Innovation and the Management of Human Resources

CPROST Report # 00-03

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Introduction

There is often a perception that the primary objective of science and technology (S&T) policy is the further development of industries in the manufacturing sector. Governments in most jurisdictions support, in one way or another, S&T programs in the firm belief that investments in S&T have a positive, if indefinable, effect on economic growth. Economic growth is widely assumed to be a social benefit, and that growth in knowledge and technological inputs must inevitably result in social progress. While virtually all studies of innovation have focussed on their economic impacts, innovations have impacts on society and the development of human capital which are at least as important as their economic impacts. Policy-makers need to consider the application of S&T, to and the role of technological innovation of, in the development of human capital at the firm level.

Studies of innovation in Canada have been carried out at the national level, but because of the preponderance of industrial activity in Ontario and Quebec, the results understandably reflect the characteristics of these manufacturing based provinces. (See for example Baldwin & Da Pont, 1996;

Baldwin *et al*, 1994). There have also been studies of regional industrial clusters (or "poles") and comparisons of regional, or sub-national, innovative performance. A recent review of this subject, in the Canadian context, has been published by de la Mothe and others in "Local and Regional Systems of Innovation" (de la Mothe and Paquet 1998). These regional clusters are the building blocks of the Canadian national system of innovation. But in the knowledge-based economy, where knowledge, embedded in the training of the human capital of the innovative firm is the primary resource for the innovative firms, what is the relationship between the innovative behavior of the firm and the way it manages its human resources?

Survey Methodology

A short questionnaire for use with BC enterprises has been developed by the authors. The overall results have been reported by Holbrook and Hughes. (Holbrook and Hughes 1998) The questionnaire was not intended to cover all aspects of technological innovation identified in the OECD "Oslo Manual" (OECD 1997) but it had to conform to the main points in the OECD standard. To ensure a reasonable response rate, the questionnaire was short (no more than one page, printed on both sides) so that it would be user friendly, take little managerial time to complete, be comprehensible to a small technology-based entrepreneur based in BC, and be faxable to expedite its return.

A similar survey covering the Okanagan region of BC, a non-metropolitan area dependent mainly on agriculture and resource extraction, was conducted in July, 1997 (Holbrook, et al. 1999). For the Okanagan phase of the project, the questionnaire was modified from the version used for the Lower Mainland. Some of the modifications were the result of conclusions drawn from the analysis of the Lower Mainland responses; others were added to provide additional information on knowledge management and highly qualified personnel.

The samples in both surveys were drawn from two industrial sectoral groups, "high technology" and "policy sectors". Firms were selected in eight industrial sectors from the two groups: high tech (manufactured products, computer services, and technical services) and policy sectors (food products, forest products, electrical products, construction, and transportation). To be included in the sample, a firm had to employ at least five people, and have been in operation for at least five years. This criteria was applied based on the assumption that smaller, newer firms are still in the process of stabilizing, and are likely to be quite transient. It is commonly thought that much innovation occurs in this entrepreneurial environment, the so-called "bleeding edge". These surveys was primarily interested in the characteristics of *successful* innovators. Given that the majority of new ventures fail within the first five years, firms that survived the first five years are more likely to be the successful innovators.

From this survey of innovation of enterprises in four sectors, it was possible to select questions that related innovation to human capital management practices. To no great surprise, innovative firms (those that had introduced a new product or process in the last five years), were also those that scored highly on questions that measured their ability to manage highly skilled human resources.

New and Unique to the Market

In the process of carrying out this research, a new issue arose. Firms are described as being innovative if they have developed a technologically new product or process. The Oslo Manual defines an innovative firms as one that has introduced a product or process innovation is *new to the firm* in the past three years. But for reasons outlined below (and confirmed during focus group testing of the BC questionnaire), this definition was changed to innovation was *new to the market* for the past five years. Oslo Manual type surveys in Europe suggest that approximately half of European firms

are innovative. This result, on the surface, appears to be the same as the CPROST results, however the CPROST survey changes two component variables of the construct "innovation".

The first change, extending the period for product introduction from three years to five years, lowers one of the entry requirements for innovation. Except in certain, highly competitive industrial sectors (like computers and software) product life cycles are not usually three years or less. In most manufacturing industries, as well as in most services, product life cycles are at least three years, and sometimes much longer. For example, by using a three year product life cycle, Boeing Aerospace (or Airbus Industrie, for that matter), would only be considered innovative for about three years of any given decade, given their approximately ten year product development cycles. Many other industries, from consumer electronics to automobiles, are similar. This classification issue is ameliorated in the case of large firms by having multiple product lines, and staggering product life cycles : small and medium size firms with single product lines are unable to do this. This result is shown in the Canadian 1993 Survey of Innovation in Manufacturing Enterprises (Baldwin & Da Pont, 1996). For the period 1989-1992, 50% of larger firms were considered innovative, compared to only 30% of small firms (less than 100 employees). Assuming a five-year development cycle, the CPROST method considers as many as 75% to 80% of firms to be *potentially* innovative.

On the other hand, the second CPROST change within the construct "innovation" moves the entry requirement in the opposite direction. To most practitioners, that is, people in the working world, developing and selling new products, and competing with one another, innovation has quite a specific meaning. "New" is not equivalent to "innovative." Anyone can introduce a product they have not sold before or a production process they have not used before, particularly after a competitor has taken the risks and proven the new technology. Innovation to these people implies a large element of risk-taking, of putting the company on the line to become a market leader, rather than following simply for the sake of survival. To be innovative, a product should have no equivalent competition at the time it is introduced, therefore *new to the market* This is a customer-based definition of innovation, and it is the purchasing habits of customers that determine whether an innovation is successful or not. Using Schumpeterian arguments, market instability and consequently growth comes about with changes to the productive process, and the producer drives this process of innovation. Nevertheless, it is incumbent on the consumer to accept the new product, and by purchasing it, to encourage and reward the innovator. It is the first new product in the market that introduces the instability that causes growth, subsequent entries by competitors attempt to restore the stability of the market and eliminate the possibility of growth until the next innovation comes along. Consequently, *new to the firm* should not be considered the entry point for innovation, indeed, most of the time, it is exactly the opposite, restoring the stability to an economy destabilised by innovators.

Survey Results

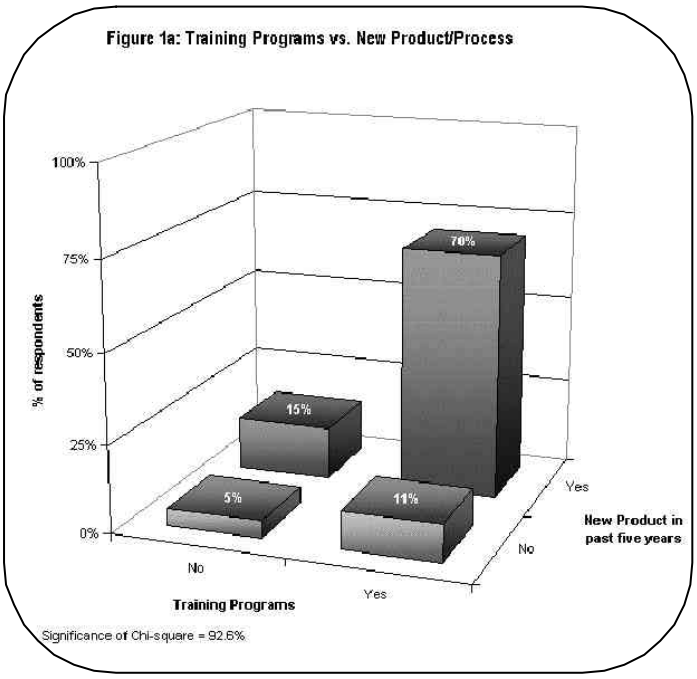
The results below summarize the responses to questions on the innovation surveys that refer to personnel practices within the firms, and which if answered positively, would be indicative of good personnel management within the firm.

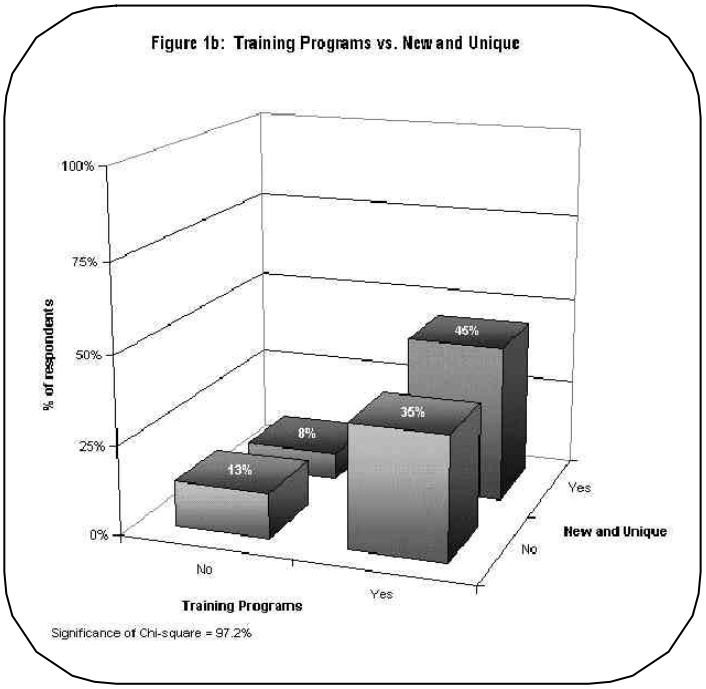
Training programs

Table 1: Training Programs by Innovativeness

% of all respondents		Training Programs		
		No	Yes	sig of χ^2
New Product or Process in the past five years	No	5%	11%	0.074
	Yes	15%	70%	
New & Unique Product or Process in the past five years	No	13%	35%	0.028
	Yes	8%	45%	

Innovative firms are more likely to have some type of training programs than non-innovative firms: Training was carried out by firms of all sizes, but larger firms were more likely to have such programs: 77% of small firms, 85% of medium firms and 91% of large firms reported having training programs. However there is a strong dependency between training and the "new and unique" factor, and the presence or absence of training programs, a dependency which is less strong when the standard Oslo definition of "innovative" is used.(Figure 1a and 1b)





Acquisition of skills

Acquisition of skills is always an important issue for firms. Firms were asked how they went about acquiring skilled workers:

Table 2: Skill Acquisition Strategies by Innovativeness

% of respondents by category		Train to acquire required skills	Hire to acquire required skills	Contract to acquire required skills
New Product or Process in the past five years	No	80%	77%	50%
	Yes	91%	75%	45%
New & Unique Product or Process in the past five years	No	87%	69%	31%
	Yes	92%	80%	54%

By size of firm:

Table 3: Skill Acquisition Strategies by Firm Size

% of respondents by category	Train to acquire required skills	Hire to acquire required skills	Contract to acquire required skills
Small (less than 20 employees)	89%	70%	44%
Medium (less than 100 employees)	93%	86%	46%
Large (more than 100 employees)	81%	88%	50%

Availability of personnel

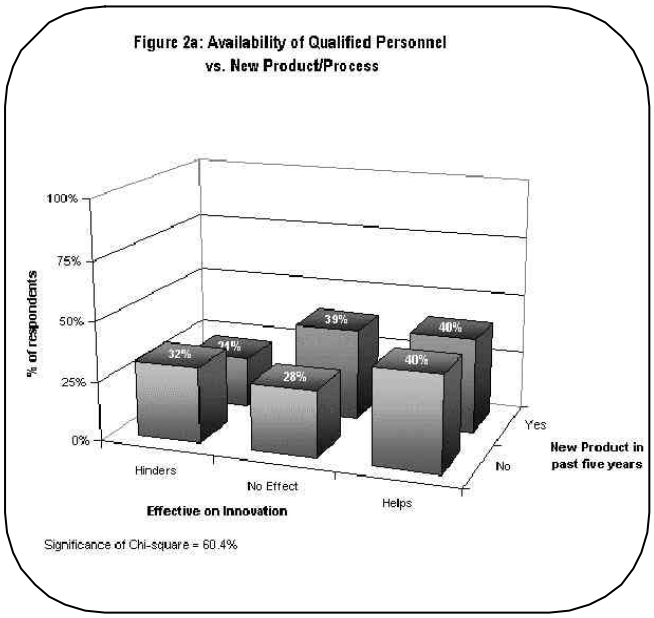
The availability of personnel is always a concern for managers and owners. Respondents were asked whether the availability of qualified personnel helped, had no effect, or hindered innovation in their firms:

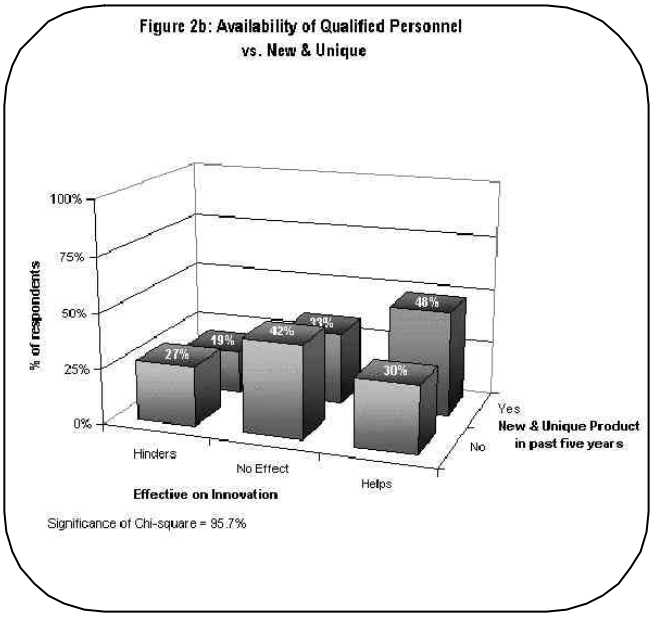
Table 4: Effect of Availability of Personnel by Innovativeness

% of respondents by category		Availability of Personnel			
		Hinders	No Effect	Help	sig of χ^2
New Product or Process in the past five years	No	32%	28%	40%	0.396
	Yes	21%	39%	40%	
New & Unique Product or Process in the past five years	No	27%	42%	30%	0.043
	Yes	19%	33%	48%	

Using the Oslo definition of innovation, there is no significant dependency present in the data. However, by using the "new and unique" definition, a significant dependency is indicated between the effects of availability of

personnel and innovativeness. The data shows that for innovative firms, the availability of qualified personnel helps innovation, where it is considered to have an effect. (Figure 2)





By size of firm:

Table 5: Effect of Availability of Personnel by Firm Size

% of respondents by category	Availability of Personnel		
	Hinders	No Effect	Help
Small (less than 20 employees)	21%	38%	41%
Medium (less than 100 employees)	34%	32%	34%
Large (more than 100 employees)	9%	45%	46%

Post-secondary education

Specific skills and a demonstration of the ability to learn are two major characteristics of individuals with post-secondary education, be it from a technical college or a university. Approximately 40 % of the working population of British Columbia have some post-secondary education[1]. Thus firms were divided into two categories - those with more than 40% of employees with some post-secondary education and those with less than 40%.

[1]BC has a higher percentage of workers with post-secondary training than the national average: 37% as opposed to 33% for Canada as a whole

Table 6: Employees with Post-secondary Education by Innovativeness

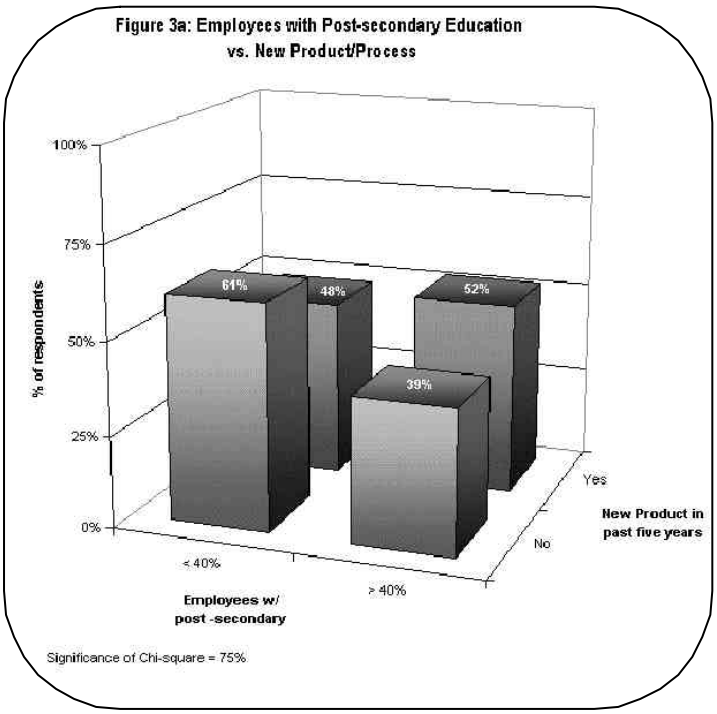
% of respondents by category		Employees with Post-secondary Education		
		< 40%	> 40%	sig of χ^2
New Product or Process in the past five years	No	61%	39%	0.250
	Yes	48%	52%	
New & Unique Product or Process in the past five years	No	61%	39%	0.008
	Yes	40%	60%	

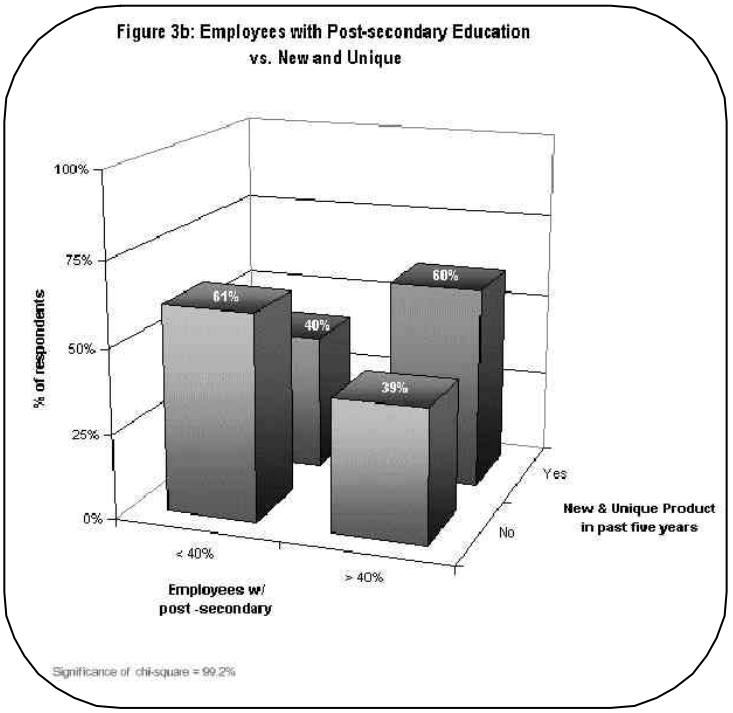
There is a significant dependency between the number of employees with post-secondary education and whether the firm has produced a new and unique innovation (figure 3). The dependency between these two variables using the Oslo definition of innovation is not significant. Interestingly, there is no dependency (χ^2 = .85) between having a high percentage of employees with post-secondary education and training programs in the firm. The presence of well-educated employees does not appear to automatically create a demand for further training. These findings are a strong argument for additional public-sector investment in post-secondary education programs, and in enhancing access to these programs.

By size of firm:

Table 7: Employees with Post-secondary Education by Firm Size

% of respondents by category	Employees with Post-secondary Education		
	< 40%	> 40%	sig of χ^2
Small (less than 20 employees)	45%	55%	0.037
Medium (less than 100 employees)	61%	39%	
Large (more than 100 employees)	80%	20%	





Other Results

Statistics Canada has recently carried out a major survey of innovation in the manufacturing and natural resources sector[2]. As part of this survey it asked questions concerning training and hiring practices in Canadian industry. This survey used the Oslo manual definition of innovation – "new to the firm". They found the following;

Obstacles to innovation:

- 62% found it difficult to hire qualified staff and workers
- 33% found it difficult to retain qualified staff and workers
- 62% found it difficult to devote staff to innovation
- 40% reported a lack of skilled personnel
- 18% reported a lack of marketing capability

Factors assisting innovation:

- 24% gave a high level of importance to hiring university graduates
- 40% gave a high level of importance to hiring graduates from technical schools and colleges
- 68% gave a high level of importance to hiring experienced employees
- 10% gave a high level of importance to recruiting from abroad
- 80% gave a high level of importance to training employees
- 60% gave a high level of importance to using employee teams

Analysis

New to the market presents a methodological concern for many innovation researchers, which lies in the problem of defining and operationalizing "market." This study makes no attempt to precisely determine the market of each respondent: it is assumed that the respondent knows the market in which the firm competes. Strictly speaking, this lack of definition introduces a large degree of uncertainty: how do we know that we mean the same thing by the term "market" as the respondent? However, this may be something of a case of academic isolation from the practitioners being studied. To a business person, "your market" again has a specific meaning: the set of all potential customers for a firm's products and/or services, as well as competing firms with equivalent products and or services that these potential customers might use. This use of the word is more akin to its use in "market share", referring to that portion of all potential customers using a particular product, than to the more general meaning of the term "market" (as in "free market" or "market failure") to economists.

Using a "new to the market" measure addresses other problems inherent in innovation surveys based on the Oslo Manual. Innovations fall into one of three categories: new to the firm, new to the nation, new to the world. The new to the firm category has already been addressed. A product that is new to the world is obviously innovative, although it begs the question "How do you know?" or the statement "Prove it!" Only a very small percentage of new products are new to the world. These innovations are of great interest, since they indicate extreme competence of the firms and systems of innovation producing them. That leaves "new to the nation." Although this measure is perceived to

[2]The questionnaire is available on the Statistics Canada web-site at <<http://www.statcan.ca/english/concepts/pdf/science/0497-99.pdf>>

be of importance to policy makers, it does not necessarily represent the reality of practitioners, who are more concerned with their markets. These markets may be regional, or they may be transnational, that is, not corresponding to political boundaries. Markets rarely coincide with national boundaries, except in cases of highly regulated. As this research program has found, firms serving non-metropolitan regional markets tend to have low exports, relying on suppliers and customers as sources of innovation. These firms import knowledge to a region. On the other hand, firms serving transnational markets export products or services beyond their regional or national milieu, and rely on internal R&D as a source of innovation. These are knowledge exporters.

The importing or exporting of knowledge can serve as an excellent indicator of the expertise of a regional system of innovation. A predominance of firms with a regional focus will indicate that the region is underdeveloped. Coupling this with other indicators of economic activity, and longitudinal research will indicate whether the region is developing or not. (This is also very useful when applied to particular industrial sectors or clusters, since it can indicate the growth of pockets of expertise, or clusters). On the other hand, a region or cluster dominated by firms with a transnational focus will indicate competence or even special expertise in that region. In both instances, these indications are of greater interest and usefulness to policy makers than whether a product or process is new to a particular country.

Conclusions

Some messages for policy makers interested in the emerging knowledge-based economy can be derived from the data. Innovative firms do appear to need trained individuals, and those which have produced innovations which are new and unique to the market which they serve, even more so. Governments, ever mindful of the need to make the transition to the "new economy" need to invest heavily in post-secondary education. It is no accident that current growth of the Irish economy has been accompanied by massive investments by the government in post-secondary education.

Another area requiring improvement is knowledge on the levels transfers from studies to employment. Given the high cost of post-secondary education, more knowledge is needed as to about how the resulting talents are used, and how, over time, technical knowledge is either augmented or depreciated. Studies of the stocks and flows of human capital lead directly to the study of the actors and networks that make up an NSI. This is a field which is only just beginning to be being examined, but which is probably important in smaller economies than in larger ones, where the sheer number of networks and individual actors, results in individual actor-networks having less individual influence on the system.

With the current emphasis on job creation as a policy goal in itself, the analysis of non high-tech sectors becomes more important. Natural resource based industries and consumer service based industries can all be innovative within their markets. In BC these services industries tend to cluster, by sector, so that it is important to be able to situate them in any policy framework devoted to enhancing the innovativeness of firms as a whole. The link between the tourism sector and other (innovative) sectors such as agrifoods, is also important, at least in the BC context.

While the limited data from the survey can only provide a glimpse of the policy issues emerging from the analysis of regional results within BC, the effects of geographical separation do appear to influence the responses. In previous surveys of high-technology firms in the Okanagan, it has been reported that life-style is an important component for firms choosing to locate there and for employees to be drawn the region (Padmore, private communication). It may be that in some

sectors, innovative firms may succeed in remote areas, simply because of the temperament of the individuals who are likely to work in those sectors. The question remaining is whether there is a clustering effect, that there is a lower limit to the number of highly skilled individuals required to establish an innovative cluster, or indeed , whether an cluster of individuals, or firms, is required to establish an innovative industrial sector. Do innovative firms attract skilled individuals, or the reverse, or is it a matter of establishing an environment in which both skilled individuals and innovative firms can flourish? Perhaps it is a case of "If you build it they will come"?

Finally, and perhaps most important, is the issue of whether the firm in question has developed a new and unique innovation. Given the strong correlation between the positive responses to the personnel-related questions, and the "new and unique" definition of innovation, it would appear that policy analysis should be directed towards this definition of innovation .As noted above, respondents are probably better equipped than researchers to define what their markets and whether their innovations are indeed new to the markets which they serve. Firm innovativeness should be based on a *new to the market* determination. "New to the firm" is not necessarily innovative, and "new to the nation" does not address the economic realities of transnational markets. "New to the world", while capturing innovation, does not capture all innovative activity within a regional system of innovation. Innovation research, to capture innovative activity in most manufacturing and service sectors, must also capture data on product life cycles and analyze that data by industrial sector. This would allow innovative activity to be determined on the basis of actual industrial conditions, rather than an arbitrary and probably inappropriate external determination of product life cycle.

Acknowledgements

The authors would like to acknowledge the encouragement and support for this project from the Social Sciences and Humanities Research Council of Canada, Statistics Canada and the Science Council of BC.

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