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Measuring Innovation: Making Innovation Surveys work for Developing Countries

Introduction

As the central role of innovation in driving economic growth has become more widely recognized, policymakers are becoming aware that they need information on innovative practice to help them design effective policies, and monitor their impact over time. It is generally agreed that the evidence has to be collected systematically and repeatedly, in order to better understand not only the trends of innovative activity over time, but mainly the factors influencing them.

Therefore, some developing countries have started to conduct innovation surveys using the 'OSLO manual', guidelines that were basically developed for OECD countries. Their experience shows that the manual fails to capture some of the more important aspects of innovation in the context of developing countries, limiting the relevance and usefulness of these surveys. This has given rise to a debate about what constitutes innovation - particularly in the context of least developed countries - and how this should be translated into a survey questionnaire that is applicable across countries, for benchmarking purposes. Related to this, are the largely unexplored questions of how to construct useful innovation indicators from the data and how to effectively feed this information into the policymaking process.

This TPB reports on recent efforts to adapt innovation surveys to the context of developing countries in order to provide more meaningful results for policymaking.

Polcuch, Lugones and Peirano describe the characteristics of innovation in developing countries, highlighting the specific characteristics of the economy and society that influence the innovation process. They stress the importance of minor, incremental, and organizational changes, and the acquisition of embodied technology for innovation in less developed countries. They identify some measurement priorities, including organizational changes, innovation expenditures and innovation capabilities, and suggest ways to adapt surveys accordingly.

Lynn Mytelka explains why an 'innovation system' approach is a useful tool for the design of a policy-relevant innovation survey. She discusses a number of principles to design innovation surveys from a systems perspective. She also analyses ways of making surveys more policy-relevant - stressing the utility of panel data for adaptive policy making and pointing at the possible use of survey results to design policies supportive to innovative clusters.

On the basis of expertise gained from the European Community Innovation Surveys (CIS), *Anthony Arundel* discusses the use of CIS data by the European policy community and identifies some of the lessons learned so far. He explains why the impact of the CIS on policy making has been modest, and suggests ways to improve the uptake of survey results by the policy community.

Finally, *Goedhuys and Mytelka* look at some conceptual and measurement issues related to innovation in developing countries, where the concept of innovation is more broadly defined. They suggest a wider set of innovation activities and changes in products and processes that should be included in innovation surveys. They conclude that the scope for policy-relevant research is potentially very wide and propose some interesting areas for research.

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Innovation in Developing Countries: Characteristics and Measurement Priorities[1]

This paper discusses the particular characteristics that innovation processes assume in developing countries. It is based on working documents used in preparing the 'Annex on Innovation Surveys in Developing Countries' for the upcoming third edition of the OECD Oslo Manual. The working documents were discussed by several expert groups thereby fuelling the lively international debate that started in 2001 with the publication of the Bogotá Manual providing guidelines for adapting innovation surveys to the Latin American context (see box, page 4).

■ Main characteristics of innovation in developing countries

It is widely accepted that dissemination mechanisms and incremental change account for most of the innovation occurring in developing countries. The example of the first South African innovation survey showed that 86% of innovations in the South African industry are of an incremental nature.

While the term 'developing countries' does not refer to a homogeneous set of countries, some characteristics of economies or societies in a rapidly developing world deserve special attention due to their influence on innovation.

Size and structure of markets and firm: The relatively small size of the markets, their structure of concentration, as well as the relatively smaller size of firms, are key factors that shape the innovation process in developing countries. Not only is the small and medium-enterprise sector very significant in terms of numbers of firms, but enterprises considered in most developing countries as 'big' usually operate at suboptimal production scales. With higher unit costs and far from optimal efficiency, this influences the viability of R&D projects in smaller firms.

Local markets in developing countries tend to be small - in some cases due to less developed infrastructure - reducing the scope of the firm's actions and relevance of actual innovations. Hence "new to the market" may have different meanings in such environments.

Competitiveness is mostly based on the exploitation of natural resources or cheap labour, rather than on a quest for efficiency or differentiated products. This leads to the informal organization of innovation, and fewer R&D projects.

Informality: Developing country economies have an important degree of informal practice, which in most cases is not a favourable context for innovation. The sometimes great creativity invested in problem-solving in the informal economy is not applied systematically, and tends to result in isolated actions which neither increase capabilities nor help establish an innovation-based development path.

State participation: Due to the existence and, in some cases, prevalence of state-owned firms - or massive para-statal firms - the lack of competition sometimes discourages innovation or drains local markets of innovative potential. As is the case in some Latin American countries large state-owned enterprises (for example in sectors such as oil, aerospace or telecommunications) may become technological leaders through important investments in experimental development work. Moreover, in countries with 'traditional' economic systems such as China, major government S&T policies and programmes may have more impact on innovation than the activities and strategies of private enterprises.

Reduced innovation decision-making power: The dominant presence of externally-controlled or multinational corporations results in reduced decision-making of local firms or subsidiaries with respect to innovation. Technology transfer from multinational corporations and from abroad is therefore a fundamental source of innovation.

Weak innovation systems: In less developed economies fewer resources are devoted to innovation activities system-wide, therefore reducing the innovation potential of firms. The government is a major player in R&D execution and funding, mainly due to low levels of resources devoted to R&D by businesses.

Flows of information within national systems of innovation are fragmented, and in some cases there is an absence of linkages between science, and technology actors. Weak or absent linkages challenge the capacities of firms to overcome (technology-related) problems, and draw firms towards solutions implying mostly acquisition of embodied technology.

Barriers to accumulation of capabilities by the firms are high and difficult to tackle, particularly in the case of highly qualified human capital, local and international linkages and tacit knowledge incorporated into organizational routines.

Additionally, the innovation landscape in developing countries is deeply shaped by other exogenous systemic factors such as: macroeconomic uncertainty; high firm turnover; physical infrastructure (sometimes lack of basic services such as electricity or 'old' communications technologies); institutional fragility; lack of social awareness about innovation; risk-averse nature of firms; lack of entrepreneurs; existence of barriers for business start-up; and the lack of public policy instruments for business support and management training.

As a result of these particular features, four characteristics of the innovation process stand out:

(i) Acquisition of embodied technology (equipment) for both product and process innovation is a major component of innovation.

(ii) Minor or incremental changes can be the most frequent type of innovation activity in some developing countries, together with innovative applications of existing products or processes.

(iii) Organizational change is extremely significant in the innovation process. Besides its direct impact on firm performance, it also contributes to the firm's preparedness to absorb new technologies incorporated in machinery and other equipments. Heterogeneity frequently prevails with regard to technological, organizational and managerial patterns. For instance, 'high tech' firms often coexist with informal businesses (in many cases the majority), and organizational structures are often insufficiently 'professionalized'. This leaves a lot of room for organizational change, which is often independent from product and process innovation processes.

(iv) Innovations in the agricultural sector have a high economic impact, due to the significant overall economic weight of this sector.

Measurement priorities

In developing countries, it is less important to collect data about the number of innovative firms, or undertake innovation counts. Rather, innovation surveys should elicit information for public and private stakeholders to analyse the various innovation strategies present in the innovation system under scrutiny, and to evaluate and understand how these patterns contribute to strengthening the competitiveness of particular firms and to a country's economic and social development.

When addressing the main issues related to innovation strategies - such as innovation activities, obstacles, capabilities, linkages, and results - survey forms need to address all types of firms (the complete sample), and not only innovative firms. This enables the construction of indicators for potentially innovative firms (i.e. those firms that have made innovation efforts, but have not achieved results during the period of analysis). Potentially innovative firms are especially interesting as policy targets, since a key element in innovation policies in developing countries is to assist such firms to overcome the obstacles that prevent them from becoming innovative - that is, converting their efforts into innovations.

(i) Innovation capabilities

The concept of innovation capabilities is extremely helpful in describing the different stages in which firms, and industrial sectors, can be classified. The most significant innovation capability is knowledge accumulated by the firm, mainly embedded in human resources, but also in procedures, routines and other characteristics of the firm. Innovation capabilities, as well as technological capabilities, are the result of learning processes that are conscious and purposeful, but also costly and time-consuming, non-linear, path-dependent, and cumulative. There are many difficulties in measuring innovation capabilities, since it implies measuring knowledge that is not codified, but 'stored' in individual's minds or organizational routines. At the same time, it is not easy to find reliable data from firms about the exchange of knowledge with other agents or organizations.

The priority given in developing countries to measuring innovation capabilities leads to an emphasis on aspects of surveys that have received less attention elsewhere. These include human resources, linkages, quality assurance systems, and the incorporation and use of information and communication technologies (ICTs).

There is also an increased need to examine more complex issues such as the types of decision-making support systems put in place by the firm's management, as well as the firm's actual potential for knowledge absorption.

(ii) Expenditure on innovation activities

In order to measure firms' innovation efforts appropriately, it is essential to understand the intensity of innovation activities carried out. It is therefore important to obtain more details about the kinds of innovation activities that were undertaken by the firm in the reference period and, where deemed feasible, to collect data on expenditure by innovation activity.

In order to explain firm development, innovation expenditure needs to be complemented with more general information on the development of the

sector of economic activity in which the firm is active. This information could be obtained through innovation surveys, if it is not readily available through other sources at National Statistics Offices.

(iii) Organizational innovation

The absorption of new technologies, mostly incorporated in machinery and other equipment, requires significant organizational change.[2]

Considering the increased relevance of organizational innovations for firm performance, efforts and results related to these need to be given the same importance as to those related to product and process innovations, as well as marketing innovations. Compared to product and process innovations, organizational innovations are usually the result of more diffuse - although still intentional - actions. The presence of tangible elements, such as machinery and equipment, or patents, is less frequent, and the relationship between assigned resources and results is fuzzier. To a large extent, since organizational change is frequently linked to other innovation activities such as incorporation of new machinery, it often lacks sufficient autonomy as to clearly identify and quantify the resulting organizational innovations.

As a consequence, in addition to questions about organizational changes achieved, data are needed on human resources training, incorporation of ICTs (hardware and software, particularly in the "back office"), and implementation of quality assurance systems. These three elements accompany organizational change and therefore provide indications about its magnitude and characteristics.

Conclusion

In order to implement these measurement priorities, some adaptations need to be made to Oslo Manual type surveys, particularly with the inclusion of pertinent questions on ICTs, and expansion of the sections on linkages, as well as an expanded and more detailed classification of innovation activities, including such issues as "reverse engineering". Also, methodological issues, such as the statistical environment in which innovation surveys are conducted, and the weakness of information systems, also need to be considered.

A lot still needs to be done to better adapt innovation surveys to primary sectors, particularly agriculture, and to non-market sectors (innovation in government).

Guidelines for Collecting Innovation Data:

At the end of the 1980s after years of consultation with expert groups, the OECD was the first organization to adopt a document to harmonize methodologies for collecting standardized information on innovation activities in firms. The first edition of the **Oslo Manual** - as the document is better known - was finalized in 1992. Its proposed questionnaire served as a basis for the first round of the 'Community Innovation Surveys (CIS), carried out in thirteen European Union member states in 1993-94. Since then the surveys have been repeated every four years in a growing number of countries and the fourth round is close to completion. The Oslo Manual was revised in 1997 to build on experience gained in the first round of surveys and a third edition building on subsequent rounds was drafted recently.

The CIS takes as a point of departure the idea that innovation processes take place through the interaction between market opportunities and firms' knowledge base, and recognizes the multiple feedback loops between earlier and later stages of the innovation process. It focuses not only on measuring R&D and patenting activities, but also on non-R&D inputs such as design, training, prototype development and market testing.

The Oslo Manual has been very influential, also in non-OECD countries. Between 1992 and 2003 at least 17 non-OECD countries conducted an innovation survey - including Singapore, Taiwan, Malaysia, Thailand, South Africa and 12 Latin American countries - most of which based their questionnaire on the Oslo Manual. In Latin-American countries, Chile conducted an innovation survey in 1995 and was soon followed by other countries in the region. Shortly thereafter discussions began on how to adapt the Oslo Manual to the peculiar situation of Latin American economies, so as to incorporate characteristics such as the more informal setting for conducting innovation, the importance of incremental and organizational change, and the important component of acquisition of capital equipment for innovation, among other characteristics of the innovation system in this developing region.

The Colombian Institute for the Development of Science and Technology (Colciencias) and the Ibero-American Network on Science and Technology Indicators (RICyT) were subsequently

An Overview

commissioned to write a Latin American Manual, which came to be known as the Bogotá Manual after its publication in 2001. With the exception of Brazil, the **Bogotá Manual** and its much larger questionnaire became the basis of most innovation surveys carried out in Latin America.

In Africa a rising number of countries have shown interest in conducting an innovation survey. The first NEPAD Ministerial Conference on Science and Technology decided to undertake activities that would generate an 'African Innovation Outlook' - a comprehensive profile of the innovation landscape. In 2004 the NEPAD secretariat commissioned a study by UNU-INTECH to develop a methodology and design a policy relevant innovation survey. Over 20 African countries are interested in carrying out a survey.

The **methodological study** developed for this purpose broadens the concept of innovation, uses the innovation systems framework as a basis for the design of the survey and tailors a small questionnaire to the African context. It also provides an interesting overview of the majority of innovation surveys carried out in non-OECD countries and compares them in terms of guidelines used, sectoral scope, size of samples, response rates and organization of the surveys.

All three documents can be downloaded from the internet.

Oslo Manual
OECD, Eurostat, 1997. "The Measurement of Scientific and Technological Activities, Proposed Guidelines for collecting and interpreting technological innovation data"
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Bogotà Manual
RICyT, OAS, Colciencias, 2001. "Standardisation of indicators of Technological Innovation in Latin American and Caribbean countries"
http://www.ricyt.org/interior/difusion/pubs/bogota/bogota_eng.pdf

NEPAD Methodological Study
UNU-INTECH, 2004. Designing a Policy-Relevant Innovation Survey for NEPAD
http://www.intech.unu.edu/publications/NEPADstudy.pdf

Better tools and concepts to measure minor or incremental changes are also needed. Future innovation surveys to be conducted in developing countries should follow as much as possible the international standards in order to produce cross-country comparable data, and further adaptations of this methodology should be internationally debated.

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Endnotes

[1]The authors wish to acknowledge all the members of the expert groups that contributed towards the documents on which this article is based. However, the contents are the sole responsibility of the authors.

[2]In the particular case of many Latin American countries, the need for firms to permanently adapt and adjust to recurrent alterations in the economic context reinforces the idea that organizational change is an essential dimension of firms' competitiveness.

Making Innovation Surveys More Systems-oriented and Policy-relevant

For several decades, under the auspices of UNIDO and UNESCO, developing countries have been undertaking industrial surveys and providing data on indicators for research, science and technology in their countries. The focus on innovation is much more recent and the very notion of innovation is often confused with inputs such as research (measured in terms of scientific accomplishments such as patents or publication) or with technological outputs (measured in terms of enterprise performance indicators such as outputs and exports). But these measures fail to capture the process of innovation and the factors that support or hinder it.

The need for a new approach became evident in the 1980s and 1990s. As traditional barriers to trade and investment were dismantled, innovation-based competition diffused around the globe intensifying the pressure on developing country firms to master imported technology and to innovate. These changes have challenged governments to develop policies that stimulate and support a process of innovation.

Recent literature stresses that innovation is neither research, nor science and technology, but rather the application of knowledge in production. This knowledge might be acquired through learning, research or experience, but until it is applied in the production of goods or services it cannot be considered innovation.

Innovation is also understood to be an interactive process involving linkages and knowledge flows between a wide range of actors in the system but especially between users and producers of knowledge, goods, services and information. This suggests that innovation is a systems-oriented phenomenon and not just a process that takes place within a single firm, or farm.

As a set of conceptual tools and frameworks, the innovation system approach is still evolving, but from its earliest appearance it has provided a comprehensive and integrated analysis of the processes whereby given societies and economies learn and innovate. Members of the OECD and especially the countries of the European Union have moved furthest in applying an innovation system framework to a widening array of policies and to develop tools, such as innovation surveys, to measure the innovative performance of economic actors. These tools, however, originated in earlier science and technology surveys and until recently were not explicitly designed to deal with innovation in a systems framework nor were they specifically developed as tools for policymakers.

At the request of NEPAD, UNU-INTECH was invited to develop an innovation survey instrument that would be of utility to African countries now interested in stimulating innovation and building knowledge-based economies. Conceptualizing innovation in systems terms and ensuring that the information obtained through an innovation survey is policy-relevant was a daunting task and is still incomplete. Nonetheless a number of principles in the design of such a survey have emerged.

■ Making Innovation Surveys More Innovation Systems Relevant

Innovation surveys do not cover the full range of actors in an innovation system. In the past they focused mainly on the industrial sector and within it on manufacturing firms. Recent innovation surveys have been shaped more by 'innovation system' thinking and the scope of the survey was thus widened to include service sector enterprises, notably utilities (electricity, gas and water supply), transportation, banking and in some instances wholesale trade and transportation. Few countries, however, have included mining and construction (Poland, Australia and Canada) and only one (Ecuador) has extended the range of respondents to include farms. No innovation survey currently includes educational or research organizations, NGOs or policymakers and only a few partially cover intermediates such as productivity centres, business associations and other service providers potentially relevant to the innovation process.

There are a number of ways to partially overcome the bias inherent in a focus on the industrial firm. The Canadian survey, for examples, enables some innovation systems-related linkages among actors to be captured indirectly by asking the respondent firms to provide data on such linkages, their purpose and importance. Similarly, the impact of innovation-related policies has been addressed through questions that ask the firm to assess the frequency and importance of access to various services, programmes or financial instruments designed to stimulate and/or support innovation-related activities. These are generally added to the core questions in the survey and tailored to the specific policies/ programmes/ services/ resources available in that particular country.

However, the focus on manufacturing and/or manufacturing and service sector firms has tended to bias questionnaires towards those factors internal to

the firm that shape choices about whether to innovate, the kind of innovation (product, process, organizational or marketing) and through what means (licensing in, arms length purchase of new generation machinery and equipment, in-house design and product development, in-house R&D, collaborative RTD). From the firm's perspective, how the process of innovation is managed within the firm thus became a relevant area for investigation and some of the questionnaires, South Africa for example, supplemented the basic CIS approach with questions designed to deal with this issue. The bias towards factors internal to the firm as opposed to across the system more broadly was also reflected in the emphasis these questionnaires placed on the enterprise's objectives and the obstacles to innovation as the enterprise sees them.

Obviously, the best way to realize a more comprehensive innovation system survey would be to widen the scope to include other actors. But this requires the use of multiple questionnaires addressing the specific concerns and activities of a more diverse range of actors. Issues of manageability thus impose the logic of reducing the scope of the survey. Also, the quality of the data available to determine the entire population including other actors than firms and the funding and administrative capability needed to undertake a larger survey are equally constraining factors. The NEPAD survey, therefore, recommends the adoption of a focus on the enterprise sector, complemented by questions that provide indicators of the broader set of linkages and knowledge flow that are needed for a dynamic innovation system. In developing countries where a large percentage of exports and output comes from the natural resource sector and innovation in agricultural crops such as rice, cassava or maize to meet domestic consumption or in export-oriented products such as flowers, coffee and fish has become increasingly important, separate survey instruments will need to be developed.

■ Designing Innovation Surveys for Policy Relevance

Innovation surveys of the past were not constructed to provide panel data which is needed for a dynamic perspective on the innovation process over time. From a policy perspective, the lack of panel data, that is a core set of respondents who are surveyed across several 'rounds' of innovation surveys, is an especially weak point in existing innovation surveys and reduces opportunities for a dynamic analysis of change in the behaviour, choices and innovative performance of these firms.

An example of the potential use to which panel data can be put is found in a recent study of changes in the type of innovative activities undertaken by firms in Argentina under differing economic conditions (Chudnovsky: 2004). The analysis builds a set of panel data for 718 firms on the basis of two Argentine innovation surveys, one covering a high growth period 1992-1996 and the second covering a period of recession, 1998-2001. The analysis shows that in the first period, firms increased expenditures on embodied and disembodied technologies, while in the second they drastically cut their expenditures on technology acquisition but maintained R&D activities. The econometric results indicate that having linkages to other agents, especially suppliers, undertaking R&D and technology acquisition expenditures had a positive payoff in terms of the probability that a firm would introduce new products and processes onto the market. Innovative firms, such as these, moreover, attained higher productivity levels than non-innovators, though small firms had a lower probability of engaging in innovative activities and of becoming innovators and this was even more pronounced in a period of recession. The policy implications of this analysis are evident.

Panel data are also useful when the survey instrument contains questions expressly designed to provide feedback on the impact of particular government policies intended to stimulate innovation. The current norm, however, is to use a 2-3 year reference period and to undertake innovation surveys at regular intervals. This does provide some time series data but does not provide the analytical possibilities that would be available through the use of panel data. Moreover, the length of time needed to carry out and analyze the data from innovation surveys, reduces their ability to provide information needed for adaptive policy making.

Developing countries have also begun to pay attention to the formation of geographical agglomerations of firms and ancillary services. These sorts of clusters are believed to offer unique opportunities, especially for SMEs to engage in the wide array of domestic linkages between users and producers and between the knowledge producing sector (universities and R&D institutes) and the goods and services producing sectors of an economy that stimulate the learning and innovation needed to transform traditional industries. Within a cluster, stable vertical relationships between users and producers, for example, can reduce the costs related to information and communication, the risks associated with the introduction of new products and the time needed to move an innovation from the laboratory or design table to market. Horizontal collaboration between same- sector small and medium-sized enterprises can also reduce transaction costs, accelerated innovation through more rapid problem- solving and greater market access. Still other studies have pointed to the positive

externalities generated by agglomerations in the availability of skilled labour and in the development of relevant infrastructure.

Yet not all 'clusters' are innovation systems. The potential for interactions and externalities that physical proximity affords may not be realized. Policies, however, might be designed to provide the necessary stimulus and support for innovation to firms located in such agglomerations. The first step in doing so would be to identify agglomerations of firms located in proximity to each other, map their sectors as a proxy for possible common interests and needs and analyze their innovative performance. The NEPAD survey questionnaire provides data on the location of firms, sectors, innovative performance and past linkage behaviour, all of which can be used to create a set of simple and complex indicators of relevance for the development of regional development policies and support services.

Lastly, innovation surveys can provide input for the development of new policies in two ways. First is by asking firms that have innovated to identify those factors that have motivated them to engage in these innovative activities. This provides feedback on the macro- policies that shape innovation processes. Second is by opening space in the questionnaire for the addition of questions that provide feedback on specific innovation-related policies and programmes in the national context. These questions could be developed in collaboration with the national agency that will administer the innovation survey.

Although the results of innovation surveys are based on data that are often two or three years old, this represents one of the rare opportunities for countries in the developing world to obtain feedback on the impact of the broader macro-economic environment and specific innovation-related policies and programmes on innovative behaviour. These data might thus encourage further efforts at policy/programme monitoring and evaluation and stimulate a process of policy dialogue, policy learning and adaptive policy-making.

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Reference

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Innovation Surveys and Policy: Lessons from the CIS

The European Community Innovation Survey (CIS) is conducted in all member states of the European Union and has been implemented every four years starting in 1993. The third CIS was completed in 2001 and a fourth CIS is in the field in 2005. Several countries have also implemented mini CIS surveys at the two-year point between the main surveys and this will become standard European practice starting in 2007.

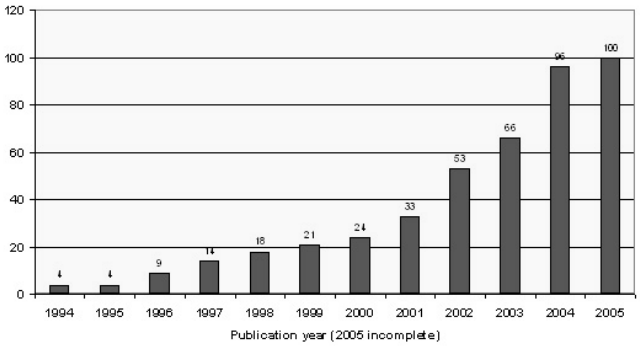
The three surveys to date have provided an enormous amount of data on innovation expenditures, innovation outcomes such as the share of sales from innovative products, the objectives of innovation, sources of information, appropriation methods, and factors that hamper innovation. A major justification for the cost of the CIS, both to Governments and in terms of the respondents' time to complete the survey, is that the data will help to improve innovation policy. This could occur either when CIS results are used to directly inform policy or when the results are used in academic research on innovation theory.

In fact, the impact so far of the CIS on European innovation policy has been modest, partly because it takes time to perfect and absorb new statistics, and partly because some of the problems with the CIS data have not yet been satisfactorily solved.

In order to understand the modest impact of the CIS to date, it is useful to review the history of R&D statistics, which are probably the most widely used and influential of all science and technology statistics among the policy community. The first R&D surveys were conducted after World War I, with further experimentation in the 1930s and in the 1950s. The next major step was the work by the OECD in the early 1960s to develop standard definitions of R&D, published as the Frascati Manual. This was followed by a large-scale survey of R&D in 1963 in 16 countries. At this point, the development of R&D statistics was roughly equivalent to the first Oslo Manual in 1992, which provided guidelines for surveying innovation, based on experimental innovation surveys in the 1980s, and was followed by the first CIS in 1993. In the R&D story, it took until 1981, 18 years after the 1963 survey, before the OECD believed that the R&D data were of reasonable quality. The use of R&D statistics by the policy community followed a similar 18 to 20 year lag.[1]

It is now 12 years after the first CIS in 1993. Compared to the history of R&D statistics, the CIS is still in its teenage years. It should therefore be no surprise that the CIS has yet to be fully adopted by the policy community or that several problems with the CIS have yet to be resolved. Nevertheless, the rate of progress is picking up, as shown in Figure 1, which gives the cumulative number of academic reports and published papers over time that have analyzed one or more of the three CIS surveys. There has been a rapid increase in publications, starting in 2000. Given the right conditions, the increase in academic research should feed into the policy making process. The visibility of the CIS is also increasing as well as access to the data, which is now available free of charge over the internet on NewCronos.[2]

Fig.1: Cumulative total of publications using CIS data



NB:The results for 2005 are for the first four months only

Available results and users

CIS results are available by country as basic indicators, such as the percentage of small firms that collaborate with the public sector, as benchmarking indicators, such as the prevalence of collaboration by sector, region or firm size class,[3] as part of detailed descriptive analysis, such as cross-tabulations between basic indicators and other factors, and through econometric analysis, where CIS data are used to construct dependent and independent variables for regression models. A series of interviews conducted by MERIT staff with members of the European policy community in the Spring of 2005 found that econometric results rarely influenced policy making. Instead, the policy community preferred detailed descriptive analysis, particularly when combined with case studies. This conflicts with the perspective of the academic community, which focuses on econometrics. This has also increased over time, with a decrease in academic reports that contain careful descriptive analyses and a trend towards increasingly complex econometrics in academic publications.

Policy relevant results

The disjunction between the needs of the policy community and the output of academic researchers is one of several causes for the modest direct influence of CIS results on policy, as when CIS data inform decisions on the need for specific policies or the design of those policies. This occasionally occurs. For example, CIS data on collaboration and innovation expenditures influenced the design of R&D support programmes in one Northern European country. The R&D programmes were altered to promote collaboration between R&D performing firms and the publicly-funded research sector. The results of successive CIS surveys on the prevalence of collaboration are also being used to assess the effectiveness of the programme. However, examples of a direct impact of the CIS on policy are rare.

The greatest influence of the CIS to date has been indirect, through its influence on shifting policy thinking from a single-minded focus on supporting R&D to a broader innovation strategy. This was due to CIS data on innovation expenditures that demonstrated the importance of innovation activities that were not based on R&D. Furthermore, the first CIS showed that there was a considerable amount of innovative activity in the 'low' technology manufacturing sectors and later surveys also identified substantial innovative activity in some branches of the service sector.

These results on the widespread prevalence of innovative activities were by no means a complete surprise. Several influential studies before the CIS, often based on case studies and experimental surveys, argued that innovation was widespread and took different forms in different sectors.[4] The first CIS simply provided empirical confirmation - although very robust - of the innovation theory that had developed in the 1980s and which was already widely accepted by influential sections of the policy community in the early to mid 1990s.

A discouraging fact is that the CIS results have made little headway in the policy community when they contradict strongly held views. The MERIT interviews with the policy community identified many such examples. In one case the CIS results showed that firms did not have a problem obtaining technical advice and information. This result was ignored, and a policy scheme to provide technical advice was developed. In other cases the CIS results conflicted with the status quo position on regional and sectoral differences in the innovative capabilities of firms, the structure of business R&D, and the importance of clusters for innovation. In each case, policy development ignored contradictory empirical results from the CIS.

The way forward

Events over the next five years will probably determine if the CIS becomes a valued set of indicators that is widely used by the policy community, or if its primary purpose is for academic research. Some of the steps that need to be taken to improve the uptake of the CIS by the policy community have already been made, such as the decision by Eurostat to provide access to the data free of charge, or the inclusion of several CIS indicators in the European Innovation Scoreboard,[5] which increases the visibility of the survey. Other steps that still need to be taken include improvements to the reliability and accuracy of the results and the development of more useful internationally comparable indicators. Two other tasks are essential but could require more effort. The first is to improve the accessibility to the policy community of academic research. This could be achieved by requiring academics, in return for access to the survey micro-data, to prepare a user-friendly report that outlines the policy relevance of their research. The second task is to improve the links between the policy community and groups that analyze the data, including national statistical offices. This requires the establishment of an interface between each national policy community and national analysts. This could take the form of either the implementation of methods to 'pull' useful research from statistical offices, for instance through formal channels where policy departments can request timely analyses, or via individuals in the policy community that have the responsibility and time to develop expertise in analyzing and interpreting innovation survey data.

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Endnotes

[1]Two papers by Benoit Godin cover the history of R&D statistics: Tradition and Innovation: The Historical Contingency of R&D Statistical Classifications, Working Paper No. 11, Project on the History and Sociology of S&T Statistics, 2001; and The Number Makers: A Short History of International Science and Technology Statistics, Working Paper No. 9, Project on the History and Sociology of S&T Statistics, 2001.

[2] EU reference database containing around 100 million statistical data covering every economic and social sector.

[3]Both basic and benchmarking indicators for CIS-3 are available in Innovation in Europe - results for the EU, Iceland and Norway, Eurostat, Luxembourg, 2004.

[4]One of the most influential of these studies is by Keith Pavitt, Sectoral patterns of technical change: Towards a taxonomy and a theory. Research Policy, 13, 343-373, 1984.

[5]See http://trendchart.cordis.lu/ under 'innovation scoreboard'.

Innovation Surveys: Implications for Data Analysis

Previous articles by Mytelka and Arundel stress the need for policy relevant research and the construction of innovation indicators that can contribute to a better understanding of the characteristics of innovative firms.

To grasp the major aspects of the innovation process, it is not sufficient to merely measure inputs to the innovation process, such as R&D, human capital and licensing, as was traditionally done, nor of their impact on firm performance - firm growth, exports, productivity. More importantly, and especially in the context of developing countries one needs to collect information on the learning process that underlies innovation. This is not an easy task, however, as learning and competence building are qualitative and multidimensional processes that are difficult to measure.

In order to proxy the learning processes, innovation surveys worldwide include questions that are directed towards uncovering the innovative efforts and related learning in the firm. Most surveys ask firms to report 'activities' that are hypothesized to have a strong learning component, such as training activities, design, R&D and reverse engineering. At the same time, the resulting innovation or the 'outputs' of the innovation process are measured in terms of newly introduced, or improved products and processes. To proxy the intensity of the learning processes, firms are asked to report the expenditures related to the innovation activities or the sales revenues from new products.

Conceptualizing innovation

An additional layer of complexity governs the analysis of innovation survey data from developing countries, where the concept of innovation is more broadly defined. In a developing country context, innovation is understood to involve the process by which firms master and implement the design and production of goods and services that are new to them. Many small improvements in product design and quality, changes in the way production is organized and knowledge managed, the introduction of new maintenance routines, creativity in marketing and modifications in production processes and techniques will collectively bring costs down, increase efficiency and flexibility to respond to changes in competitive conditions and ensure environmental sustainability. Most developing countries also

introduce process innovations through the purchase of machinery and equipment or through the licensing-in of technology.

With this as its point of departure, the survey instruments used in developing countries are likely be adapted to capture these aspects of innovation. The differences are also reflected in a number of questions about innovation practices that were included in the NEPAD questionnaire (UNU-INTECH, 2004), for example:

- The introduction of new waste management, maintenance and quality control routines, new ways of organizing production and marketing, including through sub-contracting relationships
- The purchase of new machinery and equipment from within the country or abroad over the previous three years
- Whether the firm has a licence contract for product or process technology, the year in which it was obtained and whether it was obtained from a local or foreign firm or research institute.
- The impact of licensing on learning.

However, extending the range of innovative activities for developing countries has important implications for the data analysis later on. The most important implication relates to the construction of indicators based on the data. Summary indicators, such as the proportion of innovative firms, may quickly become irrelevant. Nearly all firms surviving in a competitive environment will report to be engaged in at least one of the innovative activities as conceptualized above.

Evidence from the World Bank's Investment Climate Surveys suggests that indeed this may occur. An indicator on the 'proportions of firms undertaking innovation' - defined as firms that have either developed a major new product line, upgraded an existing product line or obtained a new licensing agreement in the last three years - reaches already very high values (85% for Zambia, 92 % for Ecuador, up to 100% for Nepal), leaving little room to analyse variations among firms.

It will therefore appear more informative to treat the different activities separately in indicator construction and to find correlations among them showing how firms innovate and what activities go hand in hand. It will also prove useful to categorize innovations and use such typologies as the basis for constructing indices of strengths and weakenesses of innovative capabilities in the broader innovation system.

Therefore the most interesting results from innovation surveys may lie less in comparing proportions of innovative firms, than in finding answers to highly policy-relevant questions, such as:

Who are the more innovative firms?

What drives or hampers firms to undertake different innovative activites?

What are the strategies of firms that undertake them?

What is the impact on firm performance?

What is the firms' perception of the policy environment?

Profiling the Innovative firm

In designing innovation policies there is a need to better understand the habits and practices of actors with respect to learning, linkages, investment and their performance with regard to different innovative activities. It is not always possible to survey all firms and thus the ability to profile the innovative firm as a target for policy and support programmes is useful. The profiling technique draws upon established relationships in the literature on innovation, notably in developing countries. The propensity to learn and innovate is related to

- the location of the firm within or close to a major urban area and thus in greater proximity to sources of new knowledge and inputs ;
- the educational level of the Owner/CEO/Manager, especially a degree from a technical university or engineering programme that stimulates and facilitates problem solving;
- the manager's global exposure through training, work or study abroad which opens opportunities for networking and creates awareness of the utility to do so;
- the ownership structure of the firm, which influences the choice of products and processes as well as their subsequent modification and change;
- the firm's sector, capturing differences in R&D intensity and competition;
- the size of the firm, which is related to its access to resources to and opportunities for knowledge scanning to support a process of innovation;
- exports (as a percentage of sales) as an indicator of the firm's competitive interests and abilities;
- the habits and practices of innovation as reflected in having innovated previously.

In Brazil, data from innovation surveys were used to profile innovative and non-innovative Brazilian firms based on four criteria - export orientation, firm size, foreign capital origin and industrial sector effect. Results of the analysis served as inputs for the Brazilian government to identify policy measures relating to financial and other forms of incentives for exporting firms to innovate and to formulate new laws that increase forms of collaboration and cooperation with universities and research centres.

Innovation strategies and firm performance

The NEPAD questionnaire includes three sets of questions that are needed to better understand the motives and hampering factors to innovation, the strategies that firms pursue and the further impact of innovation on firm performance and on the society. First, to map the innovative practices of firms, a range of questions is asked on activities giving rise to the introduction of new products, processes, forms of organization and marketing, as explained above.

Second, a set of questions examines the various sources of knowledge and information accessed by the firm, the various stimuli to innovation and the obstacles that the firm encounters in undertaking innovation. From these questions the role of linkages and collaboration for innovation becomes apparent.

Finally, a set of questions enables the analyst to relate the innovative behaviour of the firm to its overall performance. These questions ask respondents to provide information on the performance trend of the firm with respect to employment, sales, exports and patenting over the previous two years and to assess the impact of innovation on other performance indicators such as profitability, productivity, product or market expansion and environmental impact. The analysis of these relationships is traditionally the domain of academics and policy researchers whose studies may generate insights that are useful for policy.

Perception of the policy environment

Innovation surveys offer a unique opportunity to governments to assess the direct impact of policy measures. By directly asking firms if they have used specific measures aimed at stimulating innovation, it can be seen which types of firms - analysed in terms of sector, size, location and habits and practices of learning and innovation - are most responsive to regulatory incentives or are the major recipients of public support and funding, providing an informative tool for policy monitoring and evaluation.

In Thailand, some results of the innovation survey have been used to describe the state of Thailand's national innovation system, particularly the responses on performance of government science and technology institutions under the chapter on science, technology and innovation (STI) Policy.

In sum, from a limited set of questions one can analyze how technologies diffuse and knowledge spreads, investigate the various sources of knowledge used by firms and identify gaps in the national knowledge infrastructure and weaknesses in the innovation system. The scope for policy research on the basis of survey data is potentially very wide and a close interaction between researchers and policy makers is needed from the start.

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FUTURE POLICY BRIEFS

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