

Operationalizing definitions of innovation at the level of the firm

Adam Holbrook and Lindsay Hughes
Centre for Policy Research on Science and Technology
Simon Fraser University
Vancouver, BC, Canada

Introduction

The purpose of this paper is to comment on the use of the Oslo Manual(1) published by the Organization for Economic Cooperation and Development(OECD) for surveys of innovation activity. This analysis is not a rejection of these standards - rather it poses a set of questions that should be addressed for future innovation surveys based on the Oslo Manual, and offers a few possible compromises that could enable old data to be used in conjunction with data from revised Oslo-style surveys.

It is often difficult to attribute a particular output (say, increase in productivity) to investment in any one factor. There have been many attempts to measure outputs and link them to specific S&T inputs, but they are doomed to failure because of the interconnectedness of the factors within a national economic system. This is one reason that analysts look to the models of national systems of innovation in attempt to derive indicators of the stocks and flows of knowledge among the various elements of a national economy. The OECD has analysed national systems of innovation (2) and has concluded:

The study of national systems of innovation (NSI) offers new rationales for government technology policies. Government policies in the past have focussed on market failures; studies of NSI make it possible to study systemic failures.

The report goes on to argue that analyses of NSI help to identify networks and areas where networking can be of benefit, and improving policies which enhance the innovative capacities of firms. The report admits that studies of NSI are hampered by difficulties in measuring the flows of knowledge: the OECD Frascati Manual measures only a part of those flows.

The UN Conference on Technology and Development (UNCTAD) (3) stated, in the context of discussing science, technology and innovation policy reviews in developing countries:

A useful notion in this context is the national system of innovation. Which refers to the network of economic agents together with the institutions and policies that influence their innovative behaviour and performance....The NSI perspective refers to a new understanding of innovation as an interactive process in which enterprises alone or in interaction with each other play a key role in bringing new products, new processes and new forms of organization into economic use..... In the present era of internationalization, the critical issue becomes of how to integrate NSIs into the international division of labour. This may be done through exploring how well each NSI is capable of drawing on a rapidly growing of generic knowledge which is not necessarily produced in the country itself... .

The implications are clear. Any (and every) economy has an NSI. Knowledge is transferred among the components as intellectual property, embedded knowledge or people. Thus policy makers need to understand the relationships among the components of the NSI. Data have to be collected on all elements of the NSI and warehoused in an institution, an observatory, to enable their timely analysis and processing. The measurements required to understand an NSI include measurements of the stocks of knowledge and the flows of knowledge among the elements of the NSI. Each element has a capital stock of human capital, of intangible knowledge stored in some archival manner (libraries, patent and licence documents, etc), and a series of linkages to other elements of the NSI over which these stocks of knowledge flow. People move from element to element, knowledge is transferred in intangible forms (electronic, paper, etc.) and in tangible forms (the transfer or purchase of equipment). As policy makers learn where the constraints on movement of knowledge are, they can develop, as the OECD noted, policies to mitigate the conditions that cause these constraints.

The Oslo Manual

The Oslo Manual is a set of guidelines that was first published in 1993 as a draft document by the OECD committee of national experts on S&T indicators (NESTI). The theoretical development and analysis that went into the preparation of these guidelines has been described by Smith (4). Unlike its predecessor, the OECD Frascati Manual (5) which provides a precise set of definitions for the national statistical agencies of OECD member nations, the Oslo Manual is both a textbook on the nature of innovation and national systems of innovation, and a compendium of socio-economic questions on the nature of innovation in a free-market economy. The Manual is now in its second edition, following extensive revision to standardise the questions for research and the introduction of statistical standards that make it compatible - if not directly linkable - to the Frascati Manual.

However, as noted, the Manual was prepared using analyses based on the national systems of innovation of OECD countries. Indeed it is arguable that, for at least some of the OECD economies, which are either large federations, or still moving up the scale of industrial development, significant adaptations would need to be made to accommodate the presence of substantial resource-based sectors or service-based sectors. Research carried out in Canada, and reported in books edited by De la Mothe and Paquet (6) and Holbrook and Wolfe (7), has suggested that, at least in the case of Canada, there are significant variations across the country and that the assumptions of homogeneity within the national system of innovation need to be questioned. In the context of measuring innovation and innovative activities within British Columbia Holbrook and Hughes (8) have reported on some of the issues that separate a resource and service-based economy at the regional level from the larger national economy.

Joseph Shumpeter, in his classic work on innovation (9) defined five types of innovation:

- Introduction of a new product or qualitative change in an existing product
- Process innovation new to an industry

- The opening of a new market
- Development of new sources of supply for raw materials or other inputs
- Changes in industrial organisation

The OECD Oslo Manual is the internationally recognised standard for measurement of innovation. It limits its definition of innovation to the first two categories and defines innovation in terms of technological product and process innovations:

Technological Product and Process (TPP) Innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes. A TPP innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). TPP innovations involve a series of scientific, technological, organisational, financial and commercial activities. The TPP innovating firm is one that has implemented technologically new or significantly technologically improved products or processes during the period under review

In social research, it is not always clear that researchers and their subjects are talking about the same thing¹. Innovation is an example of this. The word is used in so many senses, that it appears to have lost some of its meaning. There are discrepancies between the term as it is operationalised in empirical research, and as it is used in the supporting theory. Statistics Canada, using the Oslo Manual standard, from its *Survey of Innovation, 1999*, defines innovation as:

A new product (good or service) is a product which is new to your firm whose characteristics or intended uses differ significantly from those of your firm's previously produced products...

New production/manufacturing processes are processes which are new to your firm. These involve the introduction of new production/manufacturing methods, procedures, systems, machinery or equipment which differ significantly from your firm's previous production/manufacturing processes...

Statistics Canada then asks respondents to identify themselves as being innovative if:

During the last three years...did your firm offer new or significantly improved products (goods or services) to your clients? And/or:

During the last three years...did your firm introduce new or significantly improved production/manufacturing processes?

¹ The argument which follows was taken from research which formed part of a thesis by Hughes, (10).

The questionnaire then goes on to ask:

... provide below a brief description of your most important new or significantly improved product (good or service) or production/manufacturing process during the last three years, 1997 to 1999.

Was this most important new or significantly improved product:

- a world first?
- a first in Canada?
- a first for your firm?

How long did it take from initial idea generation to implementation

The definition of innovation illustrated in these examples from Statistics Canada is consistent with the Oslo Manual. However, this definition is not consistent with theories of innovation, nor is it consistent with the perceptions of innovation held by entrepreneurs and business practitioners.

The OECD definition of innovation defines three levels of “new”: new to the world, new to a nation, and new to the firm. This division facilitates data collection, but does not sufficiently address the competitive environment in which innovation occurs. Indeed it raises some questions:

- A product or process that is new to the world is obviously innovative, but can a product or process that is new to a particular nation, geographic or political region also be considered innovative?
- A product or process new to one of the major industrial nations may well be innovative, but what about a product new to a developing nation? An innovation in Europe may have been developed in Europe, or it may have been imported from the US or Japan.
- A product or process could be new to a firm, but is it necessarily an innovation? A company that introduces a product in response to a competitors’ innovation is not also innovative. . . it is merely responding to the market in order to stay in it. Innovation involves risk, and a company that allows its competitors to take risks it is not willing to take is by definition not innovative.

Theory suggests that *new* is necessary but not sufficient for innovation. For a product or process to be innovative, it must have a sense of uniqueness to it. This does not mean that every innovation must be a world first. Nor does it mean that innovation must be radical, and that incrementally improving a product or process over time is not innovating. What it does mean is that innovation occurs within a competitive milieu, and firm level innovation should not be considered in isolation from the competitive environment in which the firm exists.

The Oslo Manual uses part of Schumpeter's definition of innovation to define TPP innovation, but it glosses over his interpretation of the role of innovation in a social system. Schumpeter accepted the Ricardian economic view of the process of production as "combinations of productive forces" resulting in products to meet the needs of consumers. Schumpeter argued that Productive forces are a hierarchy of goods, services, and resources that are required to produce products for consumers, and can all be ultimately resolved into combinations of *land* and *labour*.

Productive forces flow through the economy in a circular fashion, as workers become consumers and products of one industry become the raw materials of another. Left to its own devices, the economy is thus stable and static, with no opportunity for either development or profit. However, as Schumpeter observed, economies are dynamic. The circular flow of economic life is interrupted and modified in spontaneous ways. Some interruptions may be due to external forces, but many arise from within the economy itself. The source of these internal interruptions, and thus of the dynamism of the economy, is the process of *innovation*.

Process and market innovation deserve additional consideration. Schumpeter allowed that ideas need not be new to be innovative. Adapting productive processes from one industry to create an advantage in another industry is also considered innovative; so too is introducing a product to a market in which it has not before been available. Nor is being the first to build a new product necessarily innovative – being the first to sell it is. This places innovation in the competitive milieu – the market. Markets do not necessarily coincide with political boundaries. In the business world, the word *market* takes on a micro-economic definition: *me, my competitors, and all potential customers for our products*. In this sense, the market of a firm depends entirely on who it considers its potential customers, and who it considers its competitors. This is the environment where innovation occurs, and where innovation must therefore be studied.

“New & Unique”

In 1997, the Centre for Policy Research on Science and Technology (CPROST) at Simon Fraser University in British Columbia, Canada, conducted research into the British Columbia system of innovation (Holbrook and Hughes, *op.cit.*). This research consisted of innovation surveys conducted in different parts of the province, and included focus group testing of the survey forms and the concepts covered in them.

The focus groups were conducted with two goals: 1) to develop and test the questionnaire that would be used in the subsequent surveys; and 2) to probe the participants' understanding of the process of innovation, and how and why it occurs. In the general discussions of innovation, the focus groups consistently emphasised the importance of *uniqueness* as an important element of innovation. Innovation is a process of seeking and obtaining competitive advantage. As such, innovation requires risk. Indeed, the respondents seemed to feel that innovation is synonymous with risk. If a firm does not take risks, it cannot be innovative.

This theme also carried through to more specific discussions of definitions of innovation. Focus

group participants were given the Oslo Manual definition of innovation: the “introduction of a new product or a qualitative change to an existing product.” The focus group respondents did not feel that this captured the essence of innovation. “New and improved” products are “introduced” almost daily through television advertising, yet rarely are these products in any way innovative, or even distinguishable from their predecessors. To be innovative, a product or process must be unique in the market (that is unique in the market, or system of innovation under consideration), and it must elicit a response from the competition.

The findings from the focus groups were incorporated into the surveys of innovation conducted by CPROST. In addition to asking if the firm had introduced a new or significantly improved product or process, CPROST asked “Was that new product or process, at the time of its introduction, unique in its market?”

To return to Schumpeter’s argument, market instability and therefore 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 – most of the time, it is exactly the opposite, restoring the stability to an economy destabilised by innovators.

New to the market presents a methodological concern for many innovation researchers. That concern lies in the problem of defining and operationalising the concept of *market*. However, this may be 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 questions “How do you know?” or “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 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, not corresponding to political boundaries. Markets rarely coincide with national boundaries, except in cases of highly regulated industries. Firms serving non-metropolitan regional markets tend to have low exports, relying on suppliers and customers as

sources of innovation. These firms often import knowledge to a region. On the other hand, firms serving transnational markets export products or services beyond their regional or national milieu, and often rely on internal R&D as a source of innovation. These are the knowledge exporters. Both situations are of explicit interest to policy makers.

This kind of activity 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). 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.

A second, less tractable problem was also identified by the focus groups. The Oslo Manual (and the Statistics Canada survey) uses a three year time frame in which the reported innovations had to occur. There are many industries for which this is too short a period – capital intensive industries, particularly resource-based industries, tend to renew their production equipment over much longer life cycles. Even some high-tech industrial sectors (such as the aerospace industry) tend to have longer life cycles for the development of new products and processes as well, simply because of the cost of replacing unamortised, but perfectly useable machines. On the other hand other industries, notably electronics and software have a much shorter life cycle - in software, products are obsolete often in a matter of months.

The Oslo Manual definition of innovation should be modified to address these two issues: innovation and uniqueness. Innovation surveys should probe for market leaders, for those who lead their industry or cluster, ie. “It’s never been done before (at least around here)” rather than “I’ve never done it before.” Secondly the time frame for innovation should be made flexible, at least to accommodate the differences in product life cycles between industrial sectors. This latter condition will undoubtedly require more research, and, indeed, might differ widely from one economy to another.

Evidence from the CPROST surveys

Of the 211 firms responding to the survey 84% reported having introduced a new product or process. Of these, 63% claimed the introduced product or process was unique in its market, giving an overall response of 53% of firms having introduced a new and unique product. This categorisation, referred to hereafter as “New&Unique”, or “N&U” was used in subsequent analysis, and results using this construct were compared to the results using the variable NEW.

The CPROST innovation survey questions were for predominantly yes-no or three point. The three point questions were reduced to two point for the purposes of analysis. Roughly two thirds of the questions were taken from the Oslo Manual, while the remaining third covered two issues of interest to CPROST researchers, knowledge management and the management of highly

qualified personnel. Responses to these questions were cross-tabulated with the categories N&U and NEW, and analysed for significance of χ^2 . Results of this analysis are shown in Table 1.

Table 1: Significance of Comparisons between *NEW*, *N&U* and other variables in data set

Significance of $\chi^2 < 0.05$

	Both NEW and N&U significant	N&U more significant than NEW	NEW more significant than N&U	Neither NEW nor N&U significant
Oslo Manual Questions	6	6	2	9
Knowledge Management Questions	5	3	1	1
Human Resource Management Questions	0	2	0	2
Total	11	11	3	12

The results shows that the NEW variable gives a significant value of χ^2 when cross-tabulated with 14 of 37 variables in the data set, while the N&U variable is significant in 22 out of 37 instances. Since χ^2 is the measure of non-independence of the two categorical variables, these results indicate that the responses to the survey questions are less likely to be independent of N&U than they are of NEW. With these results in hand, we believe that N&U is a better screen for innovative activity than simple “new to the firm”.

Conclusions and Recommendations

The accession of the majority of the world’s trading nations to the WTO will have a major effect on S&T policies and programs. The WTO agreement forbids most types of industrial subsidies, even if they are offered equally to national and foreign-controlled enterprises alike. One of the few exceptions, however, is for investments in R&D and pre-competitive S&T development activities (article 8.2). Subsidies of up to 75% of R&D expenditures, and up to 50% for S&T development activities are permitted. The definition of R&D is taken from the Frascati Manual, while pre-competitive activities is are defined in a manner similar to technological product or process

innovation in the OECD Oslo Manual.

A sophisticated knowledge of a nation's S&T activities is required in order for a country to be able to put in place an S&T subsidy program. Yet without such programs, nations risk losing competitive advantages in the global marketplace. While many nations may not have a large R&D program, they still can improve their competitive position through subsidies directed at improving their pre-competitive activities. The WTO rules are only just beginning to affect the marketplace, but they will require a capacity on the part of national governments to measure their investments in innovation and in S&T to make policies (and provide subsidies) that will exploit their unique competitive advantages.

Thus quick, simple and accurate surveys of innovation will be required, which will reflect the true state of innovation in the context of a highly competitive and litigious environment. These surveys will need to be easy to administer and analyse. In order to deal with the issues raised above concerning the nature of innovation in firms, and their place in the market which they serve, it is suggested that:

- Future surveys use “new and unique to the market which you serve” and vary the time element of innovation to conform to the product life cycle of the industrial sector in question

For data from Oslo Manual compatible surveys:

- use “new to the country” plus “new to the world” to approximate “new to the market”
- aggregate industrial sectors by product lifecycle, using two categories: greater than 3 years and less than 3 years

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