Technological Innovation Studies Program

Research Report

Programme des études sur les innovations techniques

Rapport de recherche

Innovation and Performance of Small and Medium Firms: A Re-analysis of Data on a Sample of Nineteen Small and Medium Firms in th Machinery Industry

by
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May 1980

#74

Government of Canada
Gouvernement du Canada

Regional Industrial Expansion
Expansion industrielle régionale

Office of Industrial Innovation
Bureau de l'innovation industrielle

ISSN 0226-3122

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Summary

The purpose of this study was to do a follow-up survey of a number of firms in the industrial machinery sector. These firms were originally surveyed in 1975 on their R & D and innovation process and how these factors related to the ownership of the firm, market strategy, investments in R & D and export activity. From the original sample of 22 firms, a subsample of 19 small and medium size firms were selected for the follow-up study.

Senior executive of each firm were revisited and reinterviewed in a follow-up study in 1979. By tracking the changes in the nature of each firm's autonomy or HQ-subsidiary relationships through to each of the subsequent behaviours it was possible to see a strong pattern of apparently causal linkages.

The data from 1975 to 1979 demonstrated that changes in strategy by top management of the firm (whether local autonomous or MNC HQ) had a marked impact on the various activities and behaviours of the firms or subsidiaries, leading to fairly direct impacts on the innovation rating of a firm. For the Canadian-owned firms, the changes in strategy came about mostly in response to adverse economic conditions between 1975-1979. Consequently, there was a general trimming of activities and lessening of ambitions until conditions improved again. In 1979, the firms that had weathered the

storm were still inclined to be cautious but most indicated a readiness to try again if domestic conditions improved again.

The other general reason for change in strategy was the decision at foreign HQ to be risk-taking or to allocate to the Canadian subsidiary a product mandate for certain types of products. Since these changes occurred at roughly the same time as the cutbacks in the Canadian firms, it must be concluded that the foreign-owned firms are not as sensitive to Canadian domestic market conditions as Canadian firms. For the foreign owned MNC, the volume of business in the Canadian market is most likely such a small proportion of total sales, that local variations in business conditions have much less impact than variations in conditions would have on Canadian owned firms. Secondly, foreign owned firms often have the option of using slack facilities in Canada to produce inventory for other locations (passive exports), thereby again reducing the sensitivity to local market variations.

Thus in order to compete, the Canadian owned firms must take more risks in establishing R & D operations and pursuing export sales than foreign-owned competitors in Canada. In a sense, the Canadian owned firms in this sample are below a certain threshold of sufficient size in terms of both domestic and export sales volume compared to foreign MNC competitors. Most MNC's are above this critical threshold and thus their

subsidiaries in Canada are relatively immune to the same risks as faced by the Canadian owned firms.

On another aspect of the threshold concept, some of the smaller firms in the sample, both Canadian and foreign owned, claimed that they lacked sufficient technical and scientific personnel to be as active in R & D as they would wish to be. A similar problem existed with lack of personnel available for pursuit of export markets. Also among Canadian owned firms there were occasional problems of lack of managerial personnel. By way of combining all these problems into one category, the firms suffered from lack of depth in necessary senior personnel. A number of the smaller firms had considerable problems of overworked management staff and people being spread too thinly to take advantage of available opportunities. Yet there was a very strong reluctance on the part of some Canadian owned firms to take the risk of putting additional technical-managerial people on the payroll.

For larger firms in the sample, the chief personnel problem was lack of qualified machinists and shop personnel. Thus the larger firms suffer from a supply problem in personnel (want to hire and cannot find qualified people) while smaller firms suffer from a demand problem (need to hire but reluctant).

Strangely enough, the smaller firms were the least likely to use government assistance programs to either help defray the costs of R & D or to subsidize the expense of additional technical people. Reasons for this ranged from ignorance of the various programs, to reluctance to get involved in excessive paper work, to ideological resistance to the notion of having anything to do with government. For those who had experience with obtaining government support, reaction ranged from very satisfactory to very frustrated. Among larger firms, there was less perceived difficulty in working with government support programs and in some cases, an active strategy was to utilize the programs as much as possible. Some foreign subsidiaries were discouraged by their HQ from participating in support programs if the programs had limitations built in which would restrict the freedom of HQ to transfer technology from one country to another.

All respondents with experience with government support programs felt the forms and procedures were excessively complicated and bureaucratic. This was particularly true in grants for support in R & D where it was felt that government assessors of such applications used excessively high standards of "scientific merit" in reviewing applications. It was strongly felt that R & D in the machinery industry is far more applied in nature than what the assessors were prepared to accept and therefore, the R & D support programs were of limited relevance to the firms in the sample.

A feature of this industry which may be somewhat unique to Canada is that the industry is highly regionalized within Canada. Firms operating in a region tend to specialize in the needs of two or three types of industry customers for that region and build up "market knowledge" for these industries. The need to build up market knowledge and a good reputation as a producer for a regional market is a crucial factor to success in a regional market. However, the types of industrial machinery products sold in various regions in Canada are vastly different from each other. Rarely can a firm hope to expand from one region of Canada to another by staying within the market and technological knowledge of its original market.

Instead, it appears that many regional firms prefer to seek out foreign markets before trying to expand operations very much in other regions of Canada. The reason for this preference, is that it is easier to expand by staying within a specific area of technical knowledge and trying to penetrate more geographically distant markets, than it is to stay in the more geographically similar market (Canada) and learn a new technoloby and market knowledge. This situation forces small firms to prematurely try to enter foreign markets when the firm lacks sufficient depth in capital and personnel resources.

Introduction

The purpose of this study was to do a follow-up survey of a number of firms in the industrial machinery sector. These firms were originally surveyed in 1975 on their R & D and innovation process and how these factors related to the ownership of the firm, market strategy, investments in R & D and export activity. From the original sample of 22 firms, a subsample of 19 small and medium size firms were selected for the follow-up study. It was decided to concentrate on the smaller firms because the large ones were seen to be quite self-sufficient and indistinguishable in behaviour from any large multinational firm in the same industry. Smaller firms, on the other hand, had a variety of strategies and practices and had greatly differing resources to pursue their strategies. Consequently it was felt that if the study were to have some relevance for public policy development, then the study should concentrate on smaller firms whose survival and strategies are very sensitive to public policy.

The main reason for conducting a longitudinal or follow-up study was to provide data that followed up on the developments of the firms. Several of the firms in 1975 expressed intent to pursue a variety of growth strategies and the follow-up survey allows an examination of which type of strategy may be better than another. In addition, data gathered at one point in time is static and insufficient to

represent the dynamic character of the behaviour of a firm. If significant changes had occurred in the intervening period, then conclusions based on the 1975 behaviour of the firms might be invalid in terms of the 1979 behaviour of the firms.

Review of the 1975 Results

The 19 smaller firms were classified in several different ways to try to analyse the relationship between some structural variables and various behaviours of the firms. The principal classification variables were ownership (Canadian or Foreign) and degree of autonomy (Autonomous, Holding Company subsidiary, Profit Centre subsidiary, Integrated subsidiary). The behaviours of the firms were classified into market strategy (Sales and Local Assembly, Miniature replica, Local Specialized products, General products), R & D strategy (Dependent, External evolutionary, Internal evolutionary, Independent), and export behaviour (no exports, passive exports, active exports). Definitions of each of these terms will be given below and then the distributions of the firms over the various combinations of variables will be shown.

In general, a small foreign ownership effect was found for degree of autonomy in that four out of eight of the foreign-owned subsidiaries were integrated subsidiaries. Being an integrated subsidiary had a strong effect on the

market strategy, R & D and export behaviour of a firm and since only foreign-owned subsidiaries were integrated, this must be considered as a foreign-ownership effect. The other major effect found was also related to degree of autonomy and ownership. The five autonomous firms were of course not foreign-owned and most were noticably more aggressive in strategy and active in R & D than subsidiaries of any kind. The ten remaining firms were all subsidiaries (four foreign, six Canadian) with various types of autonomy and strategies. No particular relationships were found to distinguish between Canadian-owned and foreign owned holding company and profit centre subsidiaries.

Table 1 below shows the distribution of the firms over the categories of variables and each section of these variables will be discussed in turn using subsets of this basic table.

Table 1

Characteristics of the Sample Firms in 1975

Type of Firm		Sales (in millions)	Employees	Degree of Autonomy	Market Strategy	R & D Activity	Export Activity	Innovation Rating
Canadian Owned	1.	5 mil	90	Autonomous	General	Independent	Active	High
	2.	4 mil	80	Autonomous	General	Internal Evolution	None	Moderate
	3.	10 mil	400	Autonomous	General	External Evolution	Active	Moderate
	4.	3 mil	60	Autonomous	General	External Evolution	None	Low
	5.	43 mil	1000	Autonomous	General	Internal Evolution	Passive	Low
	6.	21 mil	250	Holding Company	General	Independent	Active	High
	7.	10 mil	300	Holding Company	General	Independent	Active	High
	8.	40 mil	450	Profit Centre	Mini Replica	External Evolution	Passive	Low
	9.	6 mil	225	Holding Company	Local Specialized	External Evolution	None	Low
	10.	2 mil	80	Holding Company	General	External Evolution	None	Low
	11.	4 mil	150	Profit Centre	Local Specialized	Internal Evolution	Passive	Moderate

Table 1 Continued

Type of Firm		Sales (in millions)	Employees	Degree of Autonomy	Market Strategy	R & D Activity	Export Activity	Innovation Rating
Foreign Owned	1.	15 mil	350	Profit Centre	General	Independent	Active	High
	2.	8 mil	100	Holding Company	General	Internal Evolution	Passive	Moderate
	3.	3.5 mil	100	Holding Company	Local Specialized	Internal Evolution	Passive	Moderate
	4.	5 mil	300	Profit Centre	Mini Replica	External Evolution	Passive	Low
	5.	6.5 mil	210	Integrated	Sales & Assembly	Dependent	None	None
	6.	35 mil	265	Integrated	Sales & Assembly	Dependent	None	None
	7.	24 mil	650	Integrated	Sales & Assembly	Dependent	None	None
	8.	13 mil	250	Integrated	Sales & Assembly	Dependent	None	None

Small and medium sized firms in the machinery industry in Canada are characterized by a heavy reliance on custom or small batch production. Thus they have many of the characteristics of small batch organizations as described by Woodward's research on industrial organization (Woodward, 1965). Many of them also act as agents for other manufacturers, selling mass produced items which are often imported but none of the firms in this sample has any mass production themselves. The agency products (i.e.: pump, winches, motors, valves, etc.) are often incorporated into the small batch production of a firm. A number of the firms have developed some standardized models of their products which they show in catalogues or exhibit at trade fairs, but these machines are almost never produced for inventory. Instead the firm may develop a prototype for exhibit purposes or show prospective customers examples of products produced for other customers. Thus there is a lot of pressure on the firms to be active in seeking out sales and contracts, either by bidding on contracts for tender or by trying to develop close relationships with key customers.

A significant exception to the above, are foreign owned integrated firms which act as sales and assembly operations for products developed and subassembled by the parent firm. These types of subsidiaries generally do not get involved in any custom design or production work and instead sell standardized products and assemble these products for inventory.

A second feature of this industry which may be somewhat unique to Canada is that the industry is highly regionalized within Canada. Firms operating in a region tend to specialize in the needs of two or three types of industry customers for that region and build up what Johanson and Vahlne (1978) call "general knowledge" for these industries. The need to build up general knowledge and a good reputation as a producer for a regional market is a crucial factor to success in a regional market. However, the types of industrial machinery products sold in various regions in Canada are vastly different from each other. For example, firms on the West coast of Canada concentrate on supplying the lumber, mining and fisheries industries while firms in the Western prairies supply the oil field, surface mining and agricultural industries, and so on. Rarely can a firm hope to expand from one region of Canada to another by staying within the general knowledge and technological knowledge of its original market. The only way to geographically expand in Canada, (i.e. remain within the nearest market of psychological distance) is either to buy a local manufacturer in another region or attempt to learn a new general and technological knowledge for the industries peculiar to that region.

Instead, it appears that many regional firms prefer to seek out foreign markets before trying to expand operations very much in other regions of Canada. The reason for this

preference, according to interviews with principals of the firms, is that it is easier to expand by staying within a specific area of general technical knowledge and trying to penetrate more psychologically distant markets, than it is to stay in the more psychologically similar market (Canada) and learn a new technology or general knowledge. Thus this general behaviour pattern of these firms does not seem to support the psychological distance theory of expansion, insofar as expansion of operations into the rest of Canada would be the pattern with the least problems of psychological distance. However this result may be a function of the nature of the firms studied (industrial markets) and may not be true for firms in other types of business such as consumer markets.

Degree of Autonomy

At the time of the 1975 survey, one of the foreign owned subsidiaries had just been acquired by the parent firm and the new subsidiary had previously been operating as an autonomous firm. Thus its behaviour pattern in 1975 was still largely a result of the previous autonomy while its behaviour in 1979 was as a subsidiary. All of the other firms in the sample had either been established or acquired some years prior to the study and thus their behaviour was not subject to the effects of being newly established or newly acquired. Table 2 below shows the distribution of the types of origins of the firms.

Table 2

Origins of the Firms

	Acquired Subsidiary	Established Subsidiary	Autonomous Firm
Canadian Owned	3	3	5
Foreign Owned	4	4	0

In terms of assessing the overall nature of autonomy relationships between the HQ and the subsidiary, a series of questions were asked relating to degrees of autonomy on a range of decision areas. Since the basic data was gathered by means of semi-structured interviews with subsidiary executives, no attempt was made to devise a scale for quantifying the degree of autonomy of a subsidiary. Instead, responses to the questions on autonomy (see Appendix 1 for the list of questions) were categorized into four basic types of responses:

a. largely a matter of subsidiary autonomy;
b. subsidiary autonomy within HQ policy guidelines or decision-rules, ceilings;
c. must be negotiated with HQ; and
d. largely a matter of HQ responsibility.

These four basic responses seemed to account for most of the responses to the autonomy questionnaire and provided a continuum of autonomy from largely subsidiary responsibility for decisions to largely headquarters responsibility. While it was possible to analyze the responses for each

individual type of decision, it was found to be more productive to form a global assessment of the degree of subsidiary autonomy by developing a series of basic categories of HQ-subsidiary relationships. It was found that once the responses for a few key questions were obtained (capital investments, product lines, market territories), the degrees of autonomy on many other types of decisions were easy to predict. The four types of general descriptions of HQ-subsidiary relationships were as follows:

a. Autonomous firm (AF) - where the firm has its own board of directors, has responsibility for arranging its own financing, and may issue publicly traded voting shares in Canada. Such a firm may also be controlled by a parent which owns a majority or a controlling minority position in the common stock but treats the holding as a portfolio investment. Headquarters normally makes no attempt in such cases to try to manage the subsidiary or to integrate the operations of the subsidiary with other subsidiaries. Instead the typical action of headquarters is to buy and sell such holdings as part of the management of its portfolio of investments.

b. Holding Company subsidiary (HC) - in this case, the degree of HQ involvement in the subsidiary is a bit closer and there is a longer term interest in the performance of the subsidiary and in holding control of the subsidiary. The subsidiary normally operates in a highly

autonomous manner but reports to a headquarters board or executive. Usually, such subsidiaries report only financial plans and results on an annual basis and operational plans are generally left to the responsibility of subsidiary management. HQ usually owns complete control of the subsidiary and financing is generally arranged through HQ. The subsidiary is generally responsible for determining product lines and markets as there is little or no attempt to integrate operations between subsidiaries.

c. Profit Centre subsidiary (PC) - in this case, the subsidiary must submit detailed annual budgets and operations forecasts for approval to HQ and is free to operate within the designated limits of approved plans and budgets. HQ often determines the product lines and types of markets of the subsidiary and the subsidiary can only change these by negotiation with HQ. However, once an agreement has been negotiated, the subsidiary is then generally free to manage its own affairs as long as it stays out of trouble and delivers on the promises of its plans. HQ may try to encourage some form of integration between subsidiaries but many are left with the freedom to seek out the lowest prices for supplies or components and are not bound to purchase from or sell to a sister firm if the price is not competitive.

d. Integrated Subsidiary (IS) in this case the subsidiary is closely under the direction of HQ and is responsible for local administration and fulfilling the directives issued by HQ. Such a subsidiary usually operates as part of an integrated network of operations between a series of subsidiary sister firms, with considerable transfer of products from one subsidiary to another. One form of an integrated subsidiary may be simply as assembly plant with very few managerial functions in the subsidiary except those necessary for administering the assembly process. Another form may be simply a sales outlet handling an established line of products but with no local R & D, manufacturing or product development. An integrated subsidiary may be used when an MNC first enters a foreign market and needs to limit risk and closely control the local operations (Bilkey 1978). However, an integrated subsidiary can also be used when an MNC has adopted a globally integrated production and marketing strategy and various subsidiary operations must be highly streamlined and integrated to achieve global economies of scale (Richman 1972). The development of the MNC as an international business may have matured tremendously in going from the first new ventures in foreign markets to a global integration of operations, but the effect on the subsidiary is curiously very similar at either stage.

These four general descriptions of types of firms were used to develop a typology of relationships based on varying degrees of autonomy of a firm. Table 3 below shows the distribution of the sample over the typology in 1975.

Table 3

Degree of Autonomy of Firms in the Sample (1975)

	Autonomous Firm	Holding Co. Subsidiary	Profit Centre Subsidiary	Integrated Subsidiary
		1975	1975	1975
Canadian Owned	5	4	2	0
Foreign Owned	0	2	2	4

From the 1975 data in Table 3 it can be seen that none of the subsidiaries fit the autonomous pattern as none of the HQ treated the subsidiaries as portfolio investments. Half of the foreign owned subsidiaries were of the integrated type while none of the Canadian owned subsidiaries fit this pattern. This indicated one major difference in types of HQ-subsidiary relations between domestically owned and foreign owned subsidiaries (for this industry). There was also a tendency for the Canadian owned subsidiaries to lean more toward the autonomy end of the scale than for the foreign owned subsidiaries.

Subsidiary Behaviour

The behaviour of firms as a function of their degree of autonomy was examined in these principal areas: market strategy, R & D strategy, export activity, and innovation

record. These four variables are closely interrelated and normally a causal relationship should exist between the market strategy of a firm and its R & D, export and other activities. However, the normal expectations do not necessarily hold for subsidiary operations because various functions may report to HQ directly and not be coordinated at the local level by local subsidiary management. For example, R & D at a subsidiary may be situated at the same site as subsidiary manufacturing operations but may be directly controlled by HQ with little or no connection at all with subsidiary operations (Cordell 1971). Similarly, a subsidiary market strategy may be defined by HQ as sales and service to the local market while manufacturing capacity in the subsidiary may be used to fill export orders generated by a HQ marketing department. Subsidiaries where this phenomenon of disconnected functions existing side by side occurs are called "truncated" subsidiaries (Gray Report 1971). Truncation refers to the fact that the "head" or strategic decision centres of the subsidiary are located outside the subsidiary and the subsidiary itself is a collection of "arms and legs" being controlled from elsewhere.

Market Strategy

This behaviour of the firm was classified into four basic types in a continuum from fairly low level complexity

of operations to quite complicated (and autonomous) local operations. The four types were defined as follows:

a. Local Sales and Assembly - this type of subsidiary usually occurs as part of the earliest form of internationalization after the parent has tried local sales agents (Bilkey 1978). A Sales and Assembly subsidiary either sells standard products manufactured by other parts of the MNC or else does local assembly of components imported from the parent firm. Usually such a subsidiary is restricted to sales activity in the local markets, although some of its assembly capacity could be used to supply other parts of the MNC. Such types of subsidiaries are commonly found in ethnocentric MNC's and can be quite competitive in terms of offering new products if the parent firm is innovative.

b. Miniature Replica - this type of firm may carry an extensive range of products from the parent firm but also has local component manufacture and assembly operations. A sizable local market is usually required to justify the capital cost of local production facilities but original R & D is still likely to come from the parent firm. Subsidiaries of this type are usually intended to fully service the local market and represent a mature form of ethnocentric operations and could also be found in polycentric operations (Pearlmutter et al 1973).

c. Local Specialized Manufacturing - this type of firm may have developed some local unique product which has been acquired by the MNC by purchasing the local firm. In other cases a subsidiary may have been designated as the design and production centre for certain product lines of the parent firm. In cases where a product mandate has been given to the subsidiary, it may be free to pursue export sales on its own for its particular line of products. The key distinction here is that the subsidiary has principal responsibility for its own R & D. Such a subsidiary may be found in polycentric and global operations (Pearlmutter et al, 1973).

d. General Manufacturing - this type of firm relies almost completely on its own R & D for all its product lines and is free to purchase components from the most competitive suppliers. A subsidiary of this type may have a very general mandate from HQ and will be free to pursue whatever markets or lines of business for which a case can be made to HQ. Normally such a subsidiary is found in holding company or conglomerate MNC's where little attempt is made to integrate operations between divisions or where the parent firm is organized into worldwide product groups (Davis 1976). Autonomous firms would also fit into this category although an autonomous firm may choose to concentrate on a certain segment of the market and operate more like a local specialized firm.

A fifth type of subsidiary, theoretically found in globally integrated firms is a highly specialized, highly integrated operation which is set up solely to achieve economics of scale or exploit low cost labour markets and may not even sell in its domestic market (i.e.: a Taiwan electronics assembly factory). None of this type of subsidiary was found in this sample.

Table 4 below shows the distribution of the firms in the various types of market strategy for 1975.

Table 4

Type of Strategy in the Firms

Type of Firm	Local Sales & Assembly	Miniature Replica	Local Special Manufacturing	General Manufacturing
Canadian Owned:				
Holding Company	-	-	-	3
Profit Centre	-	1	1	-
Integrated	-	-	-	-
Autonomous	-	-	-	5
Foreign Owned:				
Holding Company	-	-	1	1
Profit Centre	-	1	-	1
Integrated	4	-	-	-

In 1975 the four Canadian owned Holding Company subsidiaries were oriented toward the most self-reliant end of the continuum and the five Autonomous firms were exclusively at that end of the continuum.

In contrast, the four integrated subsidiaries among the foreign owned firms in 1975 followed a conservative market strategy of local sales and assembly while the remaining three were spread out across the other types of strategies.

Research and Development

Four types of R & D behaviour were developed to describe a continuum of R & D activity from very conservative to highly committed. Extensive discussion of the differences in the four types of R & D behaviour has been presented in the earlier report on this industry (Ondrack 1975), so only very brief definitions will be used here.

a. Dependent - almost complete reliance by the subsidiary on the parent firm for R & D.

b. External/evolutionary - basically a reliance on external sources of R & D (parent, competitor, customers, etc), but over time the subsidiary or firm adds local modifications and improvements to its product lines so that eventually local expertise is developed.

c. Internal/evolutionary - a progression from (b) above to the point where the local subsidiary or firm expertise is quite advanced and there may even be some local investments in R & D equipment and personnel.

d. Independent - a progression from (c) above to the point where subsidiary or firm R & D largely is self-reliant and the local organization has considerable investment in R & D. A firm at this stage of commitment to R & D could still utilize any of the earlier strategies along with the independent strategy.

Table 5 below shows the distribution of the firms over the four types of R & D activity.

Table 5

R & D Activity in the Firms (1975)

	Dependent	External/ Evolutionary	Internal/ Evolutionary	Independent
Canadian owned:				
Holding Company	-	1	1	2
Profit Centre	-	1	1	-
Integrated	-	-	-	-
Autonomous	-	2	2	1
Foreign owned:				
Holding Company	-	-	2	-
Profit Centre	-	1	-	1
Integrated	4	-	-	-

Among the Canadian owned firms, there is no real distinction between Autonomous firms and subsidiaries in terms of commitment to R & D. All types of firms are spread across R & D activity from External Evolutionary to Independent but none of the Canadian firms were in the Dependent category. In contrast the four integrated subsidiaries in

the foreign owned firms were in the Dependent category while the other types of subsidiaries were spread over the other types of R & D activity. Only four out of the thirteen firms in the sample were in the Independent category of R & D.

Export Activity

The next type of behaviour examined was activity in export markets. There is less of a causal relationship between HQ-subsidiary relationships and export activity as there is between HQ-subsidiary relations and other behaviours. This is because exports can frequently be denied to the subsidiary or demanded from a subsidiary depending upon HQ strategy which may change rapidly to maximize overall performance of the firm. For example, following the devaluation of the Canadian dollar in 1978, a number of foreign owned subsidiaries were suddenly required to fill export orders for the parent firm, sometimes at the cost of not being able to fill domestic orders in Canada. The types of export behaviour were extensively discussed elsewhere (Ondrack 1975, 1978) and only short definitions will be used here.

a. No export activity - a self-evident behaviour which can occur from HQ directives or from deliberate choice of strategy in an autonomous firm.

b. Passive exports - the firm concentrates on servicing the local markets but fills unsolicited orders or export orders at the request of the parent. Use of a foreign sales representative is also included here.

c. Active exports - the firm either chooses to pursue exports or has been given a mandate by the parent and has made some degree of active commitment to export sales such as an export sales force, participation in trade fairs and missions, etc. Obviously more advanced forms of internationalization (i.e. established of foreign sales subsidiaries) would also be in this category.

Table 6 below shows the distribution of behaviours of the firms over the various types of export activity.

Table 6

Export Activity in the Firms (1975)

Type of Subsidiary	No Export Activity	Passive Exports	Active Exports
Canadian owned:			
Holding Company	2	-	2
Profit Centre	-	2	-
Integrated	-	-	-
Autonomous	2	1	2
Foreign owned:			
Holding Company	-	2	-
Profit Centre	-	1	1
Integrated	4	-	-

Among the Canadian owned firms, two Autonomous firms and two Holding Company subsidiaries were active in exports but the majority of the firms were either passive or had no export activity. One among the foreign owned firms was active in export markets and the four integrated subsidiaries had no export activity.

Innovation Record

In large firms, the R & D function is fairly easy to recognize because it is a specific department with its own staff, equipment and resources. In smaller firms, the function can be much more elusive because it occurs as a sub-part of many other activities. Secondly, the results which are considered to be innovations can vary considerably between large and small firms. For example, a small firm may consider R & D to be the trial and error modification of process or product and an innovation to be a refinement of existing products. A large firm may consider this to be something done as part of routine engineering or design. For the purposes of this study, R & D was considered to be the general process of searching for product improvements and new products. Because the basic technology in most of the parts of the industry is already well-established, most of the R & D effort is devoted toward product refinement and evolution, and there are very few innovative departures in the industry.

Attempts to assess the innovation records of firms and industries are frequently made with the use of objective criteria as indices of the volume or quality of innovations. Historical data such as the number of patents and the size of the R & D budget are not entirely suitable in this industry for a number of reasons. For example, there can be quite a time lag between the development of an innovation and the receipt of a patent to the innovative firm. A less innovative firm might have developed more patents a number of years ago and none since, yet a comparison of simple numbers would be to the advantage of the less innovative firm. Secondly there is the question of quality or importance of the patents. A firm concentrating on efficiency refinements of its production process may have a series of small patents which add nothing to the development of new products while a firm concentrating on product development may have fewer patents in number but of greater importance to the market. Finally there is the problem of distinguishing between innovations which are successfully marketed and those which either never make it to the market or those which do not succeed on the market. Similar limitations apply to using the R & D budget as an index. An integrated subsidiary may have a considerable R & D expenditure carried on its budget which can have nothing to do with the subsidiary operations or if the subsidiary is a miniature replica, the R & D may only be concerned with modifications to existing technology rather than innovations.

In addition to the patent record and size of R & D budget, the number and educational levels of persons employed in R & D were studied, but it was concluded that these criteria were too often influenced by the size of the firm. More important as a criterion were the attitudes of the personnel in the firm toward innovation and their behaviors related to innovation. Assessment of these attitudes and behaviors was attempted from data gathered through interviews considering such variables as autonomy of the firm, marketing strategy, specific nature of local R & D, and the sources of their technological information.

For an independent firm which has chosen a strategy of innovation and self-reliance, the R & D department obviously must be innovative for the firm to survive. If the R & D resources are devoted to product development, the firm must be able to manage the transfer of a product concept to test designs/models, to production operations and eventually to the market. Of necessity then, the R & D perspective must be wholistic in thinking of product life cycles. In either subsidiaries or firms with strategies of dependence on external technology for products, the R & D focus can be more on production processes, creating packages of components, or designing modifications to existing products. In such firms, the products are generally in the mature phases of the life cycle and the R & D people get little exposure to the development and growth stages.

As a summary rating on the innovation record of a firm it was possible to rate firms in terms of three basic categories on innovation.

a. Active - where the firm sees innovation as being one of its major competitive strengths and prides itself on the ability to be a market leader in new developments. The track record of the firm generally matches the climate of attitudes and self-image of the firm or innovation.

b. Moderate - the firm occassionally develops some new products or processes but generally relies on its ability to produce reliable, proven, quality products, often with a high emphasis on customer service.

c. Low - the firm may rely exclusively on externally developed innovations whether from component suppliers, customers, or the parent firm. The firm prefers to compete by price, dependability and service.

Table 7 below shows the distribution of the types of R & D activities of the firms and the firm's innovation rating.

Table 7

R & D Activity of the Firm and Innovation Rating

Canadian Owned	Independent	Internal/ Evolutionary	External/ Evolutionary	Dependent	Innovation Rating
1.	x				Active
6.	x				Active
7.	x				Active
2.		x			Moderate
5.		x			Moderate
11.		x			Moderate
3.			x		Moderate
4.			x		Low
8.			x		Low
9.			x		Low
10.			x		Low
Foreign Owned					
1.	x				High
2.		x			Moderate
3.		x			Moderate
4.			x		Moderate
5.				x	Low
6.				x	Low
7.				x	Low
8.				x	Low

To a large extent, Table 7 suggests that the innovation behavior of a firm is something of a self-fulfilling prophecy. If a firm has chosen or is allowed an R & D strategy of independence, it must be prepared to commit resources to innovation oriented R & D and then have capable personnel

working in the area. Without the first two conditions being satisfied, there would be little to attract innovation-minded people to work in a firm. Similarly, a firm committed to a less independent strategy will commit its R & D orientations to different objectives and will attract different kinds of R & D personnel. Thus in this industry, the combination of autonomy, strategy and R & D objectives largely pre-determines the nature of R & D outcomes. For example, two firms in the sample were of similar size and were direct competitors in the same local market, but one firm was an integrated subsidiary while the other was an autonomous firm.

The president of the autonomous firm had chosen a strategy of technological innovation and leadership and had authorized a budget for a R & D group and laboratory. The firm was constantly striving to improve its product lines and develop technological uniqueness from competitors. The president actively sought export sales and frequently exhibited the firm's products at foreign trade fairs. The atmosphere among the firm's management was characterized by energetic behavior and pride in their technological self-reliance and the firm in fact had an industry reputation for innovativeness.

The president of the integrated subsidiary was also personally interested in innovation but could not get authorization for a R & D budget from headquarters. All of the

R & D activity was located elsewhere and the designated role of this subsidiary was to act as a sales, distribution and service center for that particular regional market. Consequently, the energies of the firm were directed to these areas and the firm was completely dependent upon external technology. However, autonomy is not by itself a sufficient condition for innovation. A third firm in the same regional market was a holding company subsidiary with the freedom to choose a strategy. This firm chose a strategy of risk-avoidance and most of their product lines were either direct imports or modifications to existing product lines because this strategy was less expensive and risky than original R & D. Obviously there is little chance of innovation emanating from a firm with this strategy.

Conclusion

The results in the 1975 study suggested a strong correlation between the strategy of a firm and its subsequent R & D orientation and this in turn strongly affected the subsequent innovation record of the firm. The differences in commitment and attitude to innovation that existed between the firms was a strong indicator of innovation performance between the firms, but these differences will rarely be revealed by conventional indices of innovation in this industry. Instead, most technological developments will occur as an iterative process and a non R & D, externally dependent firm can remain technologically competitive within the industry.

The Follow-up Study

Senior executives of each firm were interviewed at a site visit in 1975 and revisited and reinterviewed in a follow-up study in 1979. In a majority of cases the same people were interviewed, but in some firms, changes of personnel had taken place. Since the study was conducted exclusively on site at the firms, the results naturally reflect the biases and perceptions of local management. In the case of subsidiaries, a few interviews were also conducted with executives at the parent organization of Canadian-owned subsidiaries to compare HQ and subsidiary perceptions of subsidiary autonomy, but this was not possible for the majority of the firms in the study. Thus the longitudinal data can suffer from two limitations: lack of continuity of managers interviewed in 1975 and 1979, and data available only from management located in subsidiaries. With respect to the latter point, one of the objectives of the study was to focus on subsidiary autonomy from the perspective of local management rather than comparing their perspectives to those of HQ management. The size of the firms in the sample by 1979 is shown in Table 8.

Table 8

Size of Firms in Sample by Total Sales and Employees
1975-1979

	Canadian Owned (n = 11)		Foreign Owned (n = 8)	
Total Sales (in millions of $)	1975	1979	1975	1979
Less than $10	7	6	4	1
10 - 20	1	-	2	2
20 - 30	1	2	1	2
30 - 50	2	1	1	1
50 +	-	2	-	2
Total Employees	1975	1979	1975	1979
100 - 200	5	5	2	1
200 - 300	3	2	3	1
300 - 400	1	-	2	4
400 - 500	1	1	-	-
500 +	1	3	1	2

It is apparent that a moderate trend toward growth in total sales and in total number of employees occurred for all types of firms. The samples of foreign owned and Canadian owned firms are approximately equivalent in terms of a distribution over the size categories.

Howe-er, concealed in this table is the fact that one of the Canadian owned subsidiaries suffered serious losses in the intervening time period and had a significant drop in sales and numbers employed. This firm is no 11 in the list in Table 9 which shows the overall data for the sample in 1979. Firms number 6 and 7 also had serious problems in

the period between the two studies but had managed to recover a great deal by the time of the second survey. These changes will be discussed in more detail in the sections which follow.

Table 9

Data for All Firms in 1979

Canadian Owned	Sales (millions)	Employees	Degree of Autonomy	Market Strategy	R & D Activity	Export Activity	Innovation Rating
1.	6.5 mil	100	Independent	General	Independent	Active	Active
* 2.	6 mil	110	Independent	General	External Evolution	None	Low
3.	20 mil	500	Independent	General	External Evolution	Active	Moderate
* 4.	4.5 mil	60	Independent	General	Independent	Active	Active
5.	94 mil	1200	Independent	General	Internal Evolution	Passive	Moderate
* 6.	25 mil	280	Profit Centre	General	Independent	Active	Moderate
* 7.	35 mil	650	Profit Centre	Specialized	External Evolution	Passive	Moderate
8.	60 mil	600	Profit Centre	Mini Replica	External Evolution	Passive	Moderate
9.	11 mil	220	Holding Company	General	External Evolution	Passive	Low
10.	5 mil	100	Holding Company	General	External Evolution	None	Low
* 11.	2 mil	75	Integrated	Sales Assembly	Dependent	None	Low

*Indicates significant change from 1975 to 1979

Table 9 Continued

Foreign Owned	Sales (millions)	Employees	Degree of Autonomy	Market Strategy	R & D Activity	Export Activity	Innovation Rating
1.	38 mil	690	Profit Centre	General	Independent	Active	Active
* 2.	22 mil	250	Profit Centre	Specialized	Independent	Active	Active
3.	4.5 mil	200	Holding Company	Specialized	Internal Evolution	Passive	Moderate
4.	28 mil	300	Profit Centre	Mini Replica	External Evolution	Active	Moderate
* 5.	14 mil	400	Profit Centre	Specialized	Internal Evolution	Active	Moderate
6.	52 mil	320	Integrated	Sales Assembly	Dependent	None	Low
7.	75 mil	900	Integrated	Sales Assembly	Dependent	None	Low
8.	30 mil	310	Integrated	Sales Assembly	Dependent	None	Low

Autonomy

Table 10 below shows the distribution of the sample over the typology of autonomy in 1975 and 1979.

Table 10

Types of Autonomy and HQ-Subsidiary Relationships

1975 - 1979

	Autonomous Firm		Holding Co Subsidiary		Profit Centre Subsidiary		Integrated Subsidiary	
	1975	1979	1975	1979	1975	1979	1975	1979
Canadian Owned	5	5	3	1	3	4	0	1
Foreign Owned	-	0	2	1	2	4	4	3

From the data in Table 10 it can be seen that all of the autonomous firms remained autonomous over the time period, but by 1979 changes had taken place in the HQ subsidiary relationships in three Canadian and two foreign subsidiaries. Two Canadian subsidiaries changed from being Holding Company to Profit Centre subsidiaries and one changed from a Profit Centre to an Integrated subsidiary. In all three cases the move is away from subsidiary autonomy toward greater involvement and control by HQ. The reason for the shift was the same in all three cases, a fall-off in subsidiary performance which resulted in HQ asserting more control over subsidiary operations. Thus the general principle of autonomy can be illustrated in these three cases: a subsidiary can enjoy autonomy as long as it stays out of trouble, but the autonomy

can be lost if the subsidiary gets into trouble. This result is somewhat different from that found by Hedland (1979) for Swedish firms, where the general manager of a Swedish owned subsidiary is changed if the subsidiary gets into trouble but the structure remains the same.

The changes in the status of the two foreign owned subsidiaries followed different patterns and for quite different reasons. One subsidiary moved from Holding Company status to Profit Centre status as part of the general strategy of HQ to systematically acquire more control over the subsidiary and achieve a further integration of the subsidiary operations with global operations. This was the newly acquired subsidiary referred to earlier in the paper. In 1975, the subsidiary had just been purchased and was still being treated as a Holding Company subsidiary. By 1979, the new HQ had introduced many changes in systems and procedures while retaining all of the former management of the subsidiary. The overall effect was a gradual increasing of HQ influence to bring the new subsidiary into line with the system of management used by the parent firm around the world. However, there was no attempt nor plan to move further toward an Integrated Subsidiary form as the parent firm used a Profit Centre style of management around the world.

The second foreign owned subsidiary had been an Integrated type in 1975 but by 1979 had been reorganized

into a Profit Centre subsidiary. The reason for this change was that HQ decided to create an international division to coordinate world wide sales and to give some subsidiaries sole responsibility for the development and manufacture of some of the product lines. Eventually this subsidiary will have a "product mandate" for a certain sector of the total firm's product line with sole responsibility for R & D, manufacturing and marketing. In other words, the subsidiary will move more and more toward a Holding Company form of subsidiary organization (if it stays out of trouble) as a result of the change in strategy at HQ.

Thus we see in these results that considerable evolution can occur in a short period of time in the nature of HQ-subsidiary relationships. This phenomenon of fairly rapid change in subsidiary autonomy points out one of the problems of cross sectional research on organization structure. A cross sectional sample, studied at one point in time can be adequate for a descriptive analysis of organization structures but does not capture the dynamic aspects which can be offered by longitudinal studies. Similarly, cross sectional data can give misleading pictures of the representativeness of a sample. For example, the 1975 data showed that Canadian owned subsidiaries tended to be toward the more autonomous end of the HQ-subsidiary continuum of relationships while foreign owned subsidiaries tended to be toward the less autonomous end. By 1979, the distribution of both types of

subsidiaries had changed considerably as some Canadian subsidiaries lost autonomy while some foreign subsidiaries gained autonomy. A conclusion based on the 1975 data that foreign owned subsidiaries tended to be more integrated than Canadian owned subsidiaries would have been appropriate at that time but would have been erroneous given the 1979 data for the same firms.

Subsidiary Behaviour

The behaviour of firms as a function of their degree of autonomy was examined in four principal areas: market strategy, R & D strategy, export activity and innovation record. These four variables are closely interrelated and normally a causal relationship should exist between the market strategy of a firm and its R & D, export and innovation activity. However, as discussed in the previous section on the 1975 results, expectations of a causal relationship may not hold for subsidiaries as a result of HQ strategy. In the sections which follow, the changes in firm behaviour and operations will be traced to try to follow the relationship between strategy and performance of the firm.

Table 11 below shows the distribution of the firms in the various types of market strategy for 1975-1979.

Table 11

Type of Strategy in Firms

	Local Sales & Assembly		Miniature Replica		Local Special Manufacturing		General Manufacturing	
Type of Subsidiary	1975	1979	1975	1979	1975	1979	1975	1979
Canadian Owned:								
Holding Company	-	-	-	-	1	-	3	1
Profit Centre	-	-	1	1	1	2	-	1
Integrated	-	1	-	-	-	-	-	-
Autonomous	-	-	-	-	-	-	5	5
Foreign Owned:								
Holding Company	-	-	-	-	1	1	1	-
Profit Centre	-	-	1	1	-	2	1	1
Integrated	4	3	-	-	-	-	-	-

In keeping with the previously discussed changes in HQ-subsidiary relationships from 1975-1979, several changes can also be observed in the market strategy of the firms. In 1975 the four Canadian owned Holding Company subsidiaries were oriented toward the most self-reliant end of the continuum and by 1979, only one such subsidiary was left. The others had either become profit centres (more HQ control) or had scaled down their operations to a more modest level (reduction of risk). These changes reflect the adjustments made to the subsidiary operations as a result of financial crises suffered between 1975-1979.

The five autonomous firms remained in general manufacturing over the time period but one of them had suffered

some financial losses and had cut back on its research and new product operations.

In contrast, the four integrated subsidiaries among the foreign owned firms in 1975 followed a conservative market strategy of local sales and assembly and one of these firms in 1979 had become a profit centre operation with a more aggressive strategy of local specialized manufacturing. For both types of ownership, there was a reduction in the number of holding company subsidiaries and a movement toward more profit centre forms of subsidiaries. For some, this represented an advance in the scope of marketing strategy and for others a retrenchment.

Table 12 below shows the distribution of the firms over the four types of R & D activity.

Table 12

R & D Activity in Firms (1975-1979)

	Dependent		Evolutionary/ External		Evolutionary/ Internal		Independent	
	1975	1979	1975	1979	1975	1979	1975	1979
Canadian owned:								
Holding Company	-	-	1	1	1	-	2	-
Profit Centre	-	-	2	3	-	1	-	-
Integrated	-	1	-	-	-	-	-	-
Autonomous	-	-	2	2	2	1	1	2
Foreign owned:								
Holding Company	-	-	1	1	1	-	-	-
Profit Centre	-	-	1	-	-	2	1	2
Integrated	4	3	-	-	-	-	-	-

One of the Canadian autonomous firms (No. 4) made a significant change in strategy and commitment to R & D from 1975 to 1979 and now is in the Independent category of R & D. Otherwise, the general pattern of retrenchment can be observed among some of the Canadian-owned subsidiaries. Firms that used to be active in R & D, whether holding company or profit centre subsidiaries, have now cut back to more conservative positions as a result of general economic setbacks. In contrast, some of the foreign owned subsidiaries have actually moved to more aggressive types of R & D activity which is in keeping with their moves to a more aggressive marketing strategy. It appears in this case that certain of the Canadian-owned subsidiaries formerly took risks in trying to be aggressive in marketing and developing more self-reliance in R & D and then unfortunately suffered economic setbacks. The foreign owned subsidiaries were more conservative in operations at the onset of the study and did not seem to suffer the same sort of economic setbacks. Consequently they are now in a good position to expand and be more aggressive while the domestic competition is in retreat.

Table 13 below shows the distribution of behaviours of the firms over the various types of export activity.

Table 13

Export Activity in Firms
1975 - 1979

	No Export Activity		Passive Exports		Active Exports	
Type of Subsidiary	1975	1979	1975	1979	1975	1979
Canadian owned:						
Holding Company	1	1	1	-	2	-
Profit Centre	1	-	1	3	-	1
Integrated	-	1	-	-	-	-
Autonomous	2	1	1	1	2	3
Foreign owned:						
Holding Company	-	-	2	1	-	-
Profit Centre	-	-	1	-	1	4
Integrated	4	3	-	-	-	-

For the Canadian owned firms, the drop in the number of Holding Company subsidiaries was accompanied by a drop in export activity by these types of firms. However, these firms reappeared as Profit Centre subsidiaries where an increase was observed in the more passive types of export activity. Among the Autonomous firms, firm No. 4 went from no export activity to active export activity. The reason for these substantial changes in this firm was a change in top management. The new management decided on a significant change in strategy for the firm and the impact of this change in strategy can be observed in subsequent changes to R & D activity and export activity.

Among the foreign owned subsidiaries, the shift from Holding Company subsidiaries to Profit Centre subsidiaries was not accompanied by a decline in export activity. Instead a total of four subsidiaries were active in export markets in 1979 compared to only one in 1975.

The detailed record of each individual firm on all of the behaviours used in this study has been presented in Tables 8 and 9. By tracking the changes in the nature of each firm's autonomy or HQ-subsidiary relationships through to each of the subsequent behaviours it is possible to see a strong pattern of apparently causal linkages. For subsidiaries, the original strategic decision at HQ to establish a certain type of HQ-subsidiary relationship has several consequences for the strategy and behaviours of the subsidiary. Changes in operating performance of the subsidiary (as in the case of the Canadian-owned subsidiaries) can result in a change in HQ strategy toward the subsidiary. Changes in the overall international strategy of the firm (as in the case of the foreign-owned subsidiary) can also result in a change in HQ strategy toward the subsidiary. In some circumstances (retrenchment) the change can mean a loss of jobs and an overall reduction in variety and scope of activities in the subsidiary. In other cases, (expansion) the change can mean more jobs, more variety and greater level of activities in the subsidiary. From a host country perspective, the relative helplessness among subsidiaries in determining their

own scope of operations must be a serious cause for concern when retrenchment occurs, but a cause for satisfaction when expansion occurs.

A similar finding on the relationship between strategy and various activities of the firm also holds true for autonomous firms. Two autonomous firms (No. 2 and 4) experienced almost opposite changes from 1975-1979. Firm No. 2 in 1975 started to develop a strategy of active R & D with a view to developing independence and a series of innovations. Unfortunately, the firm was caught in a recession and by 1979, the firm was following a much more cautious strategy and had given up on a lot of its ambitions. Firm No. 4 had been operating routinely in the domestic market up until the change in top management and by 1979 was active in R & D, in pursuit of export markets, and in trying to compete by innovations. This is a very risky strategy for such a comparatively small firm but the energetic new management was willing to take those risks.

Lastly in this section, Table 14 shows the innovation rating of the individual firms from 1975 - 1979.

Table 14

Innovation Rating of the Firms

R & D Activity

Type of Firm	Independent		Internal Evolution		External Evolution		Dependent		Innovation Rating	
Canadian Owned	1975	1979	1975	1979	1975	1979	1975	1979	1975	1979
1.	x	x							Active	Active
6.	x	x							Active	Moderate**
7.	X	*				x			Active	Moderate
2.			x	*		x			Moderate	Low
5.			x	x					Moderate	Moderate
11.			x	*				x	Moderate	Low
3.					x	x			Moderate	Moderate
4.		x			x	*			Low	Active
8.					x	x			Low	Moderate**
9.					x	x			Low	Low
10.					x	x			Low	Low
Foreign Owned										
1	x	x							Active	Active
2.		x	x	*					Moderate	Active
3.			x	x					Moderate	Moderate
4.					x	x			Moderate	Moderate
5.				x			x	*	Low	Moderate
6.							x	x	Low	Low
7.							x	x	Low	Low

* indicates significant change in R & D activity

** indicates change in Innovation Rating without a change in R & D activity.

As was described in the earlier section on the 1975 data, the Innovation Rating of a firm is a subjective evaluation which tries to capture the spirit as much as the actual performance on innovation in a firm. If the attitude toward innovations as a source of competitive differentiation is cautious or dependent, there is little likelihood that innovations will be encouraged or developed. If there is a strongly positive attitude toward innovations, there is a much better chance that people will be encouraged to come up with new ideas. If the firm combines a positive attitude with a commitment of resources for both research and product or process development, there is almost certainly to be some sort of payoff.

The data in Table 14 show that five of the eleven Canadian owned firms remained relatively stable in their R & D activity and in their Innovation Rating (1 Active, 2 Moderate, 2 Low). Two firms did not change their R & D activity but did have changes in their Innovation Rating. One of these firms (No. 6) had an Independent R & D activity but the innovation rating went from Active to Moderate. The reason for this regressive shift was an economic crisis suffered by the firm between 1975-1979. The firm had to go through a period of cost cutting and shifts in product strategy to get back into a favourable position and these changes had a visible impact on the innovation performance of the firm. At the time of the interview in 1979, top

management of the firm felt the situation had been turned around and they could start being aggressive again. During this crisis period the firm went from being a Holding Company subsidiary to a Profit Centre subsidiary as HQ began to place the operations of the subsidiary under closer and closer scrutiny.

The second firm (No. 8) retained the same External Evolution R & D activity but the Innovation Rating went from Low to Moderate. This is because the firm enjoyed a steady period of growth and the cumulative effect of a series of evolutionary improvements to its products and processes was beginning to pay off. Secondly, the HQ of the firm managed to secure some large export contracts which had to be filled by the subsidiary in the study. The volume of this passive export activity was sufficient to allow the engineering department of the firm to consolidate the previous incremental improvements to the products into a competitively differentiated version of the product. In time, given a sufficiently high volume of sales, this subsidiary may eventually have a shift in R & D activity from External to Internal Evolutionary. For the time being, however, the Canadian HQ prefers to keep the R & D funtion located at HQ, thus lessening the potential for innovation at the subsidiary location.

In the four remaining firms in the Canadian owned sample, significant shifts occurred in R & D activity with consequent effects on the Innovation Ratings. Firm No. 7 shifted from Independent R & D to External Evolution and the Innovation Rating dropped from Active to Moderate. The prime reason for these shifts was an economic crisis with subsequent stringent tightening of controls by HQ. Firms No. 2 and 11 both shifted from Internal Evolution R & D to External Evolution (No. 2) or Dependent (No. 11) R & D activities. In both cases, the impact on innovation was to go from a Moderate to a Low rating. The reason in both cases was again economic problems but a severe reorganization occurred in firm No. 11 as it went from a Profit Centre to an Integrated subsidiary. This change in autonomy was accompanied by considerable loss of technical personnel and a greatly reduced scale of operations, from what was formerly a local specialized manufacturing operation to a sales and assembly type of subsidiary.

The last Canadian owned firm (No. 4) has already been previously mentioned as having gone through a change in top management with resultant changes in market, R & D and export activity, all toward the more active, aggressive ends of the scales. The impact on innovation was very clear to observe as the new management quickly made use of a number of product and process ideas which had lain dormant for years, as well as committing resources of the firm to active R & D. In view

of the crises suffered by other firms in the sample and the subsequent regression in R & D activity and innovations, the strategy chosen by firm No. 4 must be seen as being high risk for a firm of that size. However, if they succeed, they have the potential to grow very rapidly rather than being passively dependent on cycles of the local regional market.

Among the foreign owned subsidiaries, six remained unchanged in R & D activity and Innovation Rating while two had significant changes in R & D activity with consequent changes in Innovation Rating. One of the foreign owned firms (No. 2) was the formerly autonomous firm which had been acquired by a foreign MNC just prior to the 1975 study. This firm was initially treated as a Holding Company subsidiary and had developed a modest Internal Evolution R & D activity. The subsidiary was gradually converted to a Profit Centre to conform to the worldwide system of management used by the HQ and the subsidiary was also designated as the specialist for a certain portion of the total product line of the firm. This product mandate necessitated a larger R & D activity so the subsidiary moved from Internal Evolutionary to Independent. The increase in R & D resources combined with the previous moderate innovation record of the firm resulted in an Active innovation rating by 1979.

A very similar shift in HQ strategy occurred for firm No. 5 in that HQ decided to designate the Canadian subsidiary as the specialist in a certain portion of the product line. This change was part of a series of changes initiated by a new top management at the world HQ of the firm. The difference with firm No. 5 is that it used to be an Integrated subsidiary with only a local sales and assembly role previously. Consequently, there was no R & D base of any kind to build on in the subsidiary and the firm has recently been engaged in trying to develop a local, more independent R & D activity. Due to this lack of an experience base, the firm's Innovation rating remains at Moderate despite the presence of an Internal Evolutionary R & D activity.

Conclusion

The data from 1975 to 1979 demonstrates that changes in strategy by top management of the firm (whether local autonomous or MNC HQ) have a marked impact on the various activities and behaviours of the firms or subsidiaries, leading to fairly direct impacts of the innovation rating of a firm. For the Canadian owned firms, the changes in strategy came about mostly in response to adverse economic conditions between 1975 - 1979. In most cases, the firms had been following a fairly risky strategy of trying to be competitive on innovations and pursuing export markets simultaneously. Some of the firms became overextended and

when downturns occurred in the domestic markets, the volume of foreign sales were insufficient to carry the firms over the trough. Consequently, there was a general trimming of activities and lessening of ambitions until conditions improved again. In 1979, the firms that had weathered the storm were still inclined to be cautious but most indicated a readiness to try again if domestic conditions improved again. An exception was the one firm which was cut back to the point of being an integrated subsidiary. In this case, local management occupies an administrative level of authority for local sales and assembly and all considerations of strategy now take place only at HQ.

The other general reason for change in strategy was the HQ decision to be risk-taking (Canadian No. 4) or to allocate to the Canadian subsidiary a product mandate for certain types of products (Foreign No. 2, 5). Since these changes occurred at roughly the same time as the cutbacks in the Canadian firms, it must be concluded that the foreign owned firms are not as sensitive to Canadian domestic market conditions as Canadian firms. For the foreign owned MNC, the volume of business in the Canadian market is most likely such a small proportion of total sales, that local variations in business conditions have much less impact than variations in conditions would have on Canadian owned firms. Secondly, foreign owned firms often have the option of using slack facilities in Canada to produce inventory for other

locations (passive exports), thereby again reducing the sensitivity to local market variations. Thus in order to compete, the Canadian owned firm must take more risks in establishing R & D operations and pursuing export sales than foreign owned competitors in Canada. By taking these risks, the Canadian owned firm has a far greater danger of becoming overextended and thus must be much more sensitive to variations in Canadian business conditions. In a sense, the Canadian owned firms in this sample are below a certain threshold of sufficient size (Clifford 1973) in terms of both domestic and export sales volume compared to foreign MNC competitors. Most MNC's are above the critical threshold and following Clifford's theory, they are relatively immune to the same risks as faced by the Canadian owned firms. While there will not always be a direct causal link between the strategy of the firm and performance in innovations, there has been demonstration of a sufficient enough link in the results of this study to show that innovation is closely related to the strategy of a firm. When strategies change, for whatever reasons, a series of other related changes seem to occur and the impact is eventually observed in the attitude, activity and results in innovation.

On another aspect of the threshold concept, some of the smaller firms in the sample, both Canadian and foreign owned, claimed that they lacked sufficient technical and

scientific personnel to be as active in R & D as they would wish to be. A similar problem existed with lack of personnel available for pursuit of export markets. Among Canadian owned firms as well, there were occasional problems of lack of managerial personnel in general. By way of combining all these problems into one category, the firms suffered from lack of depth in necessary senior personnel. This was not so much a problem on the supply side (i.e. insufficient candidates for available jobs) as it was a problem on the demand side (i.e. insufficient willingness of the firms to hire necessary personnel). A number of the smaller firms had considerable problems of overworked management staff and people being spread too thinly to take advantage of available opportunities. Yet there was a very strong reluctance on the part of some to take the risk of putting additional technical-managerial people on the payroll.

There was a strong feeling of doubt that the firm could earn back a new person's salary sufficiently quickly to justify the additional expense to the firm, yet a common complaint in such firms was that they had too much work for their available staff. This reluctance to cross the threshold of hiring needed additional staff obviously acts as a strong self-imposed barrier to a firm's expansion. Hiring necessary additional staff involves an element of risk or must be considered a necessary investment for firms with

confidence about their ability to develop a greater volume of sales. A number of firms in this sample follow a risk avoidance strategy of considering personnel to be an expense which can only be justified after the additional sales volume has been obtained. Only by a lucky accident can such firms break through their self-imposed barriers of risk avoidance.

For larger firms in the sample, the chief personnel problem was lack of qualified machinists and shop personnel. Larger firms either had sufficient managerial and technical depth of staff to pursue and accommodate larger volumes of business or else had sufficient surplus in organization resources to afford the investment in necessary personnel. Thus the larger firms suffer from a supply problem in personnel (want to hire and cannot find qualified people) while smaller firms suffer from a demand problem (need to hire but reluctant).

Strangely enough, the smaller firms were the least likely to use government assistance programs to either help defray the costs of R & D or to subsidize the expense of additional technical people. Reasons for this ranged from ignorance of the various programs, to reluctance to get involved in excessive paper work, to ideological resistance to the notion of having anything to do with government.

Exceptions to this occurred of course and some smaller firms were very adept at dealing with application forms and submitting proposals. For those who had experience with obtaining government support, reaction ranged from very satisfactory to very frustrated. Among larger firms, there was less perceived difficulty in working with government support programs and in some cases, an active strategy was to utilize the programs as much as possible. Some foreign subsidiaries were discouraged by their HQ from participating in support programs if the programs had limitations built in which would restrict the freedom of HQ to transfer technology from one country to another. In summary, all respondents with experience with government support programs felt the forms and procedures were excessively complicated and bureaucratic. This was particularly true in grants for support in R & D where it was felt that government assessors of such applications used excessively high standards of "scientific merit" in reviewing applications. It was strongly felt that R & D in the machinery industry is far more applied in nature than what the assessors were prepared to accept and therefore, the R & D support programs were of limited relevance to the firms in the sample.

Appendix : The Relationship Between Marketing Activity and Innovations in a Firm

In a manner similar to the relationship between R & D activity and innovations, the approach used by a firm to marketing in this industry was also found to be closely related to the innovation record of a firm. One form of marketing is the selling of standardized products, often carried in inventory or often advertised in catalogues. This type of marketing is practised by Sales and Assembly subsidiaries or by firms with a franchise for products produced and manufactured by other firms. The second type of marketing involves obtaining contracts for unit, small batch or custom made machinery. This latter type of marketing is the one most closely related to the question of innovation and will be referred to as project marketing. It should also be recognized that a firm could supplement its project work by acting as a sales agent for some standardized projects. Also some firms may have developed some projects to a stage of maturity where a basic product is offered with the opportunity for several optional features or customizing. With semi-standard products, a firm is on the threshold of being able to produce for inventory or achieve economies of scale in production while still being able to offer a customer some degree of individual variation in the product.

Project marketing can be organized into three basic types which are described as follows:

a. Client originated projects occur when clients define needs for some machinery on their own and search out suppliers. The chief criteria for selecting a supplier are the supplier's estimated price for the project and the supplier's productive capacity. However, these factors of cost and ability are frequently heavily influenced by the supplier firm's past record in producing similar products and often by the supplier's previous relationships with the client. Since the design initiative comes from the client, the chief marketing thrust of the supplier firm is in the area of production and efficiency expertise. Thus the marketing effort consists of analyzing the clients proposed project, preparing all the estimates necessary for a competitive bid, and seeking to project an image of competence. Some clients prefer to use an open bidding system for projects while others prefer to deal only with trusted, well-known suppliers. Thus a second marketing thrust for the firm is to establish close relationships with a number of potential clients so as to be first in line when the client decides to buy some new equipment. Client originated projects are essentially a "market-pull" situation, but since virtually all the technological expertise comes from the client, the supplier can be said to be almost passive in the innovation process.

b. Supplier originated projects occur when the industrial machinery firm develops specialized expertise in various types of machines and tries to convince the market that these machines will fit their needs better than other machines. Unlike the former type of marketing which is based on production expertise, this type of marketing is based on product expertise. This is essentially a "product-push" situation and requires considerable expertise in marketing oriented toward selling. Also such a firm must have a heavier commitment to R & D because the firm is usually more reliant on internal technology.

c. Joint origin of projects occur[5] when the supplier and the client have established a long and close working relationship so that the supplier provides the technical expertise to the client and the client in turn gives the project to the supplier. This system combines the elements of both o f the above categories of marketing and is heavily dependent upon marketing research by the supplier. In the few cases where this form of marketing was found to occur, production, R & D and marketing personnel in the supplier firm worked as a team to study a client's needs, define the client's problems and do a feasibility study on a solution to the client's needs. Sometimes this is done long before clients are aware of problems themselves but usually the study is done in close contact with the client's own engineering and production staff. When the feasibility study is

completed, the supplier presents it to the client as a proposed project and if the client agrees with the feasibility of the solution, the supplier gets the contract. A good deal of the information necessary for this type of marketing research is gained when the supplier firm installs one set of machinery for the client and then follows the progress of that machinery long after installation is completed. The difference between joint origin and client origin projects is the more active role of the supplier in joint origin projects.

All three types of marketing can be combined in one firm, especially larger firms with diverse product lines and not all types of marketing would be appropriate for all products. For example, there would be no point in trying to establish the symbiotic type of supplier-client relationship characteristic of joint origin marketing if the firm only sells standardized, general purpose products. Similarly, the joint origin approach would not be appropriate for clients who only make one major purchase in many years. The joint origin approach is very appropriate, however, when the client's machinery goes through several generations of evolution so that clients who wish to remain competitive must frequently upgrade their capital investment.

All the types of marketing require personnel with a high level of technological knowledge and experience in the field.

Marketing representatives are frequently former production or engineering personnel and have a good knowledge of both how their factories function and how their client's work-places function. Except in highly specialized R & D jobs, personnel from the R & D area have frequent contact with clients and marketing personnel in order to better learn what the client has in mind or what are the client's needs. Similarly marketing personnel are often closely involved with all phases of the production process to make sure that the factory will actually deliver what was promised to the client. Very few people in the industry, except in the very large firms, are actually trained in marketing in any formal manner, except perhaps for part-time courses or seminars. Most of them learn the business through long experience in the same way that the production and design men learn their business. Frequently the marketing and production people are often the same persons in smaller firms or have changed back and forth between functions in the larger firms.

The joint origin approach was found to be significantly related to the innovative record of a firm, particularly for smaller firms without extensive R & D activity. This result is similar to results obtained by Utterback (1971) and Von Hippel (1978). Utterback's results are shown in Exhibit I below.

Exhibit I

Primary Sources of Innovation in 500 Cases*

Source	No. of Cases
1. The dominant or immediately motivating factor was the perception of a technological opportunity to create or improve a product or the production process (i.e. product push)	21%
2. Innovations were initiated in response to market, competitive, or other external environment influences (i.e. market pull)	53%
3. Innovations were responses to internal production, design and administrative changes	26%
	100%

Utterback's conclusion was that "neither the cost nor the technical knowledge required in producing an innovation are the crucial constraints. The primary limitations on a firm's effectiveness appear to be its ability and perhaps aggressiveness in recognizing needs and demands in the external environment".

(*Adapted from Utterback, J.M., "The Process of Technological Innovation Within the Firm" Academy of Management Journal, March 1971)

Von Hippel's results are shown in Exhibit Two.

Exhibit II.

Sources of Successful Innovations in Different Industires*

Type of Innovation	First Developed by: Product user	Product MFGR.
1. Instruments		
a. First of type (4 cases)	100%	0
b. Major functional improvements (44 cases)	82%	18%
c. Minor functional improvements (63 cases)	70%	30%
2. Process Equipment		
a. First of type (7 cases)	100%	0
b. Major functional improvements (22 cases)	63%	21%**
c. Minor functional improvements (20 cases)	20%	29%**
3. Polymers - all engineering innovations since 1955 whose production in 1975 exceeded 10 mil lbs (6 cases)	0	100%
4. Additives - all commercial additives developed since 1945 for use with major polymers (16 cases)	0	100%

* Source: E. Von Hippel, "Users as Innovators", Technology Review, January 1978.

** Rows do not add to 100% in cases where the source of the innovations came from other sites such as university laboratories.

In all of the above studies, the evidence is strongly suggestive that a major source of innovative creativity occurs as a result of the interchange between the supplier and the client. In cases where a firm has an active R & D operation or had a lucky development in product/process evolution, then the firm may have been able to market "supplier origin" or product push innovations. Where a firm was completely passive in relying on HQ resources or client origin technology, there were very few innovations. But when the supplier took an active interest in innovations and began to develop systematic and continuing interactions with major clients, a synergistic effect seemed to occur that contributed greatly to the innovation process. The synergistic effect is sort of a hybrid form of innovation, neither product push nor market pull. Not all firms were active in the joint origin approach nor were all technical and marketing personnel temperamentally suited to the process, but in cases where it was observed, it seemed to be a very productive strategy for innovation.

References

Beer, M. and Davis, S. "Creating a Global Organization: Failures Along the Way", Columbia Journal of World Business, 1976, Summer, pp 72-84

Bilkey, W. J. "An Attempted Integration of the Literature on the Export Behaviour of Firms", Journal of International Business Studies, 1978, Vol 9 (1), pp 33-46

Brooke, M. Z. and Remmers, H. L., The Strategy of Multi-National Enterprise, New York, Longmans, 1970

Cordell, A., The Multinational Firm, Foreign Direct Investment, and Canadian Science Policy, Ottawa, Science Council of Canada, Special Study No 22, December 1971

Davis, S. M., "Trends in the Organization of Multinational Corporations", Columbia World Journal of Business, 1976, Summer, pp 59-71

Franco, L. G., "The Move Toward a Multidivisional Structure in European Organizations", Administrative Science Quarterly, 1974, Vol 19 (4), pp 413-506

The Gray Report, Toronto, Canadian Forum Press, 1971

Hedlund, G., "Autonomy of Subsidiaries and Formalization of Headquarters-Subsidiary Relationships in Swedish MNC's", London, European International Business Association, December 1979

Ondrack, D. A. Foreign Ownership and Technological Innovation in Canada, Ottawa, Ministry of Industry, Trade and Commerce, 1975

Ondrack, D. A., "International Trade in Small and Medium Size Firms: A Canadian Study", Companies International Activities and Governmental Policies, Paris, EFMD, 1978

Ondrack, D. A., "Stages of Growth in the Structure of Multinational Corporations, Brussels, EIASM Working Paper, 1975, December

Pearlmutter, H. V., "The Tortuous Evolution of the Multinational Corporation", Columbia Journal of World Business, 1969, Jan-Feb, pp 9-18

Pearlmutter, H. V., Wind, Y., Douglas, S. P., "Guidelines for Developing International Market Strategies", Journal of Marketing, 1973, April, pp 14-23

Peccei, R. and Warner, M., "Centralisation and Decentralisation of Industrial Relations Decisions: An Analysis of Substructural Autonomy", Working Paper, Administrative Staff College, April 1976

Peccei, R., and Warner, M., "Decision-making in a Multinational Firm", Journal of General Management, 1976, pp 66-71

Prahalad, C. K., "Strategic Choices in Diversified MNC's, Harvard Business Review, 1976, July-August, pp 67-78

Richman, B. and Copen, M. R., International Management and Economic Development, Toronto, McGraw Hill, 1972

Robinson, R. D., "Ownership Across National Frontiers", Industrial Management Review, 1969, Fall, pp 41-61

Schollhammer, H., "Organization Structures of Multinational Corporations", Academy of Management Journal, 1971, September, pp 345-365

Stopford, J. and Wells, L. T., Managing the Multinational Enterprise, New York, Basic Books, 1972

Weinshall, T. D., "Multinational Corporations: Thier Development and Universal Role", Management International Review, 1975, Vol 2 (3) pp 17-76

Welge, M. K., "Need for Grounded Theory of Headquarters-Subsidiary Relationships in Multinational Enterprises", Berlin, Institute of International Management, October, 1976

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Revised January 1984