on differences in performance.

The classic and still the most comprehensive survey was A. E. Safarian's 1966 volume and the shorter 1969 study, which covered management, exports, imports, transfer of knowledge, production costs and other aspects of performance. For our purposes, one important and widely recognized result was that the average size of the U.S. controlled enterprises was substantially larger than all manufacturing enterprises as measured by employment, salaries and wages, value added, and selling value of factory shipments. Another important result was that the foreign owned enterprises had above average levels of salaries and wages, value added, and factory shipments, after standardizing by employment. Another point was that the differences between the U.S. owned and Canadian owned establishments were smaller for the larger enterprises (i.e. more than $25 million investment in Canada) than for all enterprises. The implication was that the U.S. owned enterprises were more productive than Canadian owned ones, but with the data then available it was not possible to allow for size, industry and ownership differences simultaneously.
Safarian also pointed out that his results for Canada were in line with studies by Dunning for the United Kingdom and Brash for Australia. Dunning found that the productivity of a selection of American-owned firms was 18 per cent above their British competitors, and the difference reflected superior efficiency rather than industrial composition of the two groups. In Australia, the value of production per person employed was about 36 percent higher than Australian industry generally. These differences appeared to reflect a combination of firm size, the use of modern techniques of management, and higher machinery per employee. 9

A study of the Indian pharmaceutical industry is also important. It emphasized differences in managerial practices with a range of companies from high emphasis on traditional managerial practices at one extreme, and largely Americanized at the other. The measures of performance at the firm level included such variables as growth in sales and earnings per share, a number of measures of profits and rates of return, and sales and net profit per employee. The resulting composite measures showed much higher relative economic success for the Americanized firms than those following traditional Indian management practices. The most successful companies, however, were ones that incorporated some elements of local practices and were sensitive to local values and customs. The major theme is that managerial practices were central in performance, rather than ownership per se. 10

In recent years, the practice by Statistics Canada of doing special tabulations of the basic statistical returns for research purposes with the client paying the marginal costs of the computer runs has considerably increased our information on performance. It has now become possible to standardize by industry, size and ownership simultaneously, but without violating the concept of confidentiality under the Statistics Act. This was done by D. C. MacCharles in his Ph. D. dissertation for the University of Toronto. The data indicated that
the levels of value added per employee were significantly less for small Canadian owned plants and firms than the foreign owned organizations in the same industry and size group. However, the differences between the Canadian owned and U.S. owned organizations had levels of value added per employee that were half or less than the foreign controlled organization, while the larger Canadian owned organizations were roughly comparable. This is illustrated on the basis of establishment data in Table 2, but the results for company data were similar. 11

Table 2
Selected Comparisons Between Sectors of Control

Plant-Level Data for 1974

Manufacturing Sector

<table>
<thead>
<tr>
<th>Plant Size Measured in Employees</th>
<th>Value-Added/ Production Worker (Ratio Cdn. to Fgn.)</th>
<th>Percentage Of Sales: Cdn. Fgn.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fewer than 50</td>
<td>.50</td>
<td>19% 5%</td>
</tr>
<tr>
<td>50 to 200</td>
<td>.67</td>
<td></td>
</tr>
<tr>
<td>200 to 400</td>
<td>.75</td>
<td>23% 53%</td>
</tr>
<tr>
<td>Greater than 400</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

Sources: Daly and MacCharles, op. cit.
Statistics Canada, various publications

Studies based on more disaggregated data than previously available have indicated that the product diversity apparent in earlier years has diminished, especially in Canadian owned establishments. By 1979, the earlier greater product diversity in the Canadian owned establishments than in the subsidiaries had been considerably diminished. There has also been a significant increase in intra-industry trade especially for the Canadian-owned establishments. It is
possible that some narrowing in the differences in net value added per employee has begun to occur since the last comparison was made for 1974, but this point has not yet been researched. If some important differences in productivity still persist in spite of the reduction in the differences in the extent of product diversity, this would suggest that differences in such other characteristics such as management and the use of best practice technology have also been important in the historical differences within Canadian manufacturing.

The Role of Technology in Performance

There is no question that technological developments in the broadest sense have been important in the major increases in real output per capita and living standards that have taken place in all the major industrialized countries over the last two or three centuries. Although there has been a significant increase in real capital per person employed, it would also be agreed that the increases in output have been greater than in aggregate measures of multi-factor input. Some of these increases in output in relation to various measures of multi-factor input (or total factor input) are associated with inter-industry shifts and economies of scale, but an important part of the remainder could be regarded as being associated with knowledge and the diffusion of new technology. Although one can learn quite a bit about economic growth over time and differences between countries from aggregative data and associated measures at the industry level, such approaches can explain only part of the story.

It is also useful to see what light can be thrown on these issues using the tools of management and corporate strategy, especially the role of natural science and engineering technology in performance at the level of the firm. There is no question that the natural science and engineering disciplines have an important contribution to make. The role of steam, electricity, and the internal combustion as sources of power, light and locomotion are all important in the changing
economic performance in North America since the middle of the nineteenth century, for example. Some current examples are robots, computers, lasers, fibre optics, etc. The development of the basic scientific technology and the successful manufacture of such products at lower cost is a necessary part of the story. The scientific and "hardware" aspects of technology are not sufficient, however, for successful implementation and use of the technology on a widespread basis.

A second necessary element are the related organizational aspects of openness to change, morale, motivation, etc. that are built on psychology and sociology as applied to organizations. Previous research by economists has shown long lags in the adoption of new technology (both new products and new processes of producing previous technology), and the length of these lags differs between countries. Studies of individual plants and firms (both on a comprehensive statistical basis and studies by behavioural scientists and students of management) indicate tremendous differences in incomes, and output per employee, within the same industry. Such differences persist for extended periods, but there is also considerable dynamism as new organizations enter and previous ones exit. Some organizations can improve their relative position with new management, and other well managed companies can slip in relative performance. Many observers would not have expected Chrysler to experience the rebirth that is has in recent years, and few people in Detroit would have predicted two decades ago that the Japanese auto producers would have made the inroads into the North American market for small and intermediate cars with priority on quality, use of robotics in assembly, plant layout and inventory control, and low cost that has been achieved by the 1980's.

A third important element within organizations is a management information system that would provide management at all levels of the organization the information they would need on a current basis for decision making and also to monitor and control performance within the organization. Such information could
include personnel records, pay, performance, future training needs, promotion potential, etc. Another area would be managerial accounting records on per unit costs, and how per unit costs would be affected by increased volume. Inventory control is another area and businesses in Canada and Japan have been able to reduce inventory-sales ratios in manufacturing and trade by improved inventory records and improved inventory and production management, including computerization. Higher interest rates and pressures on profit margins have put pressure on organizations to speed up the implementation of these practices.

These three dimensions of corporate managerial practices are illustrated in the accompanying Figure 1. It had been prepared to illustrate office automation, but the same three areas are fully applicable to manufacturing. The really effective development and implementation of new technology in organizations to achieve maximum profits and market penetration on a long term basis requires careful attention to all three of these dimensions rather than only one.

It would be just as important in assessing public policy to look at all three of these dimensions rather than only one. This will be explored further in the last section of this paper.

There has been quite a bit of popular discussion in recent years about high technology. Some of the discussion implies that there are some industries that are high technology (and it is sometimes suggested that high technology industries that should be encouraged, while discouraging other low technology industries). What this discussion misses is that high technology processes can be applied in any industry. There is a long tradition of scientific agriculture in North America that applies sophisticated research methods to fertilizers, new strains of crops (wheat, corn, etc.), and new varieties of livestock, chickens, etc. Computer assisted design and computer assisted manufacturing can be applied to such traditional and mature industries as textiles and footwear. And the personal
computer is beginning to have an effect on such labour intensive industries as research manuscripts and word processing machines and high speed printers are making the typing of hand-written manuscripts a high cost operation. Cost reductions of 20 per cent a year will make the use of computers increasingly attractive to individuals and organizations.

**Canadian Experience in the Development and Use of New Technology**

In considering new technology, it is crucial to distinguish between the development and the use of new technology. The development side can include basic scientific discoveries and the later innovations based on it. Once the new technology has been developed so that it is both technically successful and can be produced economically and marketed profitably, there is a later stage of how quickly it is first used in other countries, and how quickly it is used by say half the plants in the using industry. The engineering and scientific aspects are important in the initial invention stage, but the behavioural sciences and their application to the sources of change and resistance to change in organization are important in the diffusion process.

I would hypothesize that the **initial** development of new technology could be slow, risky, and expensive. Some evidence on the lags between the initial major invention and the innovation brought together by Gerhard Mensch suggest that these lags can be as short as a decade, or as long as a century. For more than a hundred major inventions over the last century and a half, the average lag from invention to innovation was 45 years. New types of knowledge do not always lead to technically successful production, and only a small proportion of the technically successful also meet the market test of profitable production. Furthermore, many important technological developments occur as an accidental by-product of researchers working on something quite different. Many of these
steps can become expensive as well as risky. For some types of research, some minimum size team is necessary to have all the areas of skills and expertise that a complex project may involve. In some cases only quite large corporations could have the people resources and cash flow to implement large technology projects. At the same time, some small organizations can make successful breakthroughs with a combination of ingenuity, hard work, and luck. Patents can sometimes protect the first inventor, but these eventually run out, and modifications and adaptations can sometimes lead to another patentable product that can provide a comparable service and capture an important market share.

However, once the initial technological developments have been made, the marginal costs of a company implementing the project can be relatively low, and the gains can be quite high. Producers of machinery in durable manufacturing are anxious to provide the buyer with technical advice and help on how to use the new technology embodied in the latest machine, and an early study showed that this diffusion process was more rapid in durable than in non-durable manufacturing. The same thing is happening in the small computer field, and the ads in the financial pages announce regular demonstration sessions for potential buyers. The micro chip has led to small and low cost computers, but the large computer companies had been working for about four decades to develop the present "hardware" and the price reductions that have taken place.

For a small country like Canada, individual firms have the option of "making" or "buying" the new technology. What can one say about the Canadian experience in these respects? On the basis of the available data and the research that has been done, there are three conclusions that can be drawn.

First, a dominant part of the new technology and inventions in Canada have been developed initially elsewhere. This is reflected in patent statistics, for example, where only about 7 per cent of the patents granted in Canada are to
Canadian residents. More than three-fifths of the patents are issued to residents of the United States. One shouldn't be too surprised at this, as the Canadian population in the OECD industrialized countries (covering North America, Japan and North West Europe). The high reliance on imported technology is also reflected in payments for research and development and other technological payments abroad that usually run between three and four times receipts from abroad.

Second, Canadians have been successful in making many important technological developments, but a high proportion of these have been first produced commercially elsewhere, principally in the United States. This again is not surprising. There are likely to be larger profits and less marketing risks in a large market than a small market, and more opportunities to take advantage of the potential economies of scale in a large market.

Third, there is usually a longer lag from the first introduction of a new process in Canada until it is used by half the plants in Canada until it is used by half the plants in that industry than the length of the diffusion process in the United States and elsewhere. This was the experience in the use of special felt presses to reduce water content in the manufacture of pulp and paper, the use of tufting machinery in the manufacture of synthetic carpeting, and the use of numerical control in the tool and die industry. There have also been press reports that the proportion of manufacturing firms using computers in Canada is about half the proportion in the United States. One of the few documented exceptions to the pattern of slower diffusion of new technology in Canada on manufacturing than in the United States was the use of the basic oxygen process for the manufacture of steel.

A number of factors seem to have contributed to this tendency for the slower adoption of new technology in Canada than in U.S. manufacturing. It would be widely accepted that the degree of tariff protection historically and the higher
degree of tariff protection historically and the higher degree of corporate concentration has contributed to less competitive pressure in Canada, which is usually regarded as important in the fast adoption of new technology. The role of Japanese competition in the European bearing industry was an important factor in introducing changes in that industry some years after complete free trade in industrial products within Japan had been achieved. If the organizational costs of introducing new products are about the same in large and small countries, the returns could very well be less in Canada than in the United States due to the smaller market size. There is also some data that indicates fairly clearly that the levels of formal education of managers in Canada tend to be lower than in the United States (reflecting the lower proportion of Canadians who go on to University) and that Canadian managers tend to move into middle and senior management levels later in their working life. As there tends to be more openness to change and new ideas with younger persons and those with a higher level of formal education, Canadian managers would appear to be less open to change than U.S. managers. There have also been studies by sociologists and political scientists that point out the emphasis on continuity and gradual change in Canadian history and the greater role of the elite in Canada. On the other hand, the United States tends to take pride in rapid (and even revolutionary change), the role of performance (rather than family status) in managerial selection and performance, and a greater openness to new ideas. The economic and social upheavals in continental Western Europe and Japan and the emergence of new business and financial leadership and increased international competition has led to more innovative leadership and faster adoption of new technology in those countries than in Canada, and the United Kingdom. The absence of a radical shake up in the U.S. economic and social structure may have led to the significant erosion of the leadership that the United States had at the end of the Second World War. One of the big questions for the 1980's and 1990's is whether the increased international competition from Japan, Western Europe and some of the
N.I.C.'s will lead to a successful industrial renaissance in the United States.

What can one say in aggregate terms about the relative size of purchased technology compared to domestically produced research and development? One important, but rarely footnoted, study by the Ministry of State for Science and Technology suggests that the amount of actual R and D performed or bought in Canada annually is small compared to the amount available for use domestically.  

The CALURA listings of payments to non-residents (including patents of invention, industrial design, other royalties and similar payments, scientific research, and product and process development research) total almost as much as domestic expenditures by foreign controlled companies. Domestic expenditures by subsidiaries in Canada on R and D was a bit less than one-fourth of the "national R and D" available to them (on the assumption that the level of R and D needed to support the subsidiary's sales is proportional to the proportion of the parent's sales.) A summary of the Canadian R and D expenditures to GDP in manufacturing is shown in Table 3.
### Table 3

**International Comparison of Industrial R and D Expenditures as a Proportion of Gross Domestic Production Manufacturing, 1973**

<table>
<thead>
<tr>
<th>Country</th>
<th>R and D Spending as a Proportion of Manufacturing GDP %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada Excluding Invisible R and D</td>
<td>2.00</td>
</tr>
<tr>
<td>Canada Including Invisible R and D</td>
<td>4.28</td>
</tr>
<tr>
<td>Australia</td>
<td>2.29</td>
</tr>
<tr>
<td>Scandinavia (total)</td>
<td>2.92</td>
</tr>
<tr>
<td>France</td>
<td>3.14</td>
</tr>
<tr>
<td>Germany</td>
<td>3.19</td>
</tr>
<tr>
<td>Japan</td>
<td>3.16</td>
</tr>
<tr>
<td>U.K.</td>
<td>4.66</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>6.45</td>
</tr>
</tbody>
</table>


The inclusion of "invisible" research and development (both purchased and available) more than doubles the Canadian share and moves the relative size of R and D in manufacturing from the lowest to one of the highest, behind only the U.S.A. and the U.K. This data would suggest that access to natural science and engineering technology is not the central problem in poor performance in the use of best practice technology.

A further important point is that it is easier to transfer such new technology from a parent to a subsidiary, than it is to transfer it on an arms length basis between two independent companies. This is especially so for relatively new technologies and in industries that are research intensive (as reflected in high ratios of R and D to sales). There is some evidence that the
proportion of internal transfers between affiliated companies has fallen since 1970, and that arms length transfers have correspondingly increased. This reflects the increased competition that has emerged internationally with the widespread reduction in tariff and non-tariff barriers and the emergence of new low cost producers. There has been a significant amount of transfer of high technology products from the industrialized countries to the countries in Eastern Europe and the developing countries, and many of these seemed to be between non-affiliated companies. It was important, however, for the country selling the technology to provide an adequate degree of training and supervision of the transfer, especially in the early stages. There are also differences in the lag of the transfer of technology abroad behind its first introduction by a U.S. based firm. The mean lag for the transfer to the subsidiaries in developed countries was six years, ten years to a subsidiary in the developing countries, and thirteen years for transfers to joint ventures or through licenses on an arm's-length basis. However, the costs of transferring a new production process to the receiving firm can be high, averaging 19 per cent of the total costs for that project to the receiving firm, with a considerable range around that average cost.

It is generally agreed that these technology transfers have a positive effect on the country receiving the technology. A transfer of a new product makes more kinds of goods available for consumption, thereby leading to a higher level of utility. The transfer of process technology would lead to lower monetary and real costs of producing the same (or similar) good and this would lead to higher real incomes in the country receiving the technology. When there are economies of scale in producing new technology, a small country can obtain such new technology by buying it for something close to the marginal cost of the transfer rather than the total cost of developing the new technology. The average cost per unit of producing new technology will typically be less if it is produced in a large
market than in a small market.

One potential limitation on the heavy reliance by a small country on the purchase of new technology from abroad might be noted. The foreign parent or the foreign licensor may specify certain limitations on the export of that product in the home market. There is no doubt that such limitations are specified in certain instances, but the last known comprehensive study was included in the Gray Report. It provided data on almost 800 companies controlled in the United States and additional companies controlled in other countries. The largest number of companies in any category reported no limitations on exports and only 2 per cent of the U.S. controlled companies and 5 per cent of other firms reported no exports allowed. A recent survey of smaller companies in manufacturing found only a small proportion of subsidiaries where export limitations initiated by the parents were reported. There were a few Canadian-owned companies who were licensing technology from foreign companies on an arm's-length basis who reported limitations on exports as a condition under the licensing arrangement. A far more important factor limiting exports of manufactured products by both subsidiaries of multinationals and independent Canadian companies was the lack of cost competitiveness, a theme outlined in the early pages of this survey.

Policy Implications

If the readers expect to find some advice on policies to be implemented next week or next month, they are going to be disappointed! This survey is more social science related to increasing knowledge than research for action. However, the analysis and the evidence thus far does suggest a different focus and emphasis on the nature of Canada's problems in manufacturing and how technology can be brought more effectively to bear on these issues. Let me state the issues rather simply, at the risk of some oversimplification and overstatement.
Much of the public and professional discussion in Canada has concentrated on the importance of natural science and engineering research and development done within Canada as central in improved performance. The implication is that such domestic R and D is a necessary, and sometimes even a sufficient condition for high growth and productivity. It really reflects a high and even exclusive priority on the natural science side of the technology triangle shown in Figure 1.
FIGURE 1

The Automation Triangle

SOFTWARE
(Microelectronic controls)

HARDWARE
(Robots, computers)

MANAGEMENT SYSTEMS
(Kanban, Q.D.C., CAD.CAM)
One fundamental problem with that emphasis is that a major part of new technology in the natural science area comes from abroad - an important part through the multinational parent to the subsidiary (some of which is paid for, but not always covering the full costs of developing the new technology). Some also is obtained on an arm's-length basis between non-affiliated companies, but becomes available with a longer lag and some associated costs by the acquiring firm. However, allowances are made for the availability of new technology from abroad (which is a central source in a small open economy), new technology is available in Canadian manufacturing to a much greater degree than most public discussion in Canada would suggest.

A further important point is that the tax treatment of expenditures on natural science and engineering research and development in Canada has been extremely generous by international standards. Furthermore, the changes introduced in the budget in late 1983 further increased that generosity. However, parts of that new legislation have had a significant impact on the legal and financial business of transferring property rights on tax incentives rather than leading entirely to increased research by the natural scientists!

Although it is too soon to assess the attitude of the new Progressive-Conservative government on this issue, it would seem that their public statements have tended to continue rather than reject the previous policies in this area.

The analysis and evidence emphasized in the last and longest section of this paper suggests that the central problem in performance in the technology area relates to the use and diffusion of new technology, rather than the lack of availability of natural science and engineering technology. The problems are much more in the managerial, social science and cultural areas of slow adoption and implementation of new technology. The problems lie in the "soft" side of the technology triangle shown earlier that has not had the attention it deserves,
either in terms of research, or the policy aspects of what, if anything, the government can do to improve the situation, even in the longer-term. The previous policies in Canada have tended to stimulate R and D in the firm without the assurance that the organization has the competent and innovative management to translate technical success into commercial success, and such an emphasis often turns out to be futile exercise.  

If the lack of openness to change on the technological and organizational side of Canadian manufacturing is an important part of the problem, what can the government do about it? Four areas can be mentioned to illustrate the possibilities.

Firstly, the government should continue to encourage steps that will increase competition domestically, by a continuation of reductions in tariff and non-tariff barriers on the international trade side, and a similar development has been occurring with an increased market share of foreign banks on the financial side. The degree of competition frequently emerges as a factor in facilitating faster diffusion of new technology, so this advice is consistent with that evidence.

Secondly, the use of non-tariff barriers and financial bail-outs frequently operate to maintain the status quo in management and managerial practices. Unprofitable operations are sometimes a reflection of inadequate management and government financial assistance tends to perpetuate the problems and prevent longer-term solutions.

Thirdly, the lack of knowledge about management and managerial performance tends to hinder a more informed policy. Management sometimes deny that there is any problem here, or blame others (government or labor unions). Management problems typically occur simultaneously with problems of small plant size and product diversity, or financial problems that limit the possibility of moving to larger plant and firm size. A regression study may attribute all the problems to
scale and specialization, while management could be an important omitted variable. Research in these areas is still limited in Canada, and the limited funding by SSHRC for strategic studies in management suggests this is unlikely to be rectified from that source. If the federal government wants to see increased funding for research in such strategic areas as management, it may have to finance such a shift in priorities through another department or agency rather than through SSHRC.

The growth in budgets and resources for the teaching of management has not moved up as rapidly as the increased number of students seeking admittance. Furthermore, Canada has lagged behind the United States and Japan in continuing education and training for management and others beyond the formal educational system. There have been some indications that there is support for reducing the previous funding under established program financing and replacing it with grants aimed more directly at areas of education of higher priority than is reflected in the current university allocation of resources. Management education, science and engineering are potential candidates for such a more selective emphasis on educational financing by the federal government.

None of these shifts in policies, even if introduced soon, could lead to early changes in Canadian performance in manufacturing. But other countries are not going to stand still. Almost all the major industrialized countries have had bigger increases in output per hour in manufacturing than Canada over the last three decades and this has persisted from 1973 to 1983. However, a correct identification of the problem is an essential first step in any steps to improve it, whether the solutions come from the private sector, changes in public policy or both.
These views are different from what you typically see and hear about Canada, and most studies about Canadian trade and industrial structure tend to either ignore or play down the importance of management.

However, the really big contrast would be found with the views of the nationalists in Canada. They tend to blame the multinationals for having arbitrary limitations on exports, for importing technology rather than producing it domestically (even though more expensively), or by using transfer prices to divert corporate income (and the associated corporate profits) to the parent. They would advocate producing more natural science and engineering R and D domestically, and for many years gave little attention to the diffusion and implementation of new technology (although that has begun to change). They may not get high marks for the research support for their views, but they have been quite successful in getting press coverage and regular lobbying with cabinet ministers and civil servants.
Footnotes


3. Previous studies by Eastman and Stykolt, Ron and Paul Wonnacott, the Economic Council of Canada's Looking Outward, Daly and Globerman, John Baldwin and Paul Gorecki, Harris and Cox and others illustrate the number of studies.

4. Studies by Steven Globerman, Ed Mansfield and the study coordinated by Dennis de Melto while with the Economic Council of Canada have provided evidence on these themes.


6. The comparison of the level of consumer prices in Canada and the United States was based on the 1965 comparison done by Craig West and others and reported in Dorothy Walters, Canadian Income Levels and Growth: An International Perspective (Ottawa: Economic Council of Canada, 1968), p. 260. This was carried forward to 1983 using annual data for indexes of consumer prices in both countries from U.S. Department of Commerce, Business Conditions Digest, April 1984, pp. 99 and 101. This comparison suggests that consumer prices were about 8.5 per cent higher in Canada than the U.S. in 1983. When hourly compensation in Canada was 93 per cent of U.S. levels in 1983, real hourly compensation was about 15 per cent less in Canada. It is unfortunate that Canada has not participated in the International Comparison Project sponsored by the World Bank and the United Nations as 1965 is now a long way back for inter-country comparisons of price levels and the structure of prices. Significant changes in price levels, relative prices, compensation, and exchange rates have taken place since the mid 1960's.


13. The whole topic of growth accounting has a large, and at times controversial, literature that most of the readers will be generally familiar with, and no attempt to document it will be attempted here. Studies for most countries indicate rates of increase in output in relation to inputs from about 1950 to 1973 that were substantially above the longer-term experience for those countries, but that a significant slowdown in output in relation to factor inputs has occurred in most countries from 1973 to date. However, the reasons for the slowdown and the relative contributions of different factors to that slowdown still defy a consensus among the researchers in this area.


17. Gerhard Menseh, *Stalemate in Technology: Innovations over come the Depression* (Cambridge, Mass: Ballinger, 1979), based on Table 4-1 to 4-4, pp. 124-128.


Careless have reached similar conclusions earlier. John Porter, The Vertical Mosaic (Toronto: University of Toronto Press, 1965) and Wallace Clement, The Canadian Corporate Elite (Toronto: McClelland and Stewart, 1975), esp. Chapter Five, pp. 172-223, have emphasized the important role of elites in Canadian business. This emphasis on the elites reflects a historic tendency in Ontario especially to view the educational system as an institution to preserve the position of elites. Science and management subjects developed in universities many decades later than in the United States.

I would think that the results of these earlier Canadian studies by historians, sociologists, and political scientists would be consistent with Mancur Olson’s recent work on economic growth of nations.


37. D. J. Daly, "Natural Science and Human Science Research - Does Research Funding Match Canada's Problem Areas?" in *Cahiers No. 9* (Ottawa: Social Science Federation of Canada, 1983).


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