

R&D centres of excellence in Canada

Prescott C. Ensign, Julian M. Birkinshaw and Tony S. Frost

INTRODUCTION

This chapter examines CoEs in the context of the R&D operations of foreign subsidiaries in Canada. Its aim is to provide some background on the literature on foreign-owned R&D operations in Canada, and then to provide evidence from the authors' current research on this topic. To some extent the 'centre of excellence' terminology is a case of old wine in new bottles, in that there has been a steady stream of research over the past thirty years concerned with understanding the R&D activities of foreign firms in Canada. However, the CoE terminology does also add something, in that it helps to clarify the role of R&D centres within their corporate system, and the conditions under which they are able to deliver on that role.

The guiding research questions for this chapter are two. What is the evidence for R&D CoEs in foreign-owned subsidiary companies in Canada? And what are the factors that are associated with their existence? The chapter is in two parts. The first part draws on the existing literature—both literature concerned with the development of CoEs in multinational firms and the literature that looks specifically at R&D in Canada. The second part is written on the basis of our recent empirical research in this area. Specifically, it reports on a survey of 99 foreign-owned subsidiaries in Canada, and on a series of case-study interviews conducted by the authors over the last five years.

CENTRES OF EXCELLENCE AND THE MULTINATIONAL FIRM

There are two distinct schools of thought on the theory of the multinational corporation (MNC). The first line of thinking, emerging from trade economics, saw the *raison d'être* of MNCs as their ability

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to internalize transactions across national boundaries (Hymer, 1976). Many variants of this approach have been put forward (for example Buckley and Casson, 1976; Dunning, 1980; Rugman, 1981), but they are all concerned with explaining *why* MNCs exist in the first place. The other line of thinking is based in organization theory, and is concerned much more with *how* the MNC works rather than why it exists. The distinctive feature of the MNC, according to this approach, is that it operates in multiple countries, each of which is characterized by a distinct task environment or organizational field (Ghoshal and Nohria, 1989; Westney, 1993). In order to respond effectively to its environmental heterogeneity, the MNC must adapt the roles of its subsidiaries, but it must also achieve cooperation and consistency between them. This ‘differentiation-integration’ dichotomy was first put forward by Lawrence and Lorsch (1967) and has since seen wide application in the MNC literature (Prahalad and Doz, 1987; Bartlett and Ghoshal, 1989).

In this chapter we focus on the latter theory, which we will refer to as the ‘differentiated network’ model of the MNC (Nohria and Ghoshal, 1997; Ensign, 1999). Our argument is that CoEs first arise as a function of the subsidiary’s task environment (including both local and corporate actors), and they then endure, partly because of the specificity of the assets associated with them and partly because knowledge flows are ‘sticky’ (von Hippel, 1997).

Differentiation of activities and practices

The open-systems perspective on organization theory sees the focal organization adapting to and interacting with other organizations in its task environment (Thompson, 1967). **In** the case of the MNC that is operating in multiple countries, it thus follows that each subsidiary unit has to adapt to its own unique task environment consisting of local suppliers, customers, competitors, and governmental bodies (Ghoshal and Bartlett, 1990). The activities that the subsidiary undertakes, and the capabilities that it develops over time, will be a function of the specific demands placed on it by actors in the local environment (Porter, 1990).

Careful examination of the differentiated network model reveals that the question of *what* is being differentiated varies from case to case. Two groups of studies can be discerned. The first group looked at the *actual activities* performed by the subsidiary. Bartlett and Ghoshal (1986), for example, identified four different roles, namely

strategic leader, contributor, implementer, and black hole, which varied according to the strategic importance of the local market and the strength of the subsidiary. The second group looked at *management practices* in subsidiary units, and related them to the competing demands of the host country and the corporate parent (for example Robinson, 1994; Rosenzweig and Nohria, 1995), typically finding that the host country exerted a stronger pull than the parent firm did.

The distinction between the two groups is important in the context of the overall theory of the MNC. *Differentiation of activities* is a form of task specialization, the result of which could be that all R&D in semiconductors is performed in California while all manufacturing of semiconductors is performed in South Korea. These activities are then leveraged globally, without any other subsidiary units around the world being involved. *Differentiation of management practices*, by contrast, relates to the way certain common tasks are performed. Thus, even though all marketing subsidiaries around the world have to undertake after-sales service, for example, it is possible that the demands of the US market will force the US subsidiary to develop a particularly strong set of capabilities in after-sales service.

While this distinction can be made on paper, the reality is somewhat more complex. Any given subsidiary unit consists of a set of activities *and* their associated practices, and the two cannot be easily disentangled. As a result, our belief is that the term CoE can be more usefully applied to *activities*, rather than *practices*. Activities can be readily identified, and they can be explicitly invested in and recognized by the parent company. Even if it is actually the practices within that subsidiary unit that are valuable, it still makes more sense to define the CoE in terms of the activity. Note that this approach is somewhat different from that used by Lyle and Zawacki (1997) and Moore and Birkinshaw (1998), who see CoEs as ‘virtual’ groupings of individuals with shared expertise.

Defining a CoE

What are the features of CoEs that have arisen in this discussion? One element is that the centre is recognized internally for ‘excellence’, which means that its capabilities are superior to those available elsewhere in the corporation (and to some extent outside the corporation as well). In addition, there has to be some form of corporate recognition for their excellence. This implies an intention that their excellence is used effectively, and it also implies an ongoing commitment by the

corporation and by the subsidiary unit to invest in the subsequent development of the centre. By way of summary, we can therefore put forward the following definition:

A CoE is a set of activities that are recognized by the corporation for their superior capabilities, with the intention that those capabilities shall be leveraged and/or disseminated to other parts of the corporation.

It is worth mentioning at this point that the current study will focus only on R&D centres in Canada. The reason for this, as will become clear in the next section, is that R&D centres are an important topic for debate in Canada, among both subsidiary managers and government policy-makers. Furthermore, compared with many of the other countries discussed in this book, Canada has a relatively high amount of R&D work done in its foreign-owned subsidiaries, so R&D is an area that can be addressed particularly well in this chapter.

Hypothesis development

There is now an established line of academic thinking that models the MNC as a differentiated network of semi-autonomous units. While some of this research has focused on the processes of adaptation to home-country and host-country pressures (Westney, 1993), the line of thinking that is most relevant here is concerned with the *opportunities* created by firms that operate in multiple national markets, and particularly the learning that such diversity offers. As noted by Frost (1998, p. 1), ‘a potentially important source of competitive advantage for multinational firms is the capacity of their foreign subsidiaries to generate innovations based on stimuli and resources resident in the heterogeneous host country environments in which they operate’. This claim is supported by a growing body of research on subsidiary innovation and the internationalization of R&D (for example Porter, 1990; Cantwell, 1992; Frost, 1998).

This line of inquiry suggests two distinct albeit related arguments. The first, typically cast at the country level, looks at the strength and dynamism of a particular location as providing a ‘latent’ opportunity for multinational firms to derive a learning benefit from that location. Fundamentally, this is an argument about locational advantage—the strength of the industry ‘diamond’ in a particular location, to use Porter’s (1990) terminology. The second argument is a subsidiary-

level argument and points to the connectivity of the unit to key actors and resources in the host country. In this view, learning and technical progress are facilitated by active participation by the subsidiary in the 'technological community' that defines the individual and organisational structure of a particular field (Powell *et al.*, 1996). Thus, to make the latent learning opportunity manifest requires the subsidiary to be 'embedded' in the local milieu (Frost, 1998). From these arguments, we derive our first two hypotheses:

Hypothesis 1: The greater the strength and dynamism of the host country in the subsidiary's sector, the more likely is the subsidiary to contain a CoE.

Hypothesis 2: The greater the subsidiary's linkages to external sources of competence, the more likely it is to contain a CoE.

While the subsidiary can draw from opportunities and stimuli in the local business environment, it can also draw from its ties to the rest of the multinational network. Of course the relationship with the head office is fundamentally about control, but in addition the subsidiary is typically connected to a large number of other units within the multinational, many of which potentially represent sources of competence, ideas, and resource flows that could stimulate the development of a CoE. For example, if the subsidiary is selling to another business unit within the multinational network then the relationship with that customer can be an important source of ideas about how to improve its product offering. The argument, in other words, is that internal network linkages can work in a very similar way to relationships in the local market. They can stimulate the emergence of new ideas, and they can foster the emergence of specific capabilities in the subsidiary that become a CoE.

Hypothesis 3: The greater the subsidiary's linkages to sources of competence within the multinational network, the more likely it is to contain a CoE.

Notwithstanding this logic, the relationship of the foreign subsidiary to the parent company headquarters is still of vital importance. Birkinshaw and Hood (1998) suggest two common processes of 'subsidiary development', which in this context means the emergence of a CoE. Parent-driven investment (POI) consists of investment by the

parent company and then the subsequent development of the appropriate capabilities in the subsidiary. Subsidiary-driven charter extension (SDE) begins with the entrepreneurial efforts of the subsidiary to generate advanced capabilities in a given area. The parent company then acts as the sanctioning body, granting the subsidiary the right to pursue a new or extended charter. The point is that both of these processes involve the parent company, but in very different ways.

This discussion is important when considering the *autonomy* of the foreign subsidiary as a factor in the emergence of a CoE. The SDE process, as shown by Birkinshaw (1997), requires the foreign subsidiary to have considerable autonomy, in terms of the ability to identify and pursue interesting market opportunities without explicit permission from the parent company. On the other hand, the POI process is likely to be facilitated by strong links between parent and subsidiary managers, which all else being equal means a relatively low level of autonomy. Of course, what is not known is the relative importance of POI and SDE to the emergence of CoEs, so it is very difficult to specify a priori the likely effect of autonomy. Our preference is to be consistent with the research of Birkinshaw (1997), Crooke11 (1986) and others, which showed that subsidiary autonomy was important for world product mandates to emerge in Canada (the setting for the current research). Thus:

Hypothesis 4: The greater the autonomy of the subsidiary, the more likely it is to contain a CoE.

To summarize the argument so far, the foreign subsidiary is conceptualized as sitting at the interface between its local market network and the ‘differentiated network’ of the multinational enterprise. Both of these networks represent important sources of stimuli to the foreign subsidiary that, depending on their specific nature, will cause CoEs to emerge in the subsidiary. Other factors, such as the industry and competitive environment of the subsidiary, are not explicitly considered in this formulation.

R&D COES IN CANADA

Canadian trade policy

Let us now consider the particular case of R&D CoEs in Canada, or more generically, the emergence of R&D activities in foreign-owned

subsidiaries in Canada. By way of background, in the post-war years Canada, like many other countries, adopted a fairly protectionist attitude towards trade. Tariffs between Canada and the rest of the world, including the US, were very high, and all foreign acquisitions of Canadian companies were for a time subject to review by the Foreign Investment Review Agency (FIRA). As a result, many large multinationals found that under the circumstances the best way of serving the Canadian market was to build a ‘miniature replica’ firm (White and Poynter, 1984), which as the name suggests consisted of a replication of all the principal functions of the parent company but at a scale appropriate to serving the Canadian market place. Importantly, this often included R&D, though with a heavy emphasis on product development or adaptation, rather than basic or applied research.

The miniature replica subsidiary was the dominant model in Canada in the 1970s. The winds of change began blowing in the early 1980s, driven by the increasing interest in free trade on a global level, and by the closer-to-home recognition that the prosperity and competitiveness of Canada (relative to the US) was being gradually eaten away through protectionist trade policies (the protectionist FIRA was even replaced in 1985 by Investment Canada). The Free Trade Agreement with the US was signed in 1988, and the North American Free Trade Agreement that included Mexico was signed in 1993.

Free trade heralded the demise of the miniature replica subsidiary. In its place, two basic models emerged. One was a ‘minimalist’ approach, which involved closing the inefficient activities that had been necessary in a protectionist environment and retaining only those activities that were needed to serve the local market. The other was a ‘specialization’ approach that involved refocusing the existing value-adding activities in Canada towards certain product or technology areas. While there were obvious and real concerns that most multinational firms would take the former approach, the reality has clearly been more balanced. Many multinationals have retained and refocused their Canadian assets, and others have actively invested in their Canadian subsidiaries.

R&D operations in Canada

This historical information is important in the context of the current study, because it helps us make sense of how R&D operations have

emerged in Canadian subsidiaries. In the authors' experience, most foreign-owned subsidiaries with R&D operations actually had those operations in the pre-free-trade environment, and through a combination of parent company investment and subsidiary manager initiative have turned these operations into CoEs with clear and valuable expertise in a limited technological area. Many of the best-known subsidiary companies in Canada fit this description, including General Electric, Du Pont, and Pratt & Whitney. There are also cases of subsidiaries whose R&D is very applied and locally focused (notably many pharmaceutical firms working on regulatory approval), and a significant number in which the R&D operations arose through the acquisition of a previously independent Canadian company. Finally, there is a fourth category of subsidiaries whose R&D operations have emerged organically in the last decade of free trade. However, there are relatively few good examples of this.

As a final point regarding the specific situation in Canada, it is important to realize that federal and provincial governments still play an active role in encouraging foreign R&D investment in Canada. Tax credits of up to 50 per cent are available for R&D investments in Canada, which makes Canada a very cost-effective location to undertake R&D. In addition there are many other ways for government to invite foreign investment in R&D, including infrastructural developments, investment in personnel training and development, tax holidays, and so on.

Academic literature on Canadian R&D investment

As observed, there is a significant body of literature on R&D activities in Canada, most written by economists and with regard to the macroeconomic factors that stimulate or suppress R&D investment. Below we provide a quick summary of some of the more relevant work in this area.

In the first significant study of the foreign-owned sector in Canada, Safarian (1966) found no differences in the R&D expenditures of Canadian owned and foreign-controlled firms but was unable to put this issue to rest. Bones (1980) found that most R&D in Canada is conducted by foreign-controlled firms. Specifically, R&D is concentrated in those industries with the highest degree of foreign ownership. Frankl (1979) argued that R&D expenditures in Canada would nearly double if R&D in Canadian subsidiaries of foreign corporations were proportional to their parent firm R&D expenditures.

Rugman (1981) presented support for the position that less R&D is done in the Canadian operations of foreign firms than either in the parent multinationals or in domestic firms of similar size. His argument was that the concentration of initial and ongoing R&D in the parent firm protected its knowledge advantage against the risk of dissipation (Rugman 1981). Hewitt (1983) corroborated this finding. In a study of US multinationals, Hewitt (1983) indicated that 'it is possible that Canada constitutes a special case in the sense that the reasons for locating R&D in Canada are different from the reasons for placing it anywhere else outside the United States'. Alexander (1983) corroborated the work of Hewitt (1983) by showing that Canada performs less R&D than other nations and that firms in Canada generate proportionately less R&D than in other countries. In her research she found evidence that federal government grants are positively related to R&D expenditures but that R&D is not affected by foreign control or industry concentration.

Most Canadian industrial R&D is performed by a few firms. Of the 6628 firms that reported performing R&D in 1995, 25 firms accounted for more than half of the R&D expenditures. In 1995, 23 firms spent more than 50 million Canadian dollars each; 47 firms spent more than 25 million dollars each; and 192 firms spent more than 5 million dollars each (Statistics Canada, 1997). Of the 6628 firms conducting R&D in 1995, 447 (6.7 per cent) were under foreign control and accounted for 2452 million dollars (32 per cent) of R&D expenditures (Statistics Canada, 1997).

As this brief review indicates, it is widely recognized that Canada has an ongoing problem in attracting a level of R&D investment that is commensurate with its overall economic standing, but there is no consensus regarding the reasons for this state of affairs. Partly, it is a function of the high level of foreign ownership of Canada's industrial sector, but that is not the whole story, because multinational firms are increasingly open to the idea of locating R&D operations abroad, and are encouraged to do so in Canada by generous tax credits.

DATA COLLECTION AND FINDINGS

This chapter draws on the findings from a five-year study of the emergence of CoEs in foreign-owned subsidiaries in Canada. Data were collected in two ways. First, a series of interviews was conducted in subsidiary companies with a view to understanding *how* significant

value-adding operations in R&D and manufacturing had emerged. A total of around 50 interviews were conducted, 30 in the period 1994-95, and 20 in the period 1997-98. These interviews were semi-structured, the objective being to understand the process of evolution and the key factors effecting the process, rather than to formally test any propositions.

Second, we administered a questionnaire in 1998 to collect systematic data on the existence of, and factors associated with, CoE in subsidiary companies. This questionnaire was put together in collaboration with other researchers whose work is reported in the current book. Because it is essentially the same questionnaire as the one used by others, we will provide only a brief description of the questionnaire development and data collection procedures.

Questionnaire development

To develop the instrument the research team met on four occasions. The first meeting defined the objective of the questionnaire. Subsequent meetings were used to more carefully define the core constructs and then the wording of specific items. We also made use of existing scales from previous studies. Finally, after the second iteration of the survey instrument we pilot tested it using a number of executives from one multinational company.

Sample selection

We developed a list of 780 foreign-owned (greater than 50 per cent of equity) companies with annual sales of greater than 50 million Canadian dollars. The mailing list was developed using well-established sources such as *Scott's Directory*, *The Financial Post 1000*, and *The Globe and Mail 500*. Although some companies deliberately exclude themselves from such listings, our research suggests that this mailing list include more than 90 per cent of the population. Service firms were excluded from this sample because the focus was on manufacturing and R&D activities that have a rather different meaning in the service sector.

Administration of questionnaire

The questionnaire was mailed to the sample companies in late 1997. We followed up on our first mailing with a reminder letter. After this follow-up, a total of 99 questionnaires were returned in usable form,

Table 8.1 Descriptive statistics on survey sample ($n=99$)

	<i>Mean</i>
Number of employees	982
Annual sales revenues	C\$569 million
Foreign sales (percentage)	21
Year of formation	1962
Mode of formation (per cent acquisition)	57
Research or development activities (percentage)	76
Manufacturing activities (percentage)	96

and an additional 96 were returned and not usable (either because of incomplete information or the wrong address). Clearly this is a less satisfactory response rate than we would have liked, but analysis suggested that the 99 respondents are representative of the population they are drawn from. Table 8.1 provides descriptive information about the responding companies.

Measurement of constructs

Most questions were attitudinal, that is they asked respondents to state the extent to which they agreed or disagreed with a statement on a 1 to 7 Likert scale. Constructs used were typically aggregates of three or more individual items to enhance reliability. The definition and wording of constructs can be found in the appendix to this chapter.

Qualitative findings

The findings from the research are in three parts. First, we report on the qualitative part of the research with a few brief case-studies of R&D CoEs in Canada. Second, we report on the descriptive statistics from the survey to provide a flavour for the important characteristics of the responding companies. Finally, we report on the regression analysis that was used to test the propositions developed earlier.

Interviews were conducted with around 15 foreign-owned subsidiaries in Canada, some of which had virtually no R&D while others were ranked in the top ten R&D spenders in the whole Canadian economy. Because the process of selecting firms was based on convenience there is no value in reporting the sample characteristics. Instead, what we do here is highlight a few of the interesting cases

that we came across during the research. These cases shed light on the process of evolution of R&D CoEs, as well as various aspects of the economic and political environment in Canada.

General Electric Canada

This is a major company in its own right with sales revenues of 2.6 billion Canadian dollars in 1994, spread across 11 major businesses. Several of these businesses are 'sales only' operations that are dependent on what is manufactured in the US. But there are also several important 'world mandate' businesses, including: (1) GE Hydro, which is run on a global basis from Canada and has an exclusive production capability in massive turbines and generators; (2) large motors up to 50000 horsepower, manufactured in Peterborough, Ontario; (3) large-capacity laundry dryers, made by Cameo in Montreal, Quebec; and (4) the new energy-efficient compact T-8 fluorescent lamp.

Most relevant to this discussion are businesses like GE Hydro and large motors, which have achieved their current positions in R&D and manufacturing through a long history of experience and capability building. The hydro business, for example, built its manufacturing capability in part through the acquisition of Dominion Engineering in 1962. In the late 1970s the development and production of all large motors and generators were moved to Canada to complement the existing competence in large rotating electric machinery. By the time GE moved to its integrated operating model in the late 1980s, these businesses were firmly established as CoEs within the General Electric system.

Hewlett Packard Canada

This company has an important marketing and sales function in Canada, but in addition there are five 'centres of excellence' that are involved primarily in development work. The longest-established is Panacom, which started out as a Canadian company specializing in data-management services in the oil and gas sector. HP acquired Panacom in 1983 but a refocusing of the company away from the industrial sector meant that Panacom was without a charter. Rather than close it (which would have been politically awkward), Panacom's management was able to 'bootleg' the necessary resources to build a business in 'X' terminals. This resulted in a business with revenues of 110 million Canadian dollars in 1993.

Two more recent acquisitions were Idacom and Alcatel's fibre-channel business. Idacom was a small firm based in Edmonton, Alberta, that specialized in communication network protocols. Hewlett Packard began discussions with Idacom in the mid-1980s, but it was not until 1991 that they were acquired. This acquisition led rapidly to investment by HP in a 'protocol testing centre', something that Idacom had been planning but not been able to afford. The second was HP's acquisition of Alcatel's fibre-channel division in Toronto. This was spearheaded by a California-based division, and because this division was already working with Alcatel in this area, the integration occurred very rapidly.

Ericsson Canada

Formed originally in 1953, this company still had a very weak presence in Canada until the 1980s. The impetus for growth was the mobile telephony business. In 1982 the Canadian government gave out two licences for mobile systems, one to Bell Canada, and the other to a small firm called Cantel. Cantel's equipment provider turned out to be problematic, so they turned to Ericsson who had proven expertise in mobile systems. However, the government demanded that Ericsson undertake some local value-added before this deal could be confirmed, so Ericsson in 1984 built a small R&D and assembly operation in Montreal, Quebec. By 1986 there were thirty R&D employees.

The first big growth opportunity for Ericsson Canada came in 1988 when the all US support for mobile systems was moved to Montreal. This gave the Montreal operation a critical mass of around a hundred people, which then grew organically for a couple of years. Then in 1990 the second big growth occurred, when Ericsson decided to move development responsibility for the North American operating standard away from Stockholm, Sweden to free up resources in that location. Montreal won this responsibility on account of its track record and its involvement in both Canada and the US. Fifty more people were transferred over, and more were hired. Rapid growth in mobile telephony led to massive organic growth in development, so that by 1997 there were 900 employees at the Montreal development centre.

Commentary on the case-studies

These cases are very different from one another, but they shed light on a number of issues relating to the emergence of R&D CoEs. First, all

of these CoEs have very specific and specialized roles. None of them has a broad mandate to do research. They are either focusing their research in a particular area (for example General Electric and Ericsson) or—more likely—they are doing product development tied to a particular business area. Second, success appears to be driven from within but stimulated by opportunities in the local market. The Hewlett Packard and Ericsson cases, for example, both involve subsidiary managers actively capitalizing on opportunities in their local environment, and going out of their way to build support at headquarters. Third, success seems to depend at least to some degree on the advantages of Canada as a location for conducting business. Most of the people interviewed mentioned Canada's generous tax credits for R&D, and others pointed to the relatively low cost of doing business in Canada compared to Europe and even certain US locations.

Finally, it seems as if the mode of entry does not matter that much. In the cases of entry through acquisition, the R&D centres went on to develop their own unique capabilities. Also, in the cases of subsidiaries that emerged in the years before free trade, the ones that survived and prospered appear to be those that built distinctive capabilities and customers on their own without regard for tariff barriers.

Descriptive statistics

This section provides an overview of the sample companies, and descriptive data about the main constructs investigated in the regression analysis.

Subsidiary formation

Of the 99 firms, 55 reported entry into Canada through acquisition or merger. Greenfield entry was reported by 41 subsidiaries and joint venture was reported as the mode of entry by three subsidiaries. Entry dates range from 1877 to 1997. The average date of formation was 1962; the most frequently reported year of entry was 1995.

Parent firm nationality

The majority (70 per cent) of respondents were subsidiaries of US parents. Subsidiaries of UK firms represented 15.2 per cent of the sample and Japanese subsidiaries represented 8.9 per cent of the sample. Other parent company homes were Germany, Finland, Sweden and the Netherlands.

Sales

Mean total sales for the responding firms were 566 million US dollars. The median was 60 million US dollars and the range was 1.4 million to 30000 million US dollars. Average foreign sales were 21 per cent of total sales. The median, however, was 2 per cent with a range of no foreign sales (for 36 of those 91 subsidiaries answering this question) to 100 per cent foreign sales. This is an indication that Canadian subsidiaries of foreign corporations, for the most part, are not acting primarily as a source to serve other markets.

Number of employees

The average number of persons employed by a foreign subsidiary was 985. The median was 225 and the range was from 17 to 3000 employees. On average, 2.9 per cent of a Canadian subsidiary's workforce consists of expatriates, while 63 of the 99 firms responding to this question indicated that they employ no expatriates. Although R&D employment figures were not obtained in the present survey, OECD (1996) figures indicate that R&D personnel comprise 0.8 per cent of the Canadian labour force as compared with 1.2 per cent for France, 1.3 per cent for Japan, and 1.4 per cent for Germany.

Dynamism of local environment

Table 8.2 provides the mean responses for questions about the importance of specific items to the development of competence in the subsidiary. As one might predict, demanding customers and local

Table 8.2 Responses to question about local environment dynamism

<i>Dimensions of the business environment in which the Canadian subsidiary competes</i>	<i>Average assessment</i> <i>1 = very low</i> <i>7 = very high</i>
Demanding customers	6.0
Level of competition	5.9
Availability of supply material	5.1
Quality of suppliers	5.1
Availability of business professionals	4.5
Favourable legal environment	3.4
Existence of research institutions	3.0
Governmental support	2.6

competition are perceived to be the most important, while the political and legal environment is perceived to have least impact.

R&D activities undertaken by Canadian subsidiaries

Of the 99 subsidiaries, 54 per cent responded that they undertake basic or applied research, while 76 per cent undertake development work. These figures are high relative to the foreign-owned sector in most other countries. It is interesting to note that of the 37 subsidiaries established as green-field entries, 22 (60 per cent) do not undertake research activities. Of the 48 subsidiaries established via acquisition or merger, 16 (33 per cent) do not undertake research activities. Examining development activities, it was found that of the 37 green-field subsidiaries, 15 (40 per cent) do not undertake development activities and of the 51 acquisition or merger subsidiaries, 5 (10 per cent) do not undertake development activities. This is consistent with the contention that there is a greater propensity to undertake R&D activities if foreign entry is through acquisition. Presumably such firms are previously engaged in such activity. Another important observation is that subsidiary age is significantly correlated to the undertaking of research (0.188, $p < 0.1$) and development (0.293, $p < 0.01$). Somewhat surprisingly (compare Hewitt, 1980), Canadian subsidiary sales were not found to be related to performing either research or development.

Decision-making autonomy

As one might predict, there is considerable variation in the level of autonomy depending on the decision. Most subsidiaries (58) are allowed to enter other markets in Canada without referral to headquarters, but only 19 have autonomy to enter foreign markets without referral. Table 8.3 summarizes the results for four key decision areas.

Competence in R&D

Taking *research* first, the average level of competence was 4.6 for 54 subsidiaries responding on a scale of 1 (weak) to 7 (very strong). Eighteen of 44 subsidiaries responded that their capability was recognised. The equivalent figures for *development* are an average competence level of 5.3 for the 74 subsidiaries responding, and 29 of 65 indicating that their competence is recognized by the corporation.

Table 8.3 Decision-making level

<i>Decision</i>	<i>Level decision making</i>
Entering new market within Canada	Subsidiary level = 58 Sub corporate level = 26 Corporate level = 16
Introduction of new products/services	Subsidiary level = 49 Sub corporate level = 25 Corporate level = 26
Hiring top subsidiary management	Subsidiary level = 19 Sub corporate level = 33 Corporate level = 48
Entering foreign market	Subsidiary level = 19 Sub corporate level = 25 Corporate level = 54

Investment in R&D

On a scale from very limited investment (1) to very large investment (7), the average response was 2.8 for research and 3.7 for development. Very limited investment in research was reported by 39 per cent of respondents and very limited investment in development was reported by 20 per cent of respondents.

Factors contributing to competence development

Table 8.4 indicates mean responses to questions about the factors contributing to competence development. These findings are consistent with the findings of Birkinshaw (1997), in that they suggest it is conditions within the subsidiary that are most critical, but with conditions in the product market and the corporation also important.

Regression analysis

This section of the chapter provides a formal test of the propositions developed earlier. Two OLS regression models were run, the first using competence and investment in the CoE as the dependent variable, the second using recognition of the CoE as the dependent variable. The models are reported in Table 8.5.

The results provide strong support for Hypothesis 2 (p. 135), that external sources of competence are associated with the existence of a CoE. In both models, this is the most significant predictor. Hypothesis 1,

Table 8.4 Factors contributing to competence development

<i>Factors contributing to the competencies in the Canadian subsidiary</i>	<i>Average influence</i> <i>1 = no influence at all</i> <i>7 = very strong</i>
Conditions within the Canadian subsidiary	5.8
Conditions in the product market	5.4
Conditions in the supply market	4.1
Conditions in the corporation	4.0
Institutional conditions	3.0

Table 8.5 Predictors of centre of excellence in R&D

	<i>R&D centre</i>	
	<i>Competence</i> <i>(Model 1)</i>	<i>Recognition</i> <i>(Model 2)</i>
Constant	0.655	-0.244
Sales volume	-0.073	-0.145
Percentage of foreign sales	0.071	0.295*
Mode of formation (1, 0)	0.005	0.084
Unit autonomy	0.213	0.271*
Local environment dynamism	0.439**	0.181
Internal sources of competence	0.045	0.067
External sources of competence	0.236	0.298*
<i>F test (sig.)</i>	3.06**	4.02**
<i>R-square</i>	0.296	0.316
<i>Adjusted R-square</i>	0.199	0.237

* $p < 0.05$ ** $p < 0.01$ † $p < 0.10$ Standardized beta coefficients reported, $n = 70$.

that the dynamism of the host country will be associated with the existence of a CoE, was strongly supported in model 1 (competence and investment in CoEs) but not in model 2. Hypothesis 3, that internal sources of competence are associated with the existence of a CoE, is not supported at all. Finally, Hypothesis 4, predicting that the autonomy of the subsidiary would be associated with a CoE, is supported in model 2 (R&D centre recognition). In other words, greater autonomy in the subsidiary is associated with cases in which the subsidiary is recognized for having an R&D CoE. Finally, it is interesting to note that the percentage of foreign sales in the subsidiary is an important predictor

of a CoE being recognized, though not of the level of competence and investment. This perhaps hints at the importance of international sales as a way of gaining visibility, and thus recognition, with headquarters. It may also be, therefore, that some CoEs in R&D are rather more locally focused, and while they are competent and receive investment they are not actually that well recognized.

DISCUSSION AND CONCLUSIONS

A number of important issues are raised by the findings of this research. The first is that the emergence of R&D CoEs in Canadian subsidiaries is driven primarily by external sources of competence whether specific customers, suppliers, and universities, or the overall dynamism of the local environment. This is not a surprising finding as such, in that there is a broad range of theoretical and empirical research that would lead us to hypothesize such a relationship. It is however, surprising how much more important external sources of competence are than internal ones. A concern commonly voiced in Canada is that the local business environment does not effectively support innovation and product development, yet the evidence provided here suggests that it does have a positive effect. The related concern, that Canadian subsidiaries are just branch plant operations that rely on their parent company for technology and ideas, is also challenged by this research, because internal sources of competence do not have any significant correlation with the existence of CoEs.

The second interesting issue is that the autonomy of the subsidiary appears to be positively related to the recognition of CoEs. Autonomy, as discussed earlier, provides subsidiaries with the degrees of freedom they need to act, but it also runs the risk of cutting the subsidiary off from the rest of the MNC. The data suggests that this is not such a problem, in that recognition from the rest of the MNC is actually achieved to a greater extent in more autonomous subsidiaries.

Finally, the case-studies hint at some of the processes through which CoEs emerge. The evidence here is limited, but we can see that R&D centres emerge through a drawn-out, path-dependent process that involves tapping into local sources of competence, initiative by subsidiary management, and a considerable amount of luck. There is a lesson here for policy-makers who are intent on building CoEs, namely *work with what you have*. Big new investments are extremely unusual, especially in the R&D area. Incremental investments building

on the existing stock of activities are far more likely, and will probably end up with a stronger presence both in the host country and in the parent company.

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Appendix: Construct Definition and Measurement

R&D Centres of Excellence

Building on the earlier definition, we operationalized a CoE using three different dimensions: (1) competence level in R&D, (2) formal recognition for that competence by the corporate headquarters, and (3) level of investment in R&D over the past three years. Because *competence* and *investment* were measured on seven-point Likert scales it was possible to sum them to create a single measure. However, *recognition* was measured with a series of yes/no questions, so it was kept separate. Thus we ended up with two measures:

- R&D centre of excellence (competence): respondents indicated the competence level in research and in development (1 = weak competence, 7 = very strong competence), and the level of investment in research and in development; for the past three years (1 = very limited, 7 = very large) (Cronbach's $\alpha = 0.87$).
- R&D centre of excellence (recognition): respondents assessed the extent to which 'Our competence is formally recognised by the headquarters' in research, and in development (1 = yes, 0 = no) (Cronbach's $\alpha = .78$).

Local market dynamism

Building on the elements of Porter's (1990) diamond model, and the scale developed by Birkinshaw (1997), respondents were asked to assess the local business environment on the following dimensions: (1) availability of business professionals; (2) availability of supply material; (3) quality of suppliers; (4) government support; (5) favourable legal environment; and (6) existence of research institutions (1 = very low, 7 = very high). The composite measure is the average of these six items (Cronbach's $\alpha = 0.68$).

External sources of competence

This construct was measured using two sets of similar questions that were combined and averaged. First, respondents were asked whether any specific organizations had an impact on the development of the subsidiary's competencies, where 1 = no impact at all, 7 = very decisive impact. Six kinds of organizations were identified: (1) external market customer; (2) external market supplier; (3) specific distributor; (4) specific competitor; (5) specific external R&D unit; and (6) governmental institution (Cronbach's $\alpha = 0.78$).

Internal sources of competence

The measurement of this construct mirrored the one above. Four specific organizations were identified: (1) foreign corporate headquarters; (2) specific internal corporate customer; (3) specific internal corporate supplier; and (4) specific corporate R&D unit. Respondents then assessed their impact on the development of the subsidiary's competence. Taken together these questions formed a reliable scale (Cronbach's $\alpha = 0.73$).

Subsidiary autonomy

On the basis of scale developed by Roth and Morrison (1992) and subsequently used by Birkinshaw (1997), respondents were asked to identify the level at which certain decisions were made, where 1 = subsidiary level, 2 = sub-corporate, 3 = foreign corporate HQ. Decisions were as follows: (1) hiring top subsidiary management; (2) entering a new market within the country; (3) entering a foreign markets; (4) changes to subsidiary organization; (5) introduction of new products/services; and (6) approval of quarterly plans/schedules (Cronbach's $\alpha = 0.63$).

Controls

To control for structural characteristics of the subsidiary that might also influence the creation of CoEs, we controlled for the following factors: (1) sales revenue in 1997; (2) foreign sales as a percentage of total sales; and (3) mode of formation (greenfield or acquisition). Note that number of employees was also included originally, but it is very strongly correlated with sales revenues ($r = 0.92$) so could not be included in the regression analyses.