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Inter-American Development Bank

WORKING PAPER 8

Training module for the recollection and analysis of **innovation indicators**

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This module was elaborated in the framework of the project “Strengthening the Information System in the Inter-American Science, Technology and Innovation Network”, within its component “Training and technical assistance for improving the survey and analysis of science, technology and innovation indicators in Latin American and Caribbean countries. The project’s coordinator was Mario Albornoz. The author of this module was Gustavo Lugones.

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>> Presentation

This document was elaborated in the framework of the project "Strengthening the Information System in the Inter-American Science, Technology and Innovation Network", which is part of the Regional Dialogue on policies of science and technology that is being promoted by the Inter-American Development Bank (IADB). The aim of the training activities conducted by the project is to improve the coverage of indicators of science, technology and innovation in the countries of the region through the creation or the consolidation of their capacities. Thus, the ultimate goal is that these countries, and especially those with the lesser relative development, extend the set of indicators they produce and be able to sustain this effort along the time.

The experience of Latin America and the Caribbean shows that the shortage of staffs skilled for constructing indicators acts as an obstacle for generating reliable information about science, technology and innovation activities. Such information, having the proper quality, should be the basis upon which decisions in this field should be taken. Training activities seek to contribute to the generation of a critical mass of professionals trained for collecting information and constructing reliable indicators, which are essential for specifying the variables upon which policies should operate.

The present training module on innovation indicators picks up the experience on this subject developed by the Ibero-American Network for Science and Technology Indicators (RICYT). Innovation is a major promoter of the improvement of competitiveness, economic growth and social welfare levels. The relevance of measuring innovation processes is that the indicators in this field are instruments for decision making, both in the private and the public realms. In the private sphere, indicators are essential for defining competitive strategies; in the public realm, innovation indicators play a major role for designing, implementing and assessing public policies for promoting innovation.

Thus, this module aims at being a contribution for improving methodological and technical capacities in the institutions of the area of science, technology and innovation in the region. By this way, it also seeks to contribute, as far as possible, to the construction of capacities for the integral development of Latin American and Caribbean countries.

01. Introduction

When faced with the task of measuring innovation processes a first fundamental step is to ask oneself three questions: **1) why measure?**; **2) what is the purpose of measuring?**; and **3) how to measure innovation processes?** The answers to the first two will provide the conceptual basis from which to respond to the third and organise the actions required to construct relevant and reliable indicators. Therefore, in this introduction we shall begin by addressing the first two questions, and then proceed to discuss at length the third (How to measure?), which will be the pivot for the principal contents of this module.

1.1 Why measure innovation processes?

The importance and use of measuring innovation processes is directly related to the links between innovation, genuine improvements in competitiveness, economic growth and levels of well-being of societies, links which have been extensively demonstrated by empirical evidence.

a) Innovation and genuine improvements in competitiveness

In fact, the capacity to generate, acquire, adapt and use new knowledge is an increasingly strategic factor in the evolution of competitiveness levels in organisations. At the heart of innovation processes (Oslo Manual)[1], enterprises rely on such capacities to achieve **sustainable and accumulative competitive advantages, which are termed "genuine" by Fernando Fajinzylber (1988)**.

According to Fajinzylber, **genuine** competitiveness is based on factors such as productive efficiency, product attributes (quality, intended uses, etc.) and sales networks, among others, and **can be sustained over time**. There are, in contrast, other (**spurious**) competitive advantages which rest on circumstantial factors, a favourable overall situation, public support policies (which may be short-lived or changing), price discrimination practices between domestic and foreign markets (dumping), tariff or non-tariff protection, or on socially unacceptable or unsustainable and internationally questionable practices (social and ecological dumping). In other words, spurious competitive advantages may appear to be easily and rapidly obtainable, but hard to sustain in the medium term and could even have a regressive impact on the level of income and its distribution.

Indeed, achieving genuine gains in competitiveness demands constant progress in innovation and technological know-how[2] (in both product and process technology), in manufacturing and entrepreneurial organisation and in marketing techniques.

This implies that gains in true competitiveness require considerable systematic efforts by firms. However, they offer definite advantages in terms of lower vulnerability, greater certainty and strengthening of the firm's growth path, since by making efforts like those mentioned above, it accumulates knowledge, experience and skills that enhance its future competitive possibilities.

[1] OECD (2005)
[2] Technological know-how is the capacity to assimilate and adapt technologies from outside the firm so as to rapidly boost productivity, introduce design improvements in products, etc. It is not necessarily a question of making further innovations but of gaining experience and developing productive capacity by adapting and improving the technological knowledge obtained, both in products and in production processes.

b) Innovation, growth and social well-being

A great deal of economic literature has highlighted the positive impact of innovation on the principal performance indicators of the enterprise. In fact, those firms that engage in innovation activities reveal better indicators in terms of sales, exports, productivity and employment. Particular emphasis should be placed on the fact that the best performance does not only refer to a stronger positive trend, but also to more stable development paths (Chudnovsky et al., 2004; De Negri et al., 2005; Fagerberg and Verspagen, 2002; Kemp et al., 2003; Kosacoff, 1998; Lall, 2004; Lugones et al., 2007; Lundvall, 1992; Ocampo, 2005; Reinert, 1996; Tether and Swann, 2003; Suárez, 2007).

The genuine advantages accumulated by the enterprise determine greater competitive capabilities, i.e., better possibilities to face competition both in the domestic market (from imports) and in foreign markets (export opportunities). This means that it has better chances of competing successfully against products manufactured in other countries and designed to satisfy the same requirements or the same demand (similar or substitute goods). By extension, the concept may be applied to comparisons between countries or economies, since the country of origin of the most competitive products (or firms) will prove that it enjoys higher levels of competitiveness than the rest and this improves its possibilities of boosting its rate of production and its exports, thus favouring economic growth (Chudnovsky and Porta, 1990).

Furthermore, gains in competitiveness based on the introduction of technological or organisational innovations have a strong impact in determining trends in a country's production and commercial specialisation, i.e., in the proportion of goods with the highest knowledge content in the production and commercial structure. Growth in that proportion not only strengthens the external sector of the economy (trade balance) thanks to the higher average value of this type of products, but it spurs a rise in workers' average incomes by employing relatively more skilled human resources, thus favouring an improvement in levels of well-being in society as a whole[3].

1.2 What is the purpose of measuring innovation processes?

Innovation indicators must be seen, therefore, as essential tools in both private and government decision-making. In the enterprise, they may be crucial in defining competitive strategies. On the one hand, the same set of responses to the questions included in the survey form can be used by the firm to review and eventually reformulate its strategies and practices in the technological, organisational and commercial field. On the other, it will subsequently be able to compare its individual indicators with those for the complete set and for its various cut-offs by sector of activity, size and ownership of the enterprise, etc.

As regards public policies, innovation indicators can play a central role in the design and implementation of policies both on innovation promotion and on scientific-technological activities in general, and most importantly, in assessing them. This is conditioned, of course, to the fact that the designed indicators should adequately reflect and facilitate interpretation by those responsible for formulating and managing Science, Technology and Innovation (STI) policies, the characteristics of, and prevailing trends in, innovation processes, their determining factors, the obstacles they face and the results achieved.

The technology gap that exists between the countries of Latin America and those of highest relative development make it

[3] Innovative enterprises also tend to establish more stable relations with their workers since they attach great importance to their ability to retain the firm's skilled human resources.

more pressing to strengthen these policies and, if possible, to secure an efficient use of the (always insufficient) resources devoted to them. This makes it strategically important to have access to the indicators that best serve those ends[4].

02. Conceptual framework

2.1 Basic concepts

a) The concept of innovation

According to the definition included in the third edition of the Oslo Manual (OECD, 2005), innovation is the introduction into the market of a new or significantly improved product or process, or the development of new organisational and marketing techniques. The distinctions made in previous editions of the Oslo Manual (OM) between technological and non-technological innovation are, as we see, omitted from this new edition, although they continue to appear in many national measuring exercises. In these cases, technological innovations mean product and process (TPP) innovations, with product innovations being understood as those designed to modify the characteristics and/or intended uses of goods and services, while process innovations are those affecting the form or methods of production. The other (organisational and marketing) changes would thus not enter the abovementioned group for specific attention. This is, of course, consistent with the current definition in the OM and does not affect comparability of indicators.

In this respect, the third edition of the OM defines as organisational innovation the application of new methods of organisation and changes in business practices, in workplace organisation and in the enterprise's external relations. Innovations in commercialisation involve applying new marketing methods, which may include changes in product design and packaging, promotion and distribution, and in price-fixing policies for goods and services.

Incremental improvements and novelties for the firm

A common distinction usually made in the literature on innovation (which is of great importance in analysing these processes in our region) is between radical and incremental (or marginal) innovations, depending on the **breadth** and **depth** of the changes introduced. In fact, changes involving the supply of products, or the use of completely new processes that are essentially different to preexisting ones, will not have the same significance or consequences as lesser (or marginal) transformations in the same areas, although the former may effectively make the product more attractive or the process more efficient. The same applies, of course, to organisational and commercialisation innovations. It is clear that the magnitude and impact will vary considerably in either case.

Similarly, in order to be considered an innovation, the novelty or improvement required need only be so for the surveyed firm (although it may already have been introduced by another firm), so the **scope** of the innovations reported by firms becomes particularly relevant when analysing and classifying innovation processes. This entails the need to know whether, besides involving a novelty for the enterprise, the innovation introduced is also an innovation in the local or national context

[4] For further discussion of these aspects see "Bogota Manual" (OEA, RICYT, COLCIENCIAS, CYTED, OCyT, 2000).

(market) in which the enterprise operates, or whether the novelty extends to the international market.

The measuring exercises conducted to date have given ample proof that in our countries incremental improvements prevail over radical ones, and novelties for the firm over any other factors. This is of course closely related to the extent of the efforts required (**innovation activities**) in promoting radical innovations and/or ones that extend beyond the enterprise itself, efforts that are either not within the material possibilities of many of the enterprises in the region or that involve decisions with a strong strategic commitment that entails accepting the risks and overcoming the uncertainties typical of innovation activities, which are always prone to the fact that the intended results may not be achieved. In contrast, we have already pointed out the solidity of the competitive advantages that those strategic options can bring firms and the economies in which they operate.

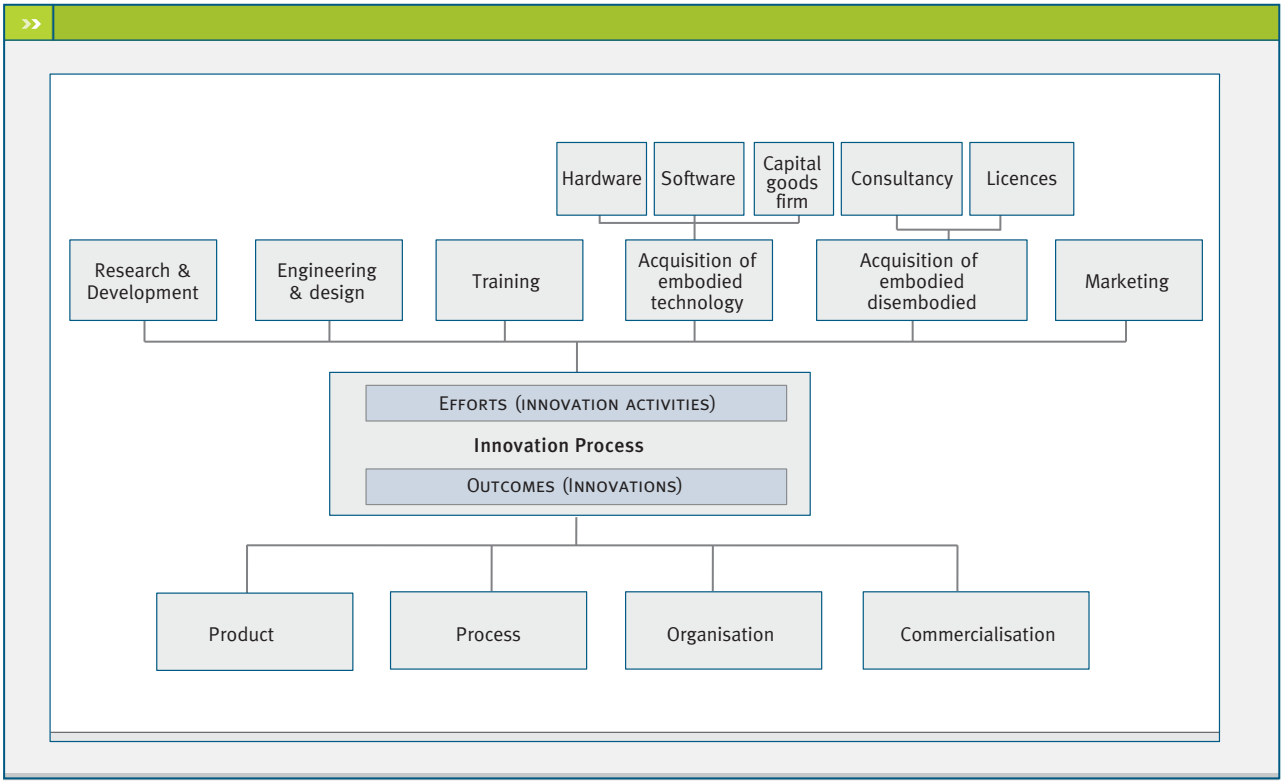
b) Innovative efforts: innovation activities

Innovating involves "*combining several different types of knowledge, capabilities, skills and resources*" (Fagerberg, 2003) in the search for a competitive advantage, either through reducing production costs, the development of new products or changes to existing ones. Far from being passive, this combination involves making explicit efforts to improve or create technological capacities and skills (Lall, 2001).

Those efforts are commonly called **innovation activities** and consist, in short, in conducting "scientific, technological, organisational, financial and commercial activities which are intended to lead to the implementation of technologically new or improved products or processes, a new marketing method, a new organisational method in business practices, workplace organisation or external relations" (OM). The firms that carry out this type of activity (innovative efforts) are considered to be innovative while those that achieve results (i.e., by introducing innovations) are called innovating.

Innovation activities involve efforts in both seeking to generate new knowledge and in acquiring, adapting or developing existing knowledge, as well as the various forms of increasing the enterprise's productive and technological capabilities, either in equipment or in human resources. This includes:

- Research and Development (R&D), both in-house (i.e., within the enterprise) or by means of an agreement or the hiring of an agent external to the firm to carry out the work;
- Acquisition of embodied (equipment, hardware and software) and disembodied (licences, patents) technology;
- Contracting consultancy firms and technical assistance;
- Engineering and Industrial Design activities;
- Personnel training.
- Marketing activities



2.2 Innovation processes

a) General characteristics of innovation processes

In the innovation process that drives technological change, the firm (enterprise) takes centre stage ("it is the home of innovation processes"). In fact, the firm "reads" and interprets the market (its structure, its characteristics, the general and specific environment, the possibilities or opportunities it offers and the difficulties it presents), and acts in consequence, i.e., it designs a strategy and executes it. In today's world the competitiveness of a firm (product or nation) increasingly depends on success in choosing the appropriate strategy and implementing it.

As an example: a firm that operates in a market in which consumers tend to prefer products with a certain degree of differentiation that sets them apart from the standard version will have to try and follow that path (product differentiation), and efforts in the field of product innovation will thus be unavoidable. A strategic alternative could be to insist with the standard or homogeneous product (commodity), in which case the firm will be under pressure from the market to boost "price competition", that is, to seek to win over consumers not on the basis of the particular characteristics of the product offered and its qualities to satisfy the specific requirements of the demand but, fundamentally, on the basis of a lower price than the competition. Nevertheless, the enterprise may find it ever more necessary to engage in innovation processes here too, in this case perhaps more closely associated with process technology or with organisational changes designed to cut costs.

Of course, the firm's strategic options will be subject (either favoured or conditioned) to possibilities stemming from its own capacities (skills, resources, accumulated knowledge). For that reason we speak of *path dependency*: the firm's past history (prior learnings and the resources and knowledge thus accumulated) will be a determining factor in the full range of

possibilities available to the enterprise. In other words, the firm can interpret that according to the characteristics of the market in which it operates or hopes to operate it makes strategic sense for it to modify its product mix, for instance, and thus move towards a greater differentiation of products, but without the capacities, skills or resources needed to carry out this strategy, which may require considerable effort in R&D, product or process development, design, marketing, or in all of this at the same time.

Hence the interest of experts in innovation processes in understanding what happens inside the enterprise, a "black box" for the neo-classical school (concerning the lack of knowledge as to its content). Interest is reinforced thanks to the growing importance assigned to technological know-how (the technological capacities of firms) in the search for the causes which explain the evolution of competitiveness levels of both firms and nations. Among those capacities is that of appropriately combining its assets in relation to the market opportunities available. This involves numerous and diverse interactions both inside and outside the firm with the remaining agents acting in the system in which the firm operates (or with which it relates).

b) Learning processes

In contrast with the neo-classical conception, which generally associates innovation with formal R&D activities, evolutionism stresses the importance of learning processes. Various authors have refined not only the concept of *learning by doing* but have constructed increasingly comprehensive classifications of the different learning processes. In the former, the essential thing is to understand that learning processes are never automatic, but require specific investment of resources of varying quality and amount depending on the case. Similarly, firms learn in different ways, each leading to improvements in the *stock* of knowledge and specific technological capacities of the firms, which in turn generates a range of paths for technological progress and not a mere reduction in average costs. In turn, the different types of learning open up different directions for incremental technical change (Malerba, 1992).

The Schumpeterian distinction between invention, innovation and diffusion as three clearly defined acts also disappears, in favour of a conception of technological change as a continuous process.[5] According to Rosenberg (1976), Schumpeter's influence has led to technological change being identified with greater innovations, and has consecrated the perception that inventive activity is an exogenous factor, not influenced by economic aspects. In contrast, *empirical studies show that, economically speaking, innovation is not just one well-defined act but a process*. Learning causes inventions to undergo changes during their life cycle, leading to perhaps greater productivity increases than those resulting from the original invention (OECD, 1992). Consequently, an innovation only takes on economic significance through a process of redesign, modification, etc. and numerous improvements that make it adaptable to a mass market; in other words, the type and extent of its influence on economic life is determined during what is conventionally defined as its diffusion stage; the evidence shows that an increase in efficiency and a fall in the price/performance ratio of a specific good are fundamentally the result of an accumulation of small improvements, which in turn derive from the experience gained in production and from repeated interactions between users and producers (Cimoli and Dosi, 1994).

There is a conception (now becoming less widely accepted) of the process of technological change that is based on a

[5] According to the Schumpeterian interpretation, an invention is conceived as an isolated creative activity in the production process and one whose impact derives from the subsequent stages of innovation and diffusion. Innovation consists of the first successful commercial introduction of an invention, whose basic technical characteristics have already been fully defined. Finally, diffusion is understood as an activity essentially similar to copying, undertaken by imitators of the entrepreneur who originally introduced the innovation in question.

marked distinction between innovation and diffusion of technology. This vision holds that the former activities are concentrated in developed countries and their outcome is the creation of technologies that are incorporated into "production capacity", i.e., the stock of capital goods and the operating know-how required to manufacture those goods within the bounds of productive efficiency (Bell and Pavitt, 1993). In less developed countries, in contrast, there are merely diffusion processes of the technologies created in developed countries.

Since the choice and adoption of existing technologies are seen as trivial, R&D activities would tend not to exist in developing countries, or even be deemed necessary. In fact, firms in developing countries can supposedly access those innovations, either free of charge or for a fee according to the case, but always without difficulties in using them with the same level of efficiency as that prevailing in developed countries. Likewise, there should be no problem in assimilating transferred technology, nor should adaptations to local conditions be required, since available alternatives supposedly exist for all relative price levels for the factors of production (Lall, 1992).

However, the distinction between innovation and diffusion as two completely separate activities (which take place in sequence) does not adequately reflect reality. Similarly, even if the appearance of "radical" innovations is unlikely in developing countries, available empirical evidence reveals that the diffusion of technologies involves a process of continuous, generally incremental, technical change whose objectives are to adapt acquired technologies to the specific context in which they will be applied and thus reach greater levels of operating efficiency. These activities are important for at least two reasons: i) as mentioned above, significant productivity increases may be obtained through the accumulation of lesser innovations; ii) as a result of differences in staffing levels, the type and quality of inputs, local tastes, etc., it is always necessary to make to some extent "idiosyncratic" adaptations to imported technologies for operations in the local environment.

In other words, a learning process needs to take place since technologies have tacit aspects and their basic principles are not always clearly understood. So, technological change at the level of the firm should be conceived as a continuous process of knowledge absorption or creation, determined in part by external inputs and in part by past accumulation of skills and knowledge (Bell and Pavitt, 1993; Lall, 1992).

In this regard, a distinction should be made between technical change and technological learning (or accumulation). The former concept includes any form in which new technologies are incorporated into a firm's productive capacity (through new equipment or plant, incremental changes, etc.). Although the inputs for certain kinds of technical change (capital goods, engineering services, etc.) can generally be acquired on the market, this is not the case when it is a question of generating continuous incremental changes in existing factories; here, the user of the technology must play an active role and have the required skills. Indeed, technological learning refers to any process that boosts the capacity to generate and administer technical change. These intangible resources are increasingly important, reflecting a rise in "knowledge intensity" in industrial production (Bell and Pavitt, 1992).

c) The determining factors of technical change: supply push or demand pull?

If, as we have seen, technical change and the growing incorporation of knowledge into production are so important for the success of firms and in raising economic growth rates and the levels of social well-being, we need to ask ourselves what this depends on.

What are the factors that determine the technological behaviour of firms? What are the "triggers", the causal factors that

lead an enterprise to decide to engage in efforts to introduce innovations or, in other words, to seek improvements in production processes and/or significant changes in the products turned out? It is clear that innovation efforts are costly, are subject to high risk (uncertainty as to their outcome) and that there may be a long waiting period for potential returns.

In principle, an enterprise is innovating for two basic reasons: to displace competition on the basis of technological superiority (in product or in process), or due to the pressure of the competition (to avoid being displaced if the competition moves to the forefront in questions of technical change).

It is true that in less relatively developed economies, cases of introduction of radical innovations are uncommon; what does prevail though is the introduction of improvements or changes that involve novelties for the firm (products not manufactured previously; methods of production hitherto not used by the enterprise, or rather so-called "incremental" improvements, i.e., modifications to products or processes preexisting in the firm) but which in most cases were already being used by local or foreign competitors[6].

The theoretical contributions to the debate on factors determining technical change (Schmookler, 1979; Mowery and Rosenberg, 1982; Freeman, 1982; Pavitt, 1984; Cimoli and Dosi, 1994) place special emphasis on what triggers the original innovations (radical innovations or novelties for the international market) introduced by firms which thus inaugurate a new form of producing a specific good or offer a new product which has distinctive characteristics in comparison to those usually available in the market. The original innovators seek to obtain temporarily unassailable competitive advantages (Schumpeter's "temporal monopolies") on the basis of mastery of a production technique the other agents lack, or to offer a product that differentiates itself from those of the competition in a certain aspect that favours it in market preferences (or in a segment of that market).

The debate also has implications for the factors that help dynamise the diffusion processes of technological novelties, i.e., the proliferation of followers who try not to lag behind changes in the local or international context. Indeed, this latter aspect (the driving force of diffusion processes) is of great importance for the less relatively developed countries which wish to reduce the technology gap that separates them from the richest.

In any case, as soon as a firm introduces an innovation into a market, the "followers" will soon appear, not wanting to lose their respective positions. So, the question to answer is: which is or are the factors that trigger the initial movement in each market, i.e., the first step to be followed by the others.

The economic literature and analyses of scientific-technological development processes offer numerous examples of different theoretical positionings as regards whether technical change is driven by changes in demand (demand-pull) or by the appearance of new scientific and/or technological knowledge (science and technology-push).

Reviewing the main contributions made to the debate and discussing the extent to which the various approaches could be

[6] See point 2.1.a) regarding the distinction between innovations that involve a novelty only for that enterprise, and those that are an innovation for the local, or even the international, market

applied to countries of less relative development is not only of theoretical value but is also of great practical importance when we need to better our understanding of the processes of technical change in our societies (particularly, at the level of enterprises) in order to make a positive impact in the quickening rate of technical change. Without wishing to explore the discussion in depth here, we shall summarise the basic elements in the controversy, distinguishing between the two traditional positions in the debate: "demand pull vs science and technology push".

Although Shumpeter clarifies the motivations of the innovators, we should ask ourselves if what drives us to accept risks and costs is identifying an unsatisfied demand, and thus a perceived market opportunity, or visualising an opportunity with the appearance of new knowledge which, when applied to production, would give the desired competitive advantage.

DEMAND AS A DRIVING FORCE (*DEMAND PULL*)

This position holds that the appearance of signs of **unsatisfied need** in a market will incentivate the search for technical solutions to ensure that the demand is satisfied. An enterprise interested in exploiting the "opportunity" offered by this unsatisfied demand will analyse the size and characteristics of the investment and technological changes required. It will investigate whether the necessary technological knowledge already exists and the possibility of acquiring it, or whether the technology does not exist, its chances of self-generating it or of entrusting it to a university or scientific-technological institute, undertaking the relevant research and development activities itself.

THE SCIENCE AND TECHNOLOGY PUSH AND ITS PULL EFFECT

This would be the case of innovations introduced into the market, although the need (demand) for a novel product or one with differential characteristics to those available is "diffuse" or not very visible before the innovation occurs. Here Schumpeter would say that the appearance of new knowledge (produced by scientific-technological activities) was responsible for driving the innovating entrepreneur to "impose"/place the novelty. The "Schumpeterian" entrepreneur interprets that the new knowledge has potential, that he can transform that potential into new products or processes, and so takes the risk of innovating, in the hope of ensuring market acceptance. If successful, he will obtain extraordinary profits, which will motivate the entry of secondary innovators or followers.

The main analytical problem is that (by definition) innovation implies the existence of a buyer's market, since by innovation we understand the introduction of novelties into the market. Of course, that demand may be "latent" or "diffuse" and may be perceived by the innovator before any others. However, whether latent or concrete, demand would appear to lead the innovator to take risks. However, as Freeman suggests, it is likely that not even Schmookler (a leading exponent of the *demand-pull* approach) would say that the basic science is demand-driven, so if the process of constant generation of new knowledge offers no possibilities, the needs would remain unsatisified.

This can be summarised by pointing out that the possible factors determining technical change in the enterprise are the impetus exerted by unsatisfied demand, competitive pressure (which depends on market structure) and the appearance of new knowledge (scientific breakthroughs) of exogenous origin. What is most certain is that innovation requires a particular combination of demand forces for novel new products and a supply of new knowledge. The form this combination may adopt

will be of particular use in explaining the timing of the innovation, i.e., the precise moment in which it occurs.

In that regard, a firm's levels of competitiveness will depend on its capacity to formulate strategies that allow it to reach, extend or retain a sustainable position in the market. A competitive strategy can thus be seen as interaction between the opportunities the enterprise perceives the market offers and the concrete possibilities of exploiting those opportunities. The possibilities will, in turn, be conditioned both by factors endogenous to the firm (such as accumulated technological and organisational capacities) and by exogenous (structural or systemic) aspects peculiar to the environment in which the enterprise operates. The weight of the mesoeconomic exogenous aspects, i.e., those corresponding to the specific context of the activity or specific market to exploit, mean that competitiveness appears as a function of the possibilities of adapting individual strategies to sectoral specificities.

d) Technological, innovation and absorption capacities

Efforts to better identify the factors determining technological change and those affecting changes in a firm's performance have led to the distinction of **three key types of capacities: technological, innovation and absorption**. These concepts are closely interrelated and have numerous elements in common: absorption skills are a critical element in innovation capacities (Cohen and Levinthal, 1990) and these, in turn, a basic component of technological capacities.

Viewing technological capacities as the knowledge and skills to acquire, use, absorb, adapt, improve and generate new technologies (Bell and Pavitt, 1995; Lall, 1992), it can be seen that technological capacities include both innovation and absorption capacities. Now, these capacities must be complemented in such a way as to produce a new combination of existing ideas, capacities, skills, resources, etc. The result of this new combination in the market is what is known as innovation. Therefore, **innovation capacities** are those skills developed by agents to secure new combinations of existing factors (internal to the organisation and its environment). In this respect, Cohen and Levinthal (1989) state that the ability to recognise the value of new and external knowledge, and to assimilate and apply it for commercial ends, is a critical component of an enterprise's capacities. This skill has been termed **absorption capacity**. Absorption capacities have three well-defined dimensions: identification, assimilation and exploitation of new knowledge. However, the three are subject to the knowledge previously acquired by the agent, i.e., to the process of knowledge accumulation, giving it an accumulative (path dependency) and specific character. Likewise, **absorption capacities are an intangible good and their benefits are indirect, which makes the measuring process difficult**.

The link established between technological, innovation and absorption capacities allows the effort of measuring capacities to be focused on the former, while investigating the behaviour of the agents in the field of technology innovation and absorption.

One of the key characteristics of technological capacities is that they are far from being uniformly distributed between countries, regions and firms. Only a few nations constantly improve their knowledge base, while a majority lags behind and may even have great difficulty in absorbing capacities considered obsolete in other parts of the world (Archibugi and Coco, 2004). Similarly, some firms stand at the technological frontier while others operate as their followers.

Although the development of technological capabilities is, by definition, a process of technological learning (Bell, 1984; Bell and Pavitt, 1995) an important distinction needs to be made when analysing frontier firms and/or follower enterprises. In the former, innovative technological capacities are solid, while in the second the firms are largely based on technologies they acquire from other companies or other NIS agents. In these cases, enterprises usually lack even basic technological

capacities, hence the importance of being able to gather information on **how technological capacities are built and accumulated in enterprises**[7] when analysing innovation processes in our region.

e) The concept of a National Innovation System (NIS)

The concept of a National Innovation System (NIS) allows for an integral analysis of the vast set of factors that interact in the processes of technological and organisational change and which affect their impact on the growth rate and orientation of development (López, 1998).

In its broadest sense, the concept includes all the elements that contribute to the development, introduction, diffusion and use of innovations (Lundvall, 1992). It therefore includes production enterprises, the education system (particularly universities and technical institutes), laboratories and public and private research centres, the financial system, and public institutions or agencies promoting science, technology and innovation.

There is growing interest in analysing them, since innovation is being increasingly recognised as the main source of genuine, sustainable and accumulative competitive advantages and, therefore, a positive force in growth and economic and social development.

However, measuring and evaluating the characteristics, dimensions and functioning of an NIS and, above all, comparing it with others is a complex operation. This is principally due to the fact that there is no "ideal" against which to contrast the different histories and, also, because each NIS presents specificities which need to be taken into account and which can give rise to different, although equally "virtuous", growth paths.

One approach to a possible form of evaluating an NIS might involve considering a set of key variables, which account for a characterisation of the **composition** of the system, of the **links** between its components and of the **innovation processes** addressed by the enterprises, particularly as regards their orientation or direction and their impact in changes in competitiveness levels and in the evolution of the economic and social development process.

The wealth that explains these variables is reinforced, of course, if in the analysis they are combined and weighted against each other and against other variables and indicators that can provide clues as to the concrete role and impact of an NIS on economic and social development. As will be seen below, it may be essential to compare the evolution of the innovative enterprise indicator with the total number of enterprises, and other data which could shed light on the depth and scope of the innovations introduced. In this regard, indicators of the technological content of production and trade, or R&D expenditure, or on other IAs, may help put the conclusions that can be extracted from an isolated analysis of the percentage of innovative enterprises into perspective.

f) The characteristics of innovation in the countries of the region and the importance of the subject approach

An analysis of innovative processes in our region must pay special attention to the characteristics that distinguish them from

7 Further information on technological, innovation and absorption capacities, as well as on the forms of measuring them may be found in Lugones, Gutti and Le Clech, "Indicadores de Capacidades Tecnológicas en América Latina. CEPAL, Sub-Regional Ofice in Mexico. Series Estudios y Perspectivas N° 89, October 2007.

those in countries of greater relative development, so as to fully benefit from the measuring exercises conducted. Generally valid for the use and interpretation of indicators of any kind, this opinion becomes more significant in relation to innovation surveys, since many of the questions included in the questionnaires (and even the same wording of those questions and of the instructions accompanying them) will often retain a high degree of similarity with those on the survey forms used, for instance, within the Eurostat (Community Innovation Survey - CIS) thus ensuring the greatest international comparability of indicators.

However, the responses to those questions should be analysed in the light of a set of features that typify innovation processes in developing countries and that differentiate them from those that occur in the mosty highly developed economies. Among the most important, it is worth mentioning[8]:

- The smaller relative size of average enterprises and the heterogeneity between them;
- The predominance in the region of the search for competitive advantages based on the exploitation of natural resources or low wages;
- The lower relative hierarchy assigned in many cases to the local branches of international companies that head the global and regional production and trade networks, the division of labour within the networks (or assigning a secondary role by concentrating activity in the phases of least technological content within a specific production process);
- The informality that prevails in organising innovation processes;
- The formation or structure of (frequently incomplete or insufficiently developed) markets and their smaller relative size;
- The obstacles to innovation that firms face, particularly the weight of market failures (economies of scale and externalities) and of exogenous systemic factors (macroeconomic uncertainty and instability, inadequate physical and social infrastructure, institutional fragility);
- Deficiencies in matters of capacity accumulation in enterprises;
- The low relative weight of R&D efforts and the predominance of the acquisition of embodied technology in innovation activities;
- Weakness in the links and relations between enterprises and other NIS agents.

These features no doubt have a decisive influence in our region in ensuring that diffusion mechanisms and innovations of an incremental nature should prevail. This means that an indicator that is frequently used internationally, such as the rate of innovating enterprises (percentage of firms that have introduced innovations out of the total number of enterprises surveyed), may be misleading as to the dynamics and real scope of innovation processes in our countries if it is not contrasted with the actions (and expenditure) made by enterprises on R&D activities, human resources management, acquisition of embodied and non-embodied technology, linkages with other agents in the system, etc.

In addition, on the basis of evidence obtained from innovation surveys and various competitiveness studies made in the region, it may be claimed that there are substantial differences in both competitiveness and in quality of employment and wage levels, depending upon the specific strategy adopted by the innovative firms, with clear advantages for, at least, three cases: a) those that make the highest spending on innovation; b) those that combine equilibrium with continuity in efforts,

[8] An in-depth discussion of the particular characteristics of innovation processes in countries of less relative development may be found in Lugones and Peirano, 2005; Fernández Polcuch, Lugones and Peirano, 2005; Suárez, 2006; and in Annex A of the third edition of the Oslo Manual.

and c) those that seek product differentiation.

This has clear implications for the methods and procedures used in measuring innovation processes. If the kind of innovation strategy most commonly used by the enterprises of a country can make significant contributions in the search for greater solidity in their external sector and for real and sustainable improvement in the average income of the population, concepts already highlighted in the Oslo Manual and Bogotá Manual, regarding the advantages of adopting the subject approach over the object approach in innovation surveys, are further reinforced.

Without eluding the measuring of results (the focus of the object approach), the former approach pays particular attention to obtaining the highest degree of detail possible regarding the efforts and linkages made by innovation enterprises. This means that not only can the strategies of firms (such as those mentioned or other possible ones) be distinguished but also outcome indicators can be contrasted with effort indicators in order to enrich the analytical possibilities provided by the surveys.

This emphasises the need to strengthen the collection of data on the linkages and innovation activities carried out by enterprises, as well as their determining factors and the obstacles they must address in this regard, in order to make better use of the elements of judgement provided by the innovation surveys.

03. How to measure innovation processes?

The principal mission of innovation surveys is to collect a body of data and information on firms' behaviour and innovation strategies, and on innovation processes in general, in such a way as to build a set of indicators to satisfy the conditions of **belonging, reliability and comparability** demanded of them.

Belonging alludes to the capacity of indicators to provide users (enterprises, researchers and policy-makers) with the elements of judgement they require to analyse the present, predict the future and, in consequence, define, review and assess their strategies and lines of action in relation to innovation processes. In that regard, the composition or formation of the set of indicators to construct is fundamental, and must be **chosen before starting on the design of the survey form and on the preparation of the field work**. In other words, the indicators that it is hoped to construct define the variables to study and determine the characteristics and modes of operation for the exercise.

Reliability is associated with the quality of the indicators, attaching maximum importance to the method and procedures used in collecting the information and in its subsequent processing.

Comparability is an inescapable condition for the use of indicators to the extent that these processes are analysed by relating them to each other, comparing experiences, efforts and outcomes. As comparisons are usually made in reference to the same object of attention (country, sector, type of enterprise, etc.) but between two points in time, it is important to look closely at the comparability of the indicators prepared on the basis of successive measuring exercises (the different surveys carried out in a single country). As we see, comparability requirements involve aspects related both to the composition of the set of indicators it is hoped to construct and to the procedures for obtaining information in such a way that two indicators with the same name or designation are indeed reflecting similar processes or characteristics.

3.1 Blocks or sets of indicators

Although the selection of indicators (as already stated, a process that will be decisive in defining the characteristics of the measuring exercise) should of course take into account the particular characteristics of the processes to assess and of the agents to interview, the availability of resources and time for data collection, and the experience accumulated by the teams entrusted with the work, among other aspects. We can present a tentative list of indicators, many of them commonly used in surveys carried out in the region and internationally, others which are less commonly used or are relatively novel, which will bring us closer to the specific aspects involved in the work of measuring innovation.

The indicators to be presented have been organised into three large blocks or modules:

1. Innovation strategies
2. Outcomes of innovation activities and appropriability
3. Obstacles to innovation, sources of funding and use of public instruments.

So, for the purposes of qualifications it is important to have at least four types of indicators: those associated with human resources for innovation, those that look at the qualification of human resources in general, those that refer to the organisation of labour and those that describe the intensity and characteristics of human resources in innovation activities.

1. Innovation strategies

1.1. AInnovation activities (efforts made)

Purpose: To know the size and structure of expenditure on Innovation Activities[9], notably:

Internal Research and Development (R&D)

External Research and Development (R&D)

Acquisition of machinery and equipment

Acquisition of hardware

Acquisition of software

Acquisition of disembodied technology

Contracting consultancy firms and technical assistance

Engineering and industrial design (EID) activities

Staff training

Marketing

Variables to survey

To make maximum use of the indicators to be obtained it is of fundamental importance to know the levels of expenditure in each sector and for each year of the period covered by the study[10].

[9] See definitions in the Annex
[10] The values should not include VAT or similar taxes.

This means that **the set of indicators** given below can now be made up, although the suggested information for collection provides ample possibilities for expanding it:

a) Number of **innovative enterprises** and percentage of the total, with innovative meaning that it has performed innovation activities, independently of the outcome achieved.

b) Number of **enterprises that have done R&D activities** and percentage of the total.

c) **Intensity of spending on innovation activities** (IA): spending on IA as a percentage of turnover for the same year or period

d) **Intensity of spending on R&D**: spending on R&D as a percentage of turnover for the same year or period

e) **Structure of spending on IA**: Percentages of total spending on IA in each sector

1.2. Linkages and cooperation with other agents in the system

Purpose: To investigate the causes or factors that impacted in the decision to establish linkages or relations with other agents in the innovation system in the framework of, or with reference to, the innovation activities of the enterprise and the characteristics of those links (objectives, formality, agents, outcomes and obstacles).

Variables to survey

a) **Purposes of the linkage**:

i. Determining factors: type of innovation sought, distinguishing between:

- product, process, organisation and commercialisation
- radical or incremental

ii. Objectives: R&D, engineering and design, training, technical assistance, information.

b) **Duration and degree of formality of the link** (existence or otherwise of a contractual agreement and monetary compensation).

c) **Type of agent with whom linkage was established** (clients, suppliers, universities, training centres, extension agencies, R&D laboratories, technological centres, consultants, head office or other enterprises in the same group, unrelated enterprises.

d) **Geographical extension of the link** (local or international, depending upon the location of the agent with whom the linkage occurs)

e) **Outcomes**: level of satisfaction with the results of the linkages

f) **Obstacles**: insufficient capacity of the personnel in the enterprise; discrepancies between the specific knowledge requirements of enterprises and the supply of available knowledge; appropiability problems with possible results; differences in pace, practices and working "cultures" between agents; distrust between agents; lack of knowledge or information on opportunities and possible benefits of the linkage.

1.3. Sources of information for innovation

Purpose: The data to be obtained here will complement and serve as control variables for those obtained in 2.

Variables to survey

a) **Internal sources**: the R&D, marketing, production and distribution areas of the enterprise.

b) **External sources**: Internet, clients, universities, research or technological development centres, journals and catalogues, consultants, trade fairs, conferences and exhibitions, databases, competitors, suppliers, other related enterprises.

1.4. Determining factors in innovative efforts

Purpose: To investigate the causes or factors that influenced the decision to engage in innovative efforts

Variables to survey

The enterprise will be consulted as to possible determining factors, such as:

a) **Detection of total or partially unsatisfied demand in the market**

b) **Use of an idea or scientific and technical novelties**

c) **Others**

1.5. Objectives of innovative efforts

Purpose: To know the objectives of innovative efforts and the way in which they are achieved.

Variables to survey

a) **Search for reductions in production costs through**:

i. use of new materials,

ii. reorganisation of the production process,

iii. incorporation of new capital goods,

iv. changes in distribution channels,

v. changes in marketing strategy,

vi. improvements in the use of labour

vii. others

b) **Product differentiation**

i. modification in the intended uses or characteristics of the product,

ii. launch of new products,

iii. search for new niches or markets,

iv. others

1.6. Technological capacities and absorption capacities

Purpose: To know the composition and characteristics of the enterprise's human resources and trends in the field (the successive exercises will allow the evolution and changes in personnel levels to be established), in order to analyse the enterprise's HR strategy.

Variables to survey

a) **Total number of personnel**

b) **Composition of the personnel by qualification**: number of employees with basic education, technical education, professionals in hard sciences (engineering, physics, chemistry or biology, etc.) and other professionals.

c) **Average seniority of personnel**

d) **R&D Department**: existence of R&D Department or Laboratory, distinguishing between formal and informal.

e) **EID Department**: existence of Engineering and Industrial Design Department, distinguishing between formal and informal.

f) **Information Technology and Systems Department**: existence of a specific department, distinguishing between formal and informal.

g) **Human resources in Innovation Activities**: number and qualification of the employees assigned to R&D, EID and IA activities in general, part- or full-time.

h) **Human resources in Information Technology and Systems**: number and qualification of the employees assigned to activities in the area, part- or full-time.

i) **Human resources in Quality Management**: number and qualification of the employees assigned to activities in the area, part- or full-time.

j) **Training**:

i. Type or objective of the efforts made during the period surveyed, in training the enterprise's human resources (in process or product technology; in ICT; in management or administrative aspects; in quality management, industrial security, etc.)

ii. number of employees included in training.

iii. Agents (internal or external) as training providers

1.7. Quality management in the enterprise

Purpose: To know the enterprise's commitment to quality management and continuous improvement.

Variables to survey.

Use of:

a) **Control points**

b) **Follow-up charts**

c) **Certified processes**

d) **Certified products**

2. Outcomes (innovations) and appropriability

2.1. Innovations introduced

Purpose: To know the number of enterprises that have introduced innovations into the market during the period studied, by type of innovation. This would allow the construction of indicators on the rate of innovating enterprises out of the total.

Variables to survey[11]

a) **Product innovations**

i. New products

ii. Significantly improved products

b) **Process innovations**

[11] See definitions in the Annex.

i. New processes

ii. Significantly improved processes

c) Innovations in organisation

d) Innovations in marketing

2.2. Scope of the innovations

Purpose: To determine the degree of novelty of the innovations introduced

Variables to survey:

whether the innovations introduced are a novelty only for the firm or also for the national market, or even for the international market.

a) Novelty only for the firm

b) Novelty in the national market

c) Novelty internationally

2.3. Impact of the innovations

Purpose: To attempt to assess the effects of innovations on the firm's performance and on the quality of the employment generated by it.

Variables to survey

a) relative evolution of sales (e.g. vis-à-vis the evolution of the sector)

b) changes in the degree of entry into foreign markets (growth in exports)

c) changes in productivity levels (sales/employment, sales/ consumption of energy or any other productivity proxy)

d) percentage of total sales in the period, explained by new or improved products

e) evolution of average wage levels in the enterprise

f) evolution of average seniority of workers in the enterprise

2.4. Appropriability

Purpose: The type of protection chosen by the enterprise will be closely related to the characteristics of the innovations introduced (depth, scope, etc.) and to the firm's competitive strategy. Therefore, these indicators will be of great use in contrasting them and complementing them with indicators of effort (innovation activities) and with those of outcomes (innovations). All the enterprises surveyed should be asked these questions.

Variables to survey

a) Methods of formal protection. Use some of the following:

i. Brand

ii. Patents

iii. Industrial design

iv. Denomination of origin

v. Copyright

b) **Methods of strategic protection**. Use some of the following:

i. Control distribution networks

ii. Arrive first in the market

iii. Scale

iv. Secret

v. Design complexity

c) **Number of patents requested**. In the case of enterprises that report having used patents as a protection mechanism, indicate the patents requested in the period surveyed and the obstacles to patenting.

i. In the country

ii. In USA

iii. In Europe

iv. In the rest of the world

d) **Number of patents obtained**. For enterprises that report having used patents as a protection mechanism, indicate the patents obtained in the period surveyed.

i. In the country

ii. In USA.

iii. In Europe

iv. In the rest of the world

e) **Difficulties or obstacles to patenting**.

i. Costs

ii. Complexity

iii. Administrative difficulties

3. Obstacles, sources of funding and use of public instruments

3.1. Endogenous and exogenous obstacles to making innovation efforts

Purpose: Although innovation activities offer enterprises tempting prospects in terms of consistent, sustainable improvement in levels of competitiveness, it is also true that they demand significant spending and investments that significantly increase fixed costs (making the possibility of exploiting economies of scale crucial), are subject to uncertainty as regards the specific outcomes to be obtained and must overcome considerable difficulties frequently originating outside a firm's field of action (negative externalities). An important input in designing policies to promote innovation is, therefore, to know the factors of greatest negative impact in the decisions taken by enterprises when engaging in innovation processes.

Variables to survey

a) **Obstacles of endogenous origin to the enterprise** (or which appear within the direct area or field of action of the firm, which could have a bearing on their removal)

i. Shortage of personnel with the necessary qualifications in the enterprise to engage in innovative processes;

ii. Problems or shortcomings in administrative or production organisation;

iii. Uncertainty as to the real possibilities of success in innovative efforts (successful introduction of innovations);

iv. Insecurity as regards the possibilities of appropriability of the outcomes (protection by patents, secret, etc.);

v. Excessively long period of return.

b) Obstacles of exogenous origin to the enterprise (or those which affect the firm but are outside its direct area or field of action, meaning that it can have no bearing on their removal)

i. Shortage in the labour market of personnel with the qualifications required by the enterprise;

ii. Problems in access to the exogenous knowledge required by the enterprise (lack of coordination between the supply of knowledge and the requirements of the enterprise; differences between the supply and demand of knowledge, in pace, cultures, attitudes and methods of work);

iii. Reduced market size, reflected in diseconomies of scale;

iv. Structure of the market in which the enterprise operates or attempts to operate (degree of competition or oligopolisation; barriers to entry);

v. Inadequacies in available physical infrastructure or too great a difference between it and the required infrastructure;

vi. Inadequacies, bureaucratic difficulties or high costs in the system of intellectual property protection;

vii. Difficulties of access or excessive cost of funding;

viii. Insufficient incentives to innovation due to a low rate of technological change in the firm's sector of activity;

ix. Insufficient incentives to innovation due to low receptivity of demand;

x. Insufficient incentives to innovation due to shortcomings in public policies.

3.2. Sources of funding for innovation

Purpose: To know the origin of the funds for innovation activities in order to begin to measure the difficulties enterprises face in this area.

Variables to survey

a) Own resources: contributions by partners, from the parent company, other enterprises in the group, reinvestment of profits.

b) Resources of different origin

3.3. Knowledge and use of public instruments of innovation promotion

Purpose: To have information and elements of judgement for the design, implementation and evaluation of public support policies for innovation activities.

Variables to survey

a) Knowledge: Number of enterprises and percentage of the total that have knowledge of official institutions and stimulus programmes for innovation activities.

b) Use: Number of enterprises and percentage of the total that have used the funds provided by those institutions and programmes.

c) Obstacles: For firms that report not having used funds from the institutions and programmes consulted in a) and b), investigate the reasons, such as rejection of projects, high interest rates, excessive demand for guarantees, bureaucratic

difficulties, difficulty in formulating innovation projects, or others.

3.2 Procedures

The criteria and procedures to use in conducting innovation surveys must be consistent with those established in the Frascati, Oslo (OECD) and Bogota (RICYT) manuals. They are crucial in ensuring that the indicators to construct are comparable both internationally and with those from surveys conducted previously in each country.

The activities to carry out in that regard include designing the survey form; drafting the corresponding instructions to guide the work of the interviewers and assist interviewees in their responses to the questionnaire; and designing the information spreadsheets that will form the basis for the subsequent construction of indicators.

1. Basic variables for the construction of indicators

The construction of innovation indicators suggested above will require a series of data that must necessarily be obtained by means of the survey form, unless the data can be accessed through other measuring exercises with the information for the same period studied. The principal data to obtain are:

a) **General data on the enterprise**: Common or corporate name; principal activity; identification code (or other); address, telephone, fax, electronic mail, Web page; legal status; number of branches of the enterprise; ownership (part of independent group or enterprise); percentage of foreign capital in the enterprise and origin; year of commencement of activities.

b) **Performance of the enterprise**: total sales (distinguishing between own products and products manufactured by third parties[12]; average sales per employee (sales/employment); principal sales markets; exports; principal export sales markets; imports; inverstments (including those reported for innovation activities).

2. Areas of activity and periodicity

a) Populational and sectoral

A first aspect to define is the minimum size (number of employees) at which enterprises can be included in the universe under analysis. Similarly, the activities, i.e., the sectors of the Uniform International Industrial Classification (UIIC) to be included in the exercise must be determined.

b) Territorial

The area of territory to cover must also be defined (national, regional, etc.).

c) Temporal

Surveys of innovation should cover the three years prior to the exercise. This enhances international comparability and is a reasonable period since the innovative behaviour of enterprises does not usually undergo significant changes in shorter periods. Therefore, the suggested periodicity is to conduct a survey every three years.

3. Statistical and analysis unit

The reporting unit may not be located in the same place as the establishment (or establishments) where the production

[12] The values should not include VAT or similar taxes.

activities are carried out. This can lead, for example, to an overestimation of the territorial representation of provincial capitals, which has a negative impact on the subsequent studies or comparisons made by region. Nevertheless, in innovation surveys the statistical and analysis unit is commonly the enterprise or firm referred to under the population heading, independently of the reporting unit. This is due to the fact that information on the firm's innovation processes is usually concentrated either in head office or the strategic management and administration offices.

4. Criteria for forming the sample

To prepare the sample it is of great importance to have a directory or statistical record of enterprises with the greatest coverage and of the best quality possible. It is advisable to make use of the samples commonly used in conducting other surveys of the same sectors of activity, in such a way as to complement the data obtained in the various surveys and enrich the possibilities of constructing indicators.

The results must be expandable and representative of the universe, at least at the two-digit level of ISIC revision 3. The sampling fraction should generally be no less than 10%. It is usual to adopt a selection method for assymetric populations with two strata per domain, one of compulsory inclusion (made up of the larger enterprises). The method determines the cut-off value for the self-represented stratum and the sampling fraction to be used for the remainder.

5. Survey methods

The most appropriate method for maximising the quantity and quality of the desired information is, without doubt, the direct interview with the enterprises in the sample. This of course requires that the interviewers are suitably prepared to ensure that they are in the best postion to help interviewees respond to the form. It is also crucial that the interviewee is fully aware of the data required or is in a position to obtain them.

One aspect of great importance is to accompany the survey form with instructions to orient responses. The instructions should not be delivered separately but be inserted in the body of the form, accompanying each one of the questions asked.

6. Treatment of the information

In the event of a real non-response rate of above 30%, a non-response analysis is recommended. As far as possible, partial non-responses should be avoided. The data collected by the interviewers should undergo a rigorous process of verification, validation, weighting and systematisation in order to guarantee the quality of the data that appear on the paper questionnaire and to ensure that they coincide with those recorded on the computerised form.

A check of logical inconsistencies should also be applied and any cases detected should be corrected. To do so, a minimum set of rules must be established before starting the field work for checking and processing the information (see point 8).

7. Criteria for classifying information

To prepare the spreadsheets to present the data obtained in each of the sections detailed in the blocks or modules described in III.1., and which will form the basis for analysis of the information, it is recommended that cut-offs be made for size of enterprise (small, medium and large), sector of activity (two-digit ISIC, at least) and ownership (nationally- or foreign-owned enterprises) for the largest possible number of indicators.

Percentages for the different indicators to construct (innovating and innovative enterprise rate, percentage of enterprises having established links with other agents, etc.) should be calculated with reference to the total population, i.e., the denominator will in all cases be the total number of enterprises surveyed. This does not exclude, of course, the preparation of indicators such as rate of innovating enterprises over the total of innovative enterprises, or the rate of enterprises having established links with other agents over the total of innovative or of innovadoting enterprises.

8. Control of errors and inconsistencies

Microediting

1. Check that the derived variable Total sales/Employment is within reasonable limits for the country and the sector of activity in question. If it is too low, check that sales are correctly recorded (too few zeros or error in the reporting currency used); if it is too high, also check whether there are too many zeros and whether the data is in the correct monetary unit.
2. Save exceptions, investment will be lower than the enterprise's total sales. If this is not so, it would be advisable to review the records and, confirm the information by consulting the enterprise surveyed.
3. If the enterprise is innovating (it says it has introduced an innovation in the period considered) it must have made expenditure on some of the innovation activities (innovative enterprise). Otherwise, it will not be considered innovating even though it has declared itself to be so. In other words, all innovating enterprises must be innovative.
4. The sum of spending on the various innovation activities has to agree with total spending on innovation.
5. Spending on acquisition of embodied technology cannot be greater than that reported in general investments.
6. As a general rule, total spending on innovation should be lower than total sales of the enterprise. This standard serves principally to check that the same monetary unit is being used.
7. The number of staff assigned to innovation activities cannot be higher than the total number of personnel in the enterprise.
8. If the enterprise claims to have introduced product innovations, the percentage of total sales in the period, explained by new or improved products, must be greater than 0.
9. If the enterprise claims to have an R&D Department or Laboratory, spending on R&D and the number of staff that perform R&D activities must be greater than 0.
10. If the enterprise claims to have an Engineering and Industrial Design Department, spending on EID and the number of staff that perform EID activities must be greater than 0.

Macroediting. Detection of suspect aggregates

In order to detect suspect aggregates a set of variables must be selected which, because of their importance, should be reviewed in the macroediting process. A tentative list could include the following:

- Total expenditure on innovation
- Structure or composition of innovation activities (spending on R&D, acquisition of capital goods and hardware and spending on other innovation activities)
- Intensity of R&D expenditure (spending on R&D/total sales)
- Intensity of IA expenditure (spending on innovation activities/total sales)
- Intensity of IA expenditure over employment (spending on innovation activities/total employment)

- Total sales
- Rate of innovating enterprises (out of the total number of firms)
- Rate of innovative enterprises (out of the total number of firms)
- Percentage of total sales corresponding to new or improved products
- Personnel in R&D
- Personnel in innovation activities

When reviewing these (or other variables) one may be seen to present unusual values for the economy or for the sector of activity[13] (it is advisable to make the analysis at sectoral level). Such cases are frequently due to incorrectly recorded information which was not detected in the microediting process.

Once a suspect aggregate is detected, it is important to determine the microdata to be investigated. Therefore, the records will be arranged by order of importance according to their weight in the suspect aggregate. A list identifying such records (number of order, branch of activity in the directory, corporate name), will be designed with the branch of activity in the questionnaire, its value in the previous year, its weight in the previous year's aggregate, its value and weight in the year prior to the survey and the coefficient of variation between both years (if they appear in the same branch in both surveys). If the enterprise is new, the value and weight of the previous year will be left blank. If it is not new but appears in a different branch in the previous year compared to the year before, the value and branch for the previous year will be entered but the record of those that have remained in the same branch in both years will be clearly distinguished in the list. In this case, the weight in the previous year will be left blank.

In addition, the records that appeared in that branch for that year, but do not do so for the previous year (including those that changed branch), will be included at the end by order of importance in the previous year's aggregate. Enterprises that have disappeared and those that have changed branch in the last year appear in this part, with the branch for the last year they appear being specified.

The data to compare are those that are high, so the factors responsible for the rise in the previous year and the year before will also appear in the list, if appropriate.

Suspect records of greater or lesser significance will be investigated until their influence in the aggregate is no longer significant.

For further information on these procedures, please consult the Methodological Study "La encuesta de innovación tecnológica en las empresas", by the EU-Mercosur and Chile Statistical Cooperation Project ASR/B7-311/96/165, (2003).

[13] If previous records for the same variables are available, the contrast or comparison of values aids detection.

Definitions

Innovations

1) Product innovation (new product or significant improvements in an existing product)

The introduction into the market of a new product or service (whose technical specifications, components, materials or functional characteristics differ significantly from those of previous products of the enterprise) or a significantly improved product or service (previously existing whose performance has been perfected or greatly improved).

2) Process innovation (new processes or significant improvements to an existing process)

This implies recreating or modifying the product manufacturing process or the provision of services, as a result of using new equipment, new inputs, new technological solutions or new software. It includes modifications in the logistics of inputs or finished products (e.g., introduction of GPS or bar codes). Its purpose may be either to produce or deliver technologically new or improved products, which cannot be produced or delivered by using existing methods of production, or to increase the efficiency of production or delivery of products already familiar to the enterprise.

3) Innovation in organisation

This is the introduction of changes or novelties in the forms of production organisation, in the management of the establishment or local office, the incorporation of significantly modified organisational structures and the implementation of new or substantially modified strategic orientations. It includes modifications to the management structure or the integration of different departments or activities and the introduction of significant new changes in relations with other enterprises or public institutions, e.g. by means of alliances, association, outsourcing or subcontracting.

4) Innovation in commercialisation

The introduction in the enterprise of new or significantly improved sales or distribution methods with the aim of improving customer satisfaction, increasing sales levels or entering new markets. These may include changes in product packaging and packing, promotion and distribution (Internet sales, franchises, direct sales or distribution licences), and in price-fixing policies for goods and services.

Innovation activities

Research and Development (R&D)

This is creative work carried out in a systematic, i.e., non-occasional, manner with the aim of generating new (scientific or technical) knowledge, or of applying or using knowledge already existing or developed by another. Three broad categories can be distinguished within R&D: basic research (creating new, mainly abstract or theoretical knowledge within a scientific or technical area, in its broadest sense, without a previously established objective or finality), applied research (creating new knowledge with the expected finality or destination established from the outset), or experimental development (manufacture and testing of a prototype, i.e., an original model or test product that includes all the characteristics and performances of the new product, process or organisational or marketing technique). Software creation is considered to be R&D whenever it involves making scientific or technological breakthroughs.

R&D activities are not always conducted within a laboratory or an R&D department. What is more, many enterprises, especially medium and small ones, do not possess formal R&D structures, which does not necessarily mean that they do not carry out this type of activities. Although it is not a simple task, the R&D activities that are carried out without a formal structure need to be identified. For example: a group of engineers from the enterprise, who work in the same or different areas, meet every Friday afternoon to think, consult bibliography, experiment and/or try out different forms of increasing productivity or the precision with which chemical substances are mixed. This should be considered a non-formal R&D process. The only restriction on R&D being considered an activity that has as its purpose to generate new knowledge is that it should be conducted non-occasionally, i.e., systematically.

External R&D is creative work which is not carried out inside the enterprise or with personnel from the enterprise, but which is entrusted to a third party, either by means of a contract or funding of a group of researchers, institution or enterprise, with the agreement that the results of the work will be the total or partial property of the contracting enterprise.

› Acquisition of capital goods, hardware and/or software

These are innovation activities only when it is a question of incorporating goods as a form of introducing improvements and/or innovations in processes, products or organisational or marketing techniques. Replacing one machine with another of similar characteristics or a new version of software already installed does not imply an innovation activity.

› Contracting Technology

This is any acquisition of rights to use patents, non-patented inventions, licences, brandnames, designs, know-how, technical assistance or technological services, linked to introducing improvements and/or innovations of processes, products or organisational or marketing techniques.

› Training

This is considered to be an innovation activity as long as it does not mean training new workers in methods, processes or téchniques already existing in the enterprise. It may involve the internal or external training of personnel, both in soft technologies (management and administration) and in hard technologies (productive processes).

› Industrial design and engineering activities

This includes all technical preparations for production and distribution not included in R&D, as well as plans and graphics for defining procedures, technical specifications and operating characteristics; installation of machinery; industrial engineering; and production start-up. These activities may be difficult to differentiate from R&D activities, so it may be of use to determine if it is new knowledge or a technical solution. If the activity involves solving a technical problem, it will fall within the activities of Engineering and Industrial Design. Modifications to the production process, e.g., the implementation of just-in-time, should also be considered an activity of engineering and industrial design.

The activities of aesthetic or ornamental product design are not innovation activities, unless they generate modifications that will change the principal characteristics or the intended uses of the products.

› Consultancy firms

Any contracting from third parties external to the enterprise of scientific and technical services related to Engineering and

Industrial Design activities. Remember that if the activities contracted from third parties are related to R&D or Training then they should be considered of external R&D and Training activities respectively.

› Marketing

This includes activities connected with the development and implementation of new methods of marketing not previously used by the enterprise, such as market research, market testing and the launch of advertising campaigns on the introduction of product innovations.

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