Standardisation of Indicators of Technological Innovation in Latin American and Caribbean Countries

BOGOTA MANUAL

RICYT / OAS / CYTED

COLCIENCIAS/OCYT

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Iberoamerican Network of Science and Technology Indicators (RICYT)
Organisation of American States (OAS) / CYTED PROGRAM
COLCIENCIAS/OCYT

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TABLE OF CONTENTS

PRESENTATION

It is a great satisfaction to be able to present the Manual for the Standardization of Technological Innovation Indicators in Latin America or, as we call it, the *Bogota Manual*.

This Manual can be considered a milestone in the conceptual formulation of technological development and innovation processes in Latin America. This is no overstatement given certain characteristics of the institutional context which enabled the initiative to be developed and the particular characteristics of the resulting text. Likewise, the working style that made the Bogota Manual possible deserves to be emphasized.

In connection with these contextual elements, it should be stressed that this Regional Manual reveals the degree of maturity attained by the collective work of the groups and institutions forming Iberoamerican Network of Science and Technology Indicators (RICYT) in addressing the most complex problems involved in measuring science, technology, and innovation in Latin America. The Manual also shows that the theoretical and methodological debate on these issues is founded today on a high degree of awareness of the innovative processes taking place in the region. Only after the experience gained in three Regional Workshops on Innovation Indicators and numerous national surveys on innovation has it been possible to produce this Manual.

The need for a Manual that establishes criteria for standardizing technological innovation indicators reflects the growing importance Latin American countries ascribe to measuring innovative processes in accordance with the major international trends. It reveals that our countries have begun to pay attention to the strategic role played by technological innovation as it affects their economic and social development.

The fact that the Bogota Manual draws its inspiration from the Oslo Manual of the Organization for Economic Co-Operation and Development (OECD) demonstrates a concern that the indicators to be used should keep to criteria and procedures which ensure their comparability at both the regional and international level. The end result exhibits a delicate balance between respect for the invaluable, solid conceptual and methodological bases provided by the OECD's Oslo and Frascati Manuals on the one hand, and the need to take into account the specific characteristics of innovation systems and firms in Latin America, on the other. The features distinguishing our countries from relatively more developed ones have caused almost all surveys carried out in the region to stray to some extent (differently in each individual case) from the recommendations set out in the Oslo Manual. It is possible, in the Manual's balanced approach, to perceive encouraging signs of the growing maturity of Latin American countries, and their capacity to tackle these processes head on.

It should also be stressed that the approach taken in performing this task has emphasized collective effort, and has focused on coordinating the sum total of contributions made by numerous regional research teams and experts working on technological innovation. This experience of team work among experts from different countries of the region should undoubtedly be repeated.

Lastly, it must be pointed out that the work which has gone into this Manual was made possible by the support of many institutions, among which should be mentioned the

Organization of American States (OAS), which funded the project, the Francisco José de Caldas Colombian Institute for Science and Technology Development (COLCIENCIAS; *Instituto Colombiano para el Desarrollo de la Ciencia y la Tecnología*), the Ibero-American Network of Science and Technology Indicators (RICYT; *Red Ibero-Americana de Indicadores de Ciencia y Tecnología*), the Ibero-American Program of Science and Technology for Development (CYTED; *Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo*), and the Andrés Bello Convention (SECAB; *Secretaría del Convenio Andrés Bello*), as should the Colombian Observatory of Science and Technology (OCYT; *Observatorio Colombiano de Ciencia y Tecnología*) and various national institutions.

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INTRODUCTION

Project for the Standardization of Technological Innovation Indicators in Latin America and the Caribbean: The Construction of a Regional Manual

The ever-accelerating rate of process and product obsolescence which characterizes the current competitive scene, and the growing significance that differentiated goods are acquiring in international trade (particularly, in the exchange between the more developed economies) have popularized the idea that technological innovation is *the* key to success for industrial firms. At a national level, the existence of innovative firms presupposes not only higher levels of competitiveness in the economy as a whole, but also the generation of technological spillover into other economic agents.

Whereas in the developed countries (DC) there is a large volume of empirical data and studies available that describes the innovative activities conducted by firms, as well as suitable estimates of the results they obtain (which confirm the links between technological innovation and competitive performance), this is not so in Latin America, where the characteristics and scope of the processes of technological change are still largely unknown.

The initiatives being deployed to improve the collection and processing of information on innovative activities of firms, and to define indicators which take into account specificities, both national, sectorial and according to the type of firm, yet which are at the same time internationally comparable, are central to breaching this gap and making any significant progress in raising awareness of the processes involved in technological change in our region.

Between June 1999 and August 2000, the OAS-funded Project of “Standardization of Technological Innovation Indicators in Latin America and the Caribbean” was carried out in the framework of the efforts undertaken by the Ibero-American/Inter-American Network of Science and Technology Indicators (RICYT). These aimed at promoting surveys and studies on technological innovation processes in the region and at strengthening the Latin American countries’ capacity to construct innovation indicators comparable both with each other and with those produced elsewhere in the world.

The project staff worked together from the project’s inception right through to its formal submission to the OAS. Supported by the project’s administrative bodies, COLCIENCIAS (in the constitutional framework of the Colombian Observatory of Science and Technology) and RICYT, the project staff both jointly and individually performed preliminary activities and studies aimed at its central objective.

The present *Manual on Technological Innovation Indicators* incorporates comprehensive knowledge and contributions from many researchers and experts, both local and from other parts of the world. While bearing in mind the international literature on the subject, it may be shown that, during the Second Ibero-American Workshop on Science and Technology Indicators (*Segundo Taller Iberoamericano sobre Indicadores de Ciencia y Tecnología*) called by RICYT, COLCIENCIAS, CYTED and the OAS in Cartagena, Colombia, from 24 through 26 April 1996, a statement was made concerning "*the need and simultaneous difficulty of establishing indicators that describe the processes of technological innovation in Latin America.*" The Cartagena Workshop's most significant conclusion was to reassert the importance of constructing technological innovation indicators that would find a compromise between the dual tension that:

- On the one hand, indicators should collect and describe the specific characteristics of technological innovation processes observed in the region, while
- On the other, the indicators constructed should allow comparative analysis of the status and dynamics of innovation processes at a global or international level.

The Cartagena Workshop's conclusions recommended that "*tasks for drawing up norms and methodologies that will lay the foundations for constructing Latin American manuals of science and technology statistics and indicators, and designing appropriate survey systems in the fields of technological innovation, research and development, and human resources be undertaken immediately*."

The results of the Cartagena Workshop were written up in *El universo de la medición. La perspectiva de la ciencia y la tecnología*.[1] Four works on technological innovation are of particular interest:

- Sandra Brisolla, *Indicadores de innovación para países en desarrollo* (Innovation Indicators for Developing Countries).
- Roberto López-Martínez & José Luis Solleiro, *Elementos para la construcción de indicadores de innovación tecnológica* (Elements for the Construction of Technological Innovation Indicators).
- Roberto Sbragia, Isak Kruglianskas & Tales Andreassi, *Indicadores de I&D en la industria brasileña* (R&D Indicators in Brazilian Industry).
- Adam Holbrook, *Indicadores de Innovación en una economía pequeña* (Innovation Indicators in a Small Economy).

As a follow-up to the Cartagena Workshop, the First Ibero-/Inter-American Workshop on Technological Innovation Indicators (*Primero Taller Iberoamericano e Interamericano sobre Indicadores de Innovación Tecnológica*) in Bogota, Colombia, from 27 through 28 February 1997, was conducted with COLCIENCIAS and RICYT's backing. During this workshop, several reports on the experience of conducting technological innovation surveys in Latin America, as well as a number of theoretical papers on the subject, were presented.

Subsequently, the Third Ibero-American/Latin American Workshop on Indicators of Science and Technology (*Tercer Taller Iberamericano sobre Indicadores de Ciencia y*

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[1] Eds., Albornoz, Mario, and Jaramillo, Hernán, *El universo de la medición. La perspectiva de la ciencia y la tecnología*, (The Measuring Universe: The Science and Technology Perspective), Santa Fé de Bogotá, Tercer Mundo, COLCIENCIAS, RICYT, CYTED, OAS, May, 1997.

Tecnología) in Santiago de Chile, from 1 through 3 October 1997, took place with the backing of RICYT, SECAB, OAS and CONICYT. This workshop provided the opportunity to hold a special session on technological innovation indicators, where the need to have a specific Manual on indicators for Latin America and the Caribbean, taking in both the advances of the Oslo Manual and specific regional characteristics was first stated aloud. On that occasion, debate focused on the document *The Oslo Manual: Context and Projections.*

During 1998, the basic team that would submit the project proposal to the OAS was formed. Initial pre-project investment was funded by RICYT and COLCIENCIAS, mainly in connection with the conceptual and methodological advances to be incorporated into the project. Their efforts yielded the following working documents:

- Ricardo Chica, *La innovación y su medición* (Innovation and its Measurement), March 1998.
- Ricardo Chica, *Algunos elementos conceptuales y metodológicos para la adaptación del Manual de Oslo* (Some Conceptual and Methodological Elements for Adapting the Oslo Manual), October 1998.
- Hernán Jaramillo, Gustavo Lugones, Mónica Salazar & Ricardo Chica, *Criterios para la normalización de indicadores de innovación tecnológica en América Latina* (Criteria for the Standardization of Technological Innovation Indicators in Latin America), October 1998.

These papers were read at the Second Ibero-/Inter-American Workshop on Technological innovation indicators (*Segundo Taller Iberoamericano e Interamericano de Indicadores de Innovación Tecnológica*) in Caracas, Venezuela, from 21 through 23 October 1998, with the backing of RICYT, SECAB, OAS and CONICYT. This Workshop became a prime opportunity for reviewing the Latin American Surveys on Innovation and presenting key ideas and concepts for the construction of a Regional Manual on Innovation. This Caracas Workshop also turned out to be an important opportunity for discussing studies that had been carried out on the basis of the Latin American Technological Innovation Surveys. A qualitatively significant step forward was taken in the analysis and application of the results of the surveys conducted by a number of the countries in the region and this in turn enhanced the content of the Innovation Surveys. In addition to these documents, the following were also read at the Caracas Workshop:

- Gustavo Crespi, *Investigación sobre los determinantes de la innovación tecnológica en la industria manufacturera chilena* (Investigation into the Determining Factors of Technological Innovation in the Chilean Manufacturing Industry).
- R. Bisang & Gustavo Lugones, *Encuesta sobre la conducta tecnológica de las empresas industriales argentinas* (A Survey on the Technological Conduct of Argentinian Industrial Firms).
- Víctor Alvarez & Virgilio Rodríguez, *Encuesta de capacidades tecnológicas e innovaciones de la industria manufacturera venezolana* (A Survey of Technological Capabilities and Innovations in the Venezuelan Manufacturing Industry).
- Xavier Durán, Rodrigo Ibáñez, Marisella Vargas & Mónica Salazar, *Los determinantes de la innovación tecnológica en Colombia y sus características por sectores*

industriales (The Determining Factors of Technological Innovation in Colombia according to Industrial Sector).

In July 1999 the Fourth Ibero-/Inter-American Workshop on Indicators of Science and Technology (*Cuarto Taller Iberoamericano e Interamericano de Indicadores de Ciencia y Tecnología*) was held in Mexico City with RICYT, SECAB, OAS and CONICYT's backing. In the relevant session on technological innovation indicators, an advance report on the OAS-funded project regarding the Construction of the Regional Manual on Technological Innovation was presented. Four contributions of significance were also presented:

- Guillermo Anlló, Laura Goldberg & Gustavo Lugones, *Aportes a la discusión sobre la construcción de indicadores de innovación tecnológica en América Latina. ¿Qué deben medir? ¿Cómo obtenerlos?* (Contributions to the Discussion on the Construction of Technological Innovation Indicators in Latin America: What They Should Measure and How To Obtain Them).
- Sandra Brisolla*, Indicadores de innovación: los siete pecados capitales* (Innovation Indicators: The Seven Deadly Sins).
- Judith Sutz, *La innovación realmente existente en América Latina: Medidas y le*cturas (The True Face of Innovation in Latin America: Measurements and Readings)*.*
- Judith Sutz, *Innovación, indicadores y contexto: una mirada desde el sur* (Innovation, Indicators and Context: A Southern Approach).

In the framework of the events scheduled by the OAS project on the Standardization of Technological Innovation Indicators in Latin America and the Caribbean, and with RICYT, SECAB and OCYT's backing, the Third Ibero-/Inter-American Workshop on Technological Innovation Indicators (*Tercer Taller Iberoamericano e Interamericano de Indicadores de Innovación Tecnológica*) took place on 8 and 9 June. The workshop's aim was to upgrade the basic project team's final version of the *Latin American and Caribbean Manual on Technological Innovation Indicators* through the specialist contribution of the participants. Equally, all the experts who had been invited to work on the project read their papers as contributions to the Regional Manual.

Briefly, from this project has emerged a Manual of Science and Technology Indicators available for the whole region. The Manual represents an amalgamation of the work of the Basic Project Team and numerous experts from the region itself and further afield. All those involved have contributed their judgements, viewpoints and experience, and thus enriched the end product. This means that the regional consensus and international validation indispensable to progress are now viable propositions. It is to be hoped that these two goals, as well as that of this Manual's circulation, will no doubt demand our best efforts in the immediate future.

FIRST PART

CONCEPTUAL CONCERNS

1. THE REGIONAL MANUAL'S AIMS

The intention behind having a Regional Manual for Technological Innovation Indicators is to answer the growing need to systematize criteria and procedures for the construction of technological innovation indicators and ensure a common methodology for measuring and analyzing innovative procedures that will aid the international comparability of any indicators constructed in the region while also bringing out any specificities typical of the various individual nations.

The need for a Regional Manual of Technological Innovation Indicators accompanying any efforts undertaken by countries in the region (within the framework of RICYT and with the support of the OAS and CYTED) with a view to reaching consensus over definitions, methodology and S&T data collection procedures, was reconfirmed in the Regional Workshops on S&T Indicators (Cartagena 1996; Santiago de Chile 1997; Mexico 1999) and in the Workshops on Innovation Indicators held in Bogota (1997 and 2000) and Caracas (1998).

The region will find the results of this initiative extremely useful as they will provide an answer to these countries' growing need for detailed information to guide public and private actions in fields such as science, technology, productivity, investment, and exports. In order to obtain such information it is necessary to build complex indicators that will describe the specificities of technological innovation processes in each country, and which are also regionally and internationally comparable.

Indeed, technological innovation is increasingly being recognized as a fundamental tool in raising levels of competitiveness and increasing a country's chances of reaching a sustainable level of development. This has generated in the region a marked increase in interest about the study and measurement of technological innovation. As well as the official national surveys conducted in Chile, Colombia, Venezuela, Mexico, and Argentina, different sectorial or subregional initiatives have also taken place, not to mention the partial exercises carried out in several Latin American countries.

1.1 WHY MEASURE INNOVATIVE PROCESSES?

Across the world in countries with various degrees of development, there is tangible interest in collecting, processing and analyzing reliable information that reveals the various different paths and characteristics that technological innovation processes take.

The follow-up of government teams who, either directly or indirectly, monitor innovative processes, is fundamentally aimed at providing a **solid basis for the design and assessment of policies** meant to strengthen Innovation Systems (IS) and support any action taken by firms to enhance their technological pedigree. Indeed, analyses aim to gather key information on the main requirements and shortcomings to be dealt with by public instruments and programs. Equally importantly, these studies can also be a useful tool in assessing the impact and incidence both of public policy and international agency support programs concerning innovative processes (Crespi & Katz 2000; Brisolla & Quadros 2000).

At the same time, follow-up can be extremely helpful for private firms (who are increasingly interested in having criteria and parameters that allow them to compare their technological conduct) in **defining strategies.** This interest is connected with the increasingly widespread recognition in the business world that **technological innovation is the master key to success for industrial firms.**

In other words, measuring innovative processes awakes the interest of private firms and public policy-makers.

At the macro level, on the other hand, the existence of innovative firms implies not only greater overall economic **competitiveness**, but also the creation of technological ***spillover*** into the remaining economic agents, which has a knock-on effect on the **development path adopted, either implicitly or explicitly, by a given country.** In fact, technological innovation is set to become the main source for acquiring a **"genuine", "sustainable", and "cumulative" competitive edge.**

By **"genuine"** advantages we mean achieving a competitive edge through accumulating knowledge, developing skills and fully exploiting any (natural or acquired) abilities that will give a firm (and by extension a country) the upper hand over their competitors, as against advantages (rightly) labeled "spurious" (F. Fajnzylber 1988), such as those based on low salaries, currency depreciation, granting subsidies or the like. By **"sustainable"** we understand mainly those advantages which, though they depend on the exploitation of natural resources, imply neither their degradation nor any environmental deterioration, by using "clean" technologies or environmentally friendly policy aimed at preserving resources (Sutcliffe 1995). Lastly, the term **"cumulative"** refers to the conditioning role played by firms' technological behavior in connection with future trajectory ("*path dependency"),* as well as to the generation of externalities linked to the processes of technological learning and improvement (Ocampo 1991).

Follow-up on innovative processes should not only aim at knowing the (quantitative) magnitudes but also at the (qualitative) features of these processes so that data can be obtained on a given economy's development path. This is of high strategic value in policy-making.

This means finding out, for example, if the action taken by firms to up competitiveness is mainly **"defensive"** (Katz, 1998), such as administrative reorganization, personnel streamlining, reducing production and supplementing supply with imports, in which efforts aimed at both incorporating technological improvements to products and/or processes and quality levels, and at strengthening marketing structure and links to foreign markets (**"offensive"** action) are absent. In addition to their unfavorable implications for employment, activity levels and the balance of trade, defensive strategies have proved to lack projection capacity in the medium-term and provide firms with nothing more than the time to plan more effective action in the face of unfavorable situations.

Technological innovation is also apt to prevent price wars typical of commodity markets, where a firm's vulnerability is greater due to its constant exposure to strong fluctuations and imbalances between supply and demand and to the constant incorporation of new competitors who either have salary or scale advantages or resort to unfair trading practices.

Differentiated goods markets, where process and product obsolescence is ever on the increase, demand of firms both proactive technological conduct and a permanent readiness and ability to change. On the other hand, such markets offer the chance to establish stable commercial relationships, to take advantage of the greater dynamism peculiar to these markets, to avoid potential disadvantages in terms of salary outlay, and to profit from endogenous advantages (the firms' own capabilities), whose future extension will not, in principle, be limited by barriers outside the firm itself provided the exogenous factors (macroeconomic context, infrastructure, regulations) work in their favor. (R. French-Davis 1990)

At the macro level, technological innovation and product differentiation is what enables a given economy to support a systematic increase in salaries without negative implications for levels of competitiveness. It is also the most promising formula for avoiding deterioration in the terms of exchange and external sector imbalances which characterize Latin American economies. It can also foster better exploitation of natural resources by favoring its domestic transformation in goods with greater technological content.

The assumption, therefore, is that the technological behavior of firms has a significant effect on their individual competitive capacity and, at the same time, far-reaching implications for a country's tacit choice of which development path to follow.

This is why exercises designed to analyze firms' technological conduct, measure their innovative efforts and assess the results, should be thought of as strategically important tools in guiding public and private action designed to improve firm performance in the marketplace and foster economic and social development, which has far-reaching implications in terms of what kind of study is required. Indeed, **for a tool to be useful in this sense indicators need to be constructed which provide accurate information on a firm's technological conduct, account for the size and characteristics of innovative processes, and yield evidence on the development paths these processes throw up.**

A complementary (though undoubtedly key) dimension to indicator construction are the possible consequences for diffusion that may obtain by conducting surveys of the kind described: the surveyed or interviewed firms and/or institutions are, in the first place, forced to reflect on their actions in the fields of science and technology and, secondly, subsequent discussion of the information gathered makes it possible to discover associations and links between performance and any action taken in connection with technological change.

These potential "spin-offs" from future regional innovation surveys may broadly compensate for the effort required in surmounting any obstacles associated with the cost of the exercise, the learning process, which by and large all countries will have to undertake to be able to carry out the exercises, or any foreseeable resistance on the firm's part to completing the questionnaires.

1.2 THE IMPORTANCE OF STANDARDIZING INDICATOR CONSTRUCTION IN LATIN AMERICA AND THE CARIBBEAN

In addition to the above-mentioned requirements, it is crucial that each country's efforts be **comparable** both regionally and internationally, if the usefulness of the indicators constructed is to be assured. In this respect, it should be noted that the studies that have so far been conducted in our region have not been carried out in accordance with any common concepts, purposes and methodologies other than those in the Manuals, "Frascati" (the OECD´s Proposed Standard Practice for Surveys of Research and Experimental Development), and "OSLO" (the OECD´s Proposed Guidelines for Collecting and Interpreting Technological Innovation Data).

Despite this common basis, the survey forms used in each case as well as the procedures followed, differ (in varying degrees) from those suggested in the OECD Manuals. Moreover, they differ from each other, since some of them tend to pay more attention to the quantitative dimension (measurement of expenditure on innovative activities, for example, is not always covered to the same extent) or, alternatively, different criteria are adopted for deciding what kind of activities and results should form part of the object to be measured.

Consequently, it is crucial for the region's countries to reach consensus on a **common set of indicators** meant to ensure the comparability of results. To this end it is necessary to construct the indicators on the basis of **shared conceptual criteria** through the use of **similar or equivalent procedures** for information gathering. Regardless of any basic agreements, each country will be able to employ additional indicators to obtain more specific information, though results obtained thus are likely to present difficulties when comparing them to those of other countries.

The two OECD Manuals provide suitable guidelines for the adoption of common criteria and procedures for measuring innovative processes in the region. For this reason, the set of basic indicators could well be defined along the lines of their recommendations. Nevertheless, certain specificities peculiar to the technological conduct of Latin American firms justify the development of a set of regional indicators (aimed at describing these specificities) which would complement the Oslo and Frascati indicators to ensure international comparability. This will be discussed in the following point.

The intention to conduct studies that yield information which is not only specific but also regionally and internationally comparable, refers to the need to make an intensive cooperative and coordinated regional effort aimed at systematizing criteria and procedures and developing a common methodology for measurement and analysis which, in turn, would allow comparison of these measurement exercises with those based exclusively on Oslo Manual procedures. At the same time this would facilitate identification of specificities peculiar to individual countries (Chica, Jaramillo, Lugones & Salazar 1998).

1.3 THE NEED FOR A REGION-SPECIFIC MANUAL

Regional, national and even local specificities distinguishing Latin American firms from their OECD counterparts in the more developed countries relate, among other factors, to the special characteristics of their respective Innovation Systems, the make-up of their markets in which these firms operate, the size and characteristics of the predominant firm, and the extent and kind of international integration of the economy in question. **Therefore,**

we should reflect on suitable forms for measurement exercises, and the extent to which it is relevant to use procedures and criteria (such as those suggested in the Oslo Manual) designed on the basis of experiences in environments that are not necessarily (or, at least, not totally) capable of being assimilated to our region's.

Latin American economies and firms are nowadays displaying special characteristics which set them apart from their peers in the first world and even their own recent past. Indeed, under the auspices of macroeconomic organization, market reforms (the opening-up of trade, market deregulation and privatization) and international reintegration, production and service activities in Latin America have undergone dramatic changes over the last two decades, giving rise to a structural shift in our economies toward configurations and behavior very different from the past, including of course major changes in firms' technological conduct.

Major changes in the international context have also contributed to these transformations, including a redefinition of firms' transnational strategies (regarding the creation of global production and trade networks), the acceleration of technological advance, the emergence of new suppliers, a greater fluidity in the circulation of technical knowledge and so on.

Available evidence (Sutz 1998; Bisang & Lugones 1998; Conacyt, México 1998; Crespi 1998; Martínez Echeverría 1997; OCEI-CONICIT, Venezuela 1998; Departamento Nacional de Planeación 1997) suggests that the current technological conduct of the firms in this region differs significantly from that prevailing over the previous ten years. Specifically, there is more interest in obtaining information, developing capacity and enhancing technological pedigree.

The changes most clearly visible from the regionwide surveys are as follows:

- Given the **widespread preference for performing technological innovation activities on the basis of informal organizational structures** (to an undoubtedly greater extent than is the case in the more developed countries), a promising trend towards consolidation, and even formalization can be observed;
- There are two dominant trends or alignments: **one, prevalent among larger firms, especially transnationals, which favors the acquisition of technology from exogenous sources, or** in other words, firms tend to acquire knowledge by procuring capital goods, software, consultancies and/or licenses and patents, and so on, rather than trying to generate it internally. **Exogenous sourcing tends to be international**, as is the case with capital goods where importation tends to become a dynamic factor especially where new product and/or process technologies are concerned. The same happens with the provision of disembodied technology through patents, licenses, and the like, or with the activities of consultancies;
- The second trend (more prevalent among small and medium-sized firms) **combines a strong interest in acquiring capital goods to procure technological improvements with the firm's endogenous or internal efforts.** Although smaller firms have marked limitations in terms of qualified human resources, they do not take suitable measures to compensate for these limitations by attempting to profit from any external knowledge available in the local or national systems (other firms, Universities, Research Institutes, Government Agencies, and so forth);

- **All things considered, in both large firms and small or medium-sized firms, the network of links and interactions between any given firm and its "environment" (Sutz 1998) can be seen to have a low degree of consolidation. The weakness and lack of co-ordination of national and local innovation systems in Latin America is perhaps one of the main elements to be taken into account when analyzing discrepancies between the behavior and performance of regional firms and firms in the more developed countries.**

At the same time, Latin American firms have greatly increased both exports and imports over the last twenty years. They have also adopted more open production, with a rising international provision of inputs, parts, and components. Also, the presence of international firms investing and operating locally has noticeably increased and the involvement of foreign firms in the region's economic activity is much more extensive than a few years ago.

Despite greater international integration and an increasing interest in technological improvement (a radically different situation from a few years ago), Latin American firms still exhibit major differences in comparison to their First World counterparts, especially in the nature and intensity of their efforts aiming at technological innovation. Thus it can be seen that:

- a much smaller percentage of firms' efforts corresponds to R&D activities, while other innovation activities, particularly organizational change, administrative reorganization, and new product marketing have increased in relative importance;
- in terms of R&D activities, less effort is put into basic than applied research.

The fact that local firms often choose to glean technological knowledge from international sources is related to an urgent need to realize immediate competitive improvements (without having to wait for their endogenous efforts to mature), thus enabling them to improve their domestic and, in all probability, foreign market positioning.

The predominance of innovations in administrative and commercial areas may, for its part, be due to a preponderance of 'defensive' strategies.

Both of these aspects, as well as the weakness of R&D, may be related to medium-sized local firms which are smaller than international standards make allowance for. This fact makes it difficult for them to absorb any fixed costs linked to such effort.

Indeed, the conduct prevailing among transnationals settling in the region is to follow the patterns set by the mother company or by other subsidiaries located in relatively more developed countries both with regard to products and processes, by introducing scant local adaptations or modifications. Opting for an external knowledge supply is frequently determined by the mother company's 'global' strategy in terms of research and technological development, which generally reserves the adaptation of technologies developed for other conditions to local availability of raw materials and energy supply (Brisolla S. and Quadros R., 2000) and each country's specific regional subsidiary profile.[2]

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[2] In fact, both in the case of domestic businesses and those affiliated to international firms, major differences are frequently found with their counterparts in technologically more developed countries, both in terms of products and processes. In other words, due to the different weighting of factors, the production methods used in the manufacture of similar products are very often different.

We are therefore dealing with hindrances to endogenous efforts, 'defensive' strategies, small and medium size of firms in terms of international parameters and Transnational Corporation (TC) subsidiaries who do not 'localize' the generation of technological knowledge.

To these issues may be added **idiosyncratic dimensions that widen the gap between local and First World businesses**. For example, marked differences can be observed between the willingness of local and First World firms in terms of the claims they make to government agencies regarding the provision of infrastructure, services, and technical assistance, or in terms of familiarizing themselves with and getting involved in relevant public policy-making and implementation.

Among the causes of the relative apathy of the Latin American business community, a certain reluctance to make contact and enter into relationships with the scientific and technological environment seems to stand out, even where subjects closely linked to the firms' field of action is involved. This resistance may be due to either **fear or distrust toward** an unfamiliar field, or to a **lack of knowledge or an insufficient degree of awareness** of the opportunities offered by the road to technological improvement in terms of competitive edge, and the risks run by firms who refuse to walk this road consistently and systematically.

Weak links between the scientific/technical system and the socio-economic system are also due to S&T's evolutionary history in the region. Here most S&T institutions have been created in isolation from real development processes.

Thus "the application in our environment of certain indicators constructed on the basis of the experiences of countries with a longer tradition in S&T and R&D may distort the assessment of results, due to them not reflecting the social systems involved or the specificities of local science and technology production and, above all, not focusing on the central issue, namely, the relationship between both systems: the S&T system and the socio-economic system." (Brisolla & Quadros 2000)

These changes and the aforementioned characteristics suggest that our firms nowadays behave in ways which are very different from those that were usual a few years ago, but which may also be very different from international patterns (be they small or large, homegrown or foreign firms).

Therefore, there is a need to design specific tools and procedures that will make it possible to identify the specific regional characteristics of our firms and our scientific/technological systems, to allow the construction of indicators capable of interpreting these changes and differences. This means interpreting them in the light of our own past as well as the present of the major OECD countries, whose structure and performance the Oslo Manual is tailored to cater for.

This Manual is but the first step (and the first result) of a joint effort that has only recently been undertaken in our region. In this sense, it is nothing more (and nothing less) than a starting point. It constitutes a conceptual and methodological platform from which our region can initiate the detailed work of agreeing on and jointly searching for the most appropriate way of developing standardized instruments and procedures that describe the particular characteristics of regional innovation processes, as well as the obvious specificities these processes exhibit in each country, while at the same time favoring an accurate comparison with indicators built at international level.

2 CONCEPTUAL FRAMEWORK: SOME CONCEPTUAL AND METHODOLOGICAL ELEMENTS FOR ADAPTING THE OSLO MANUAL*

The approach taken here assumes that, if suitably addressed, the problem of innovation measurement in Latin America implies considering a wider range of subjects than is provided in the Oslo Manual, since it is important to include aspects such as “Technological Effort”, “Innovative Activity Management”, or “Technological Capability Accumulation” when analyzing innovation in the countries of the region. Thus, the ensuing reformulation of the problem can be seen in terms of the following key questions: What is to be measured through innovation surveys? How are these measurements to be used?

While the original Oslo Manual approach answers the first question on the basis of a narrow concept of innovation; the alternative approach sets out to capture the idiosyncratic aspects of innovative processes in the region and to cover all the business strategies determining firms’ technological efforts. This is related to the answer to the second question: while under the first approach, exercises are conducted mainly to generate internationally standardizable statistics on technological innovation, the second approach stresses the characterization of the technological conduct of firms in the region, with the object of obtaining criteria and data to guide public and private action in this field.

These are, therefore, not alternative but complementary approaches, where the latter can be seen as a deepening (or subsequent stage) of the former, or **as a contextual (conceptual and methodological) framework to be applied in Latin America so that the region’s specific requirements are met, while keeping the goals of international standardization firmly in our sights.**

Of course, the Oslo Manual provides the necessary framework for any development on this subject, not only because it incorporates extremely fruitful discussions and experiences gathered by the OECD both before and after the Frascati Manual, but also because its conceptual insights provide a suitable direction for its application in Developing Countries (DC). Also, it should be accepted that the need for unambiguous measurement and standardized cross-border criteria may to some extent justify certain oversimplifications designed to avoid both conceptual as instrumental problems posed by performing these exercises in our countries.

Nevertheless, applying the Oslo Manual to our region demands adaptive developments (following the path opened up by the conceptual bases laid down in this Manual) that enable certain limitations regarding its application to our region to be overcome. The most interesting conceptual problems (and at the same time, the most complex to measure) arise when considering the specific conditions for and impact of innovative activities in our region **by shifting the focus of analysis from innovation to technological effort or to innovative activity management.**

To this end, a discussion of the Oslo Manual is presented here. It aims to throw up new ideas that will contribute to the development of a regional Manual embracing not only the Oslo Manual’s concepts but Latin American specificities as well. The discussion is divided into

* A preliminary version of this chapter was drawn up by Ricardo Chica (Los Andes University, Colombia).

three parts: Approach, Definitions and Aspects of Measurement These divisions represent an analytical presentation of the Oslo Manual. Each part includes a summary annotated with methodological and conceptual remarks, as well as reflections and contributions to give an overview of the region's special characteristics.

2.1 APPROACH

2.1.1 The Oslo Manual's approach

The Oslo Manual's approach can be characterized by three key elements, namely, its conceptual framework, priority areas for investigation and innovation factors. The three sections are followed by a fourth section, which include contributions to and recommendations for the creation of a Latin American Manual.

2.1.1.1 The conceptual framework

One of the conceptual bases adopted by the Oslo Manual in addressing the problem of measurement is the **subject approach**, which implies the adoption of a clearly evolutionist perspective which follows **a firm's innovative process** and does not look at outstanding innovations in isolation from its development. Thus, this approach stresses the significance of technological variety and diversity and their transmission mechanisms, which have a bearing on where and how innovation at the level of the firm is carried out.

The other conceptual foundation on which the Oslo Manual is based is the **chain-link model**, which views innovation as interacting with the production process as a whole. In this approach, innovation is seen as an activity aimed at solving problems arising at various stages in the production chain. This activity is based on a permanent **feedback** between the links in the chain and the interaction between market opportunities and a firm's capabilities. As a problem-solving mechanism, innovation activities are found throughout the stages of the production process and technical change is thus completely embedded in the process.

2.1.1.2 Research areas

The Oslo Manual underlines the idea that "any general information or monitoring system will also need to be complemented by case studies requiring specific in-depth analysis". With this in mind, it defines six research priorities:

1. ***Corporate strategies:*** firms are questioned about their perception of how their markets are developing and the importance of strategic decisions in connection with product and market development. Every effort should be made to obtain data classified according to strategy type.
2. ***The role of technology diffusion:*** A difficulty generally encountered when analyzing technological change and productivity involves tracking the flow of innovation and technological change from one firm to another and thereby tracking any spillover which enhances productivity. How do firms adopt innovations developed elsewhere, and how important is diffusion in innovation? The aim is to distinguish between internal and external sources which make an innovative process possible, and to identify the destination of innovative activity results, so that inter-industrial flows can be outlined. A topic related to this distinction is the role played by inter-firm co-operation through R&D (Research and Development), licenses and patents, joint ventures, etc. For example, the

capacity for inventiveness rather than technology adoption, tends to be stressed, when the latter is vital for a firm's success.

3. ***Innovation information sources and obstacles*:** This item differs from the previous one in that the idea here is to understand the relationship between actors (firms and sources), rather than the mechanism through which a certain innovation is diffused. The aim here should be to relate the technological assets and strategies of a firm to its technical information sources and to any perceived obstacles. Most firms have a wide range of potential technical information sources. A distinction is to be drawn between exogenous sources (public research institutions as sources of technical information and information on inter-firm or inter-industry technology flow), and endogenous sources of technical change (importance of R&D departments and involvement at all levels of the firm).
4. ***Inputs to innovation:*** This involves attempting to integrate the contribution made by both R&D activities and not strictly R&D activities into the analysis, thus obtaining an overview of what kind of balance the firm strikes between both activities.
5. ***The role of public policy in industrial innovation:*** Links with R&D developed in universities and government laboratories, plus potential bearing of government regulations on firms' innovative behavior (education and skill development; tax policy and accounting regulations; industrial regulations, including environmental regulations, health standards, quality controls, standardization and so on; the legal system of intellectual property rights and subsequent problems of appropriability and the workings of patent and copyright systems; the workings of the capital market).
6. ***Innovation outputs:*** On the one hand, attributes and characteristics of the product as a whole; on the other, changes in product components that enhance its efficiency, including other services related to the product.

2.1.1.3. Innovation factors

The Oslo Manual considers four factors:

- Firms
- Science and technology institutions
- Topics relating to the transfer/absorption of technology, knowledge, and capability
- Conditions for innovation

Firms

The aim here is to define what makes a firm more or less innovative and how innovation within the firm is generated. Innovation relates both to an ability to recognize opportunities and make the most of them, and to find ways of combining factors efficiently according to the opportunities that present themselves. The technological capability of any given firm is founded not only on its labor force, qualified staff, researchers and engineers, but also on the characteristics of the firm itself: its labor force's structure and characteristics, financial structure, market and competitor strategies, alliances with other firms, links with universities and other institutions and, above all, its own internal organization.

When analyzing the way in which a firm takes its decisions, the Oslo Manual classifies the options available to a firm wishing to innovate:

i) ***The strategic option*** refers to the potential behavior of firms who take decisions with the characteristics of the markets they are serving or attempting to create in mind, as well as the kind of innovation they wish to implement regarding such markets.

ii) ***The R&D option*** is divided as follows: ***basic*** research aimed at increasing the firm's knowledge on key processes relating to production, and ***strategic*** research (research with industrial relevance but no specific application); ***applied*** research aimed at producing specific inventions or modifying existing techniques; and ***product concept development*** to judge whether products are viable. The latter includes prototype design, development and trials, as well as further research into design modification or technical functions.

iii) ***Non- R&D options***

- ❖ Identifying new product concepts and production technologies through:
  - Marketing and customer relationships
  - Identification of opportunities for commercialization resulting from its own or others' basic or strategic research
  - Design and engineering capabilities
  - Monitoring competitors
  - Using consultants
- ❖ Developing pilot projects and subsequent full-scale production facilities.
- ❖ Buying technical information, paying fees or royalties on patented inventions, or buying know-how and skills through engineering and design consultancy of various kinds.
- ❖ Incorporating human skills relevant to production can be developed (through internal training) or purchased (by hiring). Tacit and informal learning (*learning-by-doing*) may also be involved.
- ❖ Investment in equipment or intermediate inputs which embody innovative work of others. This may cover components, machines or entire plants.
- ❖ Reorganizing management systems, including the overall production system and its methods, including new types of inventory management, quality control and continuous quality improvement.

Science and Technology Institutions

These constitute the scientific and engineering base, namely, the knowledge accumulated and the S&T institutions which support innovation by providing, say, technological training and scientific knowledge.

The elements of the national ***scientific and engineering base*** include:

- ❖ The specialized **technical training** system.
- ❖ The university system.
- ❖ The support system for **basic research.** (Radical breakthroughs and long-term benefits aside, basic scientific research is sometimes perceived as offering little

direct benefit to business innovation. Nevertheless, its indirect benefits can be very substantial. Scientific investigation often requires the development of highly sophisticated, ultra-sensitive equipment. Thus, many areas of basic research provide fertile ground for the training of technology-minded scientists whose experience can often be used to find satisfactory solutions to industrial problems.)

- **Public good R&D activities:** funding programs and institutions generally catering for areas such as health, the environment and defense.
- **Strategic R&D activities:** institutions and funding programs oriented to 'pre-competitive R&D' or generic technologies.
- **Non-appropriable innovation support:** funding programs and institutions catering for research in areas where it is difficult for individual enterprises to appropriate sufficient benefit from their own in-house research.

Transfer and Technology Absorption

Studies on innovation point to a series of human, social and cultural factors that are of crucial importance to the effective functioning of innovation at the level of the firm. The key factor in a firm's innovation abilities is *learning* (a great deal of technological knowledge is not written down). This generally means the circulation of knowledge to a wide variety of important individuals within the firm.

Transfer factors (which have an impact on the effectiveness of the links, information flow, and learning absorption) include: formal and informal linkages between firms; presence of expert technological 'gatekeepers'; international links; the degree of scientists' and technology experts' mobility; ease of industry access to public R&D capabilities; spin off company formation; ethics, community value-systems, trust and openness; codified knowledge.

Conditions for innovation

The external field within which firms can maneuver and change, and surrounding innovation activities at firm level, includes the institutional, structural and infrastructural aspects of the National System of Innovation: the environment, institutional regulations, the network of relations between agents and institutions, the macroeconomic settings.

The starting point is a need to overcome the limitations of existing data: R&D data measure inputs, which are not necessarily related to production results, and statistical methods of national accounting, for their part, do not reflect the impact or even the existence of technical change.

2.1.2 Analyzing Technical Change: Contributions to and reflections on the Regional Manual's approach

The following sections "Business goals and innovation", and "Conceptions of technical change" discuss two questions which will strengthen the main argument posited in the regional approach to Latin America, namely, the need to move away from accenting a narrow notion of innovation in favor of a more comprehensive approach to firms' technological efforts.

Business Goals and Innovation

The departure point for any analysis of technical change should be a description of any agents involved (the individual who undertakes it) and the identification of their goals (why they undertakes change). Consequently, such analysis should start by considering the strategies firms deploy in their quest for competitive improvements, and the way their decision to innovate is coordinated with the other elements in such strategies. This involves the concepts of competitiveness, business strategy and the dynamic interaction of the critical strategic elements.

Competitiveness

The approach taken here differs from others which limit (or equate) the concept of competitiveness to productivity achievements (Krugman 1994). Firstly, even in terms of a competitiveness-price ratio, and quite apart from the bearing endogenous efforts can have on a firm's to enhance productivity, there are exogenous factors (over which a firm has little or no influence) which have decisive effects on achievement. Significant exogenous factors include the rate of exchange, the tax system, the availability and quality of infrastructure, the specific characteristics of markets in which a firm is operating, the availability and price of input, salary levels, and labor legislation.

On the other hand, given the new techno-organizational paradigm, "strategic competitiveness", based on quality, design, market knowledge and information, ability and flexibility to meet shifting specific demands, and customer service, is increasingly crucial. Obviously, this is even more important in the case of the differentiated products which form the more dynamic markets and have an increasingly larger share in international markets.

The importance of systemic factors is also enhanced in terms of enabling capacity, an aspect that seems to be an increasingly important source of both the competitiveness/price ration and strategic competitiveness.

Even though firm performance is shown in commercial flow, which enables quantification and verification of competitive strength (this is, the ability to penetrate markets and/or maintain positioning there), this is but an analytical *ex post facto* of technological and productive capabilities.

Capital accumulation processes, in a general sense, determine the evolution of such capabilities within firms and include not only physical capital but also the different forms of social (i.e. human, knowledge, and institutional-organizational) capital. For this reason, although the firm is the competing agent, its competitive position is crucially affected by several systemic and structural factors which are articulated in the National System of Innovation. This, therefore, becomes the context of the competitive effort of firms participating in it.

Business Strategy

This leads us to look at two theoretical/methodological elements, firstly the adoption of an **endogenous approach** to analyzing technical change (that is, an approach focused on business reactions within an evolutionary process which is determined by economic dynamics), and secondly, the fact that such an endogenous approach is focused on the way in which the decision to innovate is related to other strategic decisions taken by the firm in order to attain competitive improvements (as a condition for growth and long-term profitability).

This is an approach associated with Schumpeter and Kaldor, who followed Marx's idea that technological competition lies at the heart of the capitalist economics of accumulation. Against the static efficiency approach, Schumpeter posits the fact that the businessman innovates in pursuit of the monopolistic profit that motivates and perpetuates his innovative efforts. Kaldor, for his part, insists that technological change is indissolubly linked to capital accumulation. When all is said and done, both views point to the endogenous nature of technological change.

Complex Interactions and Investment

The decision to innovate, then, is bound up with other decisions in a firm by its drive to strengthen competitiveness, which is a key factor in achieving the business goals of long term growth and profitability. In this way, competitive positioning is determined by a set of strategic moves affecting both cost structure and product characteristics, as well as other elements linked to what we have been calling "strategic competitiveness".

These moves are aimed at accumulating different kinds of capital and competitive capabilities. This makes the decision to undertake such moves (or not) an investment decision. Hence, any decisions to innovate will be affected by the particular conditions under which the investment is made, mainly, by factors such as expected demand and profitability, technology and financial conditions.

In the context of business strategy, innovative activity appears to be one link in a causal chain characterized by positive feedback or increasing dynamic returns. In such a chain, innovation is bound up with investment in capability accumulation, insofar as efforts are made to improve competitive positioning, be it via (competitiveness/price) productivity or flexibilization (strategic competitiveness) and thus achieve the business goals of profitability and growth. Innovation thus forms part of a dynamic process of cumulative causation (or *positive feedback*) which runs from investment to profitability, through competitiveness (via productivity or flexibility), and then from profitability back to further investment.

Conceptions of Technical Change

In this section, we will discuss the problem of technical change from three points of view: firstly Schumpeter and Kaldor's, secondly the neo-classical view, and lastly the evolutionist view of technical change.

Two key ideas are stressed. On one hand, although the neo-classical view has made significant progress in recognizing that 'market failures' impose conditions upon technical change (Krugman 1990), the limitations of such an approach are revealed by the evolutionist view in challenging the neo-classical conception of firm/technology relationships. On the other hand, as has just been pointed out, an appropriate categorization should also conceive of technical change (as Scumpeter and Kaldor do) as a mechanism in the competitive strategy of a firm in search of monopolistic profits.

Schumpeter and Kaldor.

Schumpeter's contribution to this discussion has been of such importance that the categorizations he formulated have determined both the content and form of subsequent analysis, in spite of the limitations and ambiguities of his marginalist conception and narrow focus on radical technical change, which neglect the importance of incremental change.

Schumpeter introduces a distinction between ***inventiveness*** (the generation of a new piece of knowledge), ***innovation*** (the translation of R&D into a new product/process that reaches the market) and ***diffusion*** (the imitation of innovation through its adoption by a relatively large number of competitors). He also pinpoints five forms of innovation: product, process, new raw material, new markets and industrial (non-firm) reorganization.

Another major theme of Schumpeter's is the prioritization of *technological push* over *demand pull*. This is, of course, a consequence of his emphasis on radical technical change and subsequent creative destruction, which lies at the heart of his conception of capitalist development. Thus, although these categories have laid the foundations for further analysis, they have also raised obstacles to the discussion of these questions in connection with developing countries where incremental, adaptive, and diffusive technical change is dominant. It is nowadays widely accepted that the accumulation of minor changes and innovations can have a strong impact on products or processes (incremental technical change in developing countries plays as important a role as radical change).

Kaldor's contribution is two-fold: his emphasis on the overlapping of capital accumulation and technical change questions the neo-classical conception that such change is exogenous, as shown by the residual methodology, and secondly, his notion that business technological dynamism determines the way in which the growth of capital intensity translates into productivity gains.

Like Schumpeter, Kaldor ignores the importance of organizational change as a source of productivity gain. This, then, is the price to be paid for his criticism of residue methodology, since (as has been stressed in the literature of the so-called *Asian Productivity Movement*) residue has the advantage of underscoring the importance of factors which cannot be attributed to the accumulation of production factors (as is the case with organizational change). It is therefore interesting to contrast the accounts of the Asiatic miracle in this literature (which stresses the importance of soft technical change in productivity gain) and those given by Jorgenson and his followers (such as Young) who, like Kaldor, emphasize the importance of capital accumulation.

The Neo-Classical View: Increasing Returns and Market Failure

The traditional view of homogeneous firms choosing technology from a continuum equally available to all disregards the essential characteristics both of firms (as organizations of collective learning rather than passive buyers) and technology (with its specific, tacit organizational components). Nevertheless, it does have something to say in terms of the following:

i) Analysis of Inventiveness/Innovation/Diffusion:

Inventiveness/Innovation Analyses focus either on input (R&D) or output (patents). In terms of R&D, uncertainty as to its benefits is highlighted, both for costs (due to technological opportunity, efficiency, and speed) and profits (likelihood of imitation). Analyses are conducted at the level of firm or industry, starting from the way in which process innovation brings about a downturn in the cost curve and product innovation brings about an outturn in the demand curve. As for their impact on measurement, these methodologies indicate that innovation deadlines and cuts in production costs are key factors in measuring the impact of R&D on welfare (Stoneman).

ii) *The Schumpeterian Hypothesis*.

The basic result of an empirical analysis of the Schumpeterian Hypothesis is that R&D is indeed dominated by large corporations and concentrated in a handful of industries. Nevertheless, there is agreement throughout the relevant literature (Davies) that statistical studies should be standardized according to inter-sectorial differences, not only in terms of technological opportunity (a key factor) but also of the relationships between R&D, firm size and market structure, which reveal significant differences according to the industries the come under. Despite results such as Arrow's classic work, or Scherer's observation that higher innovative or diffusion speed exists in non-concentrated industries, there is consensus on competition encouraging R&D only to a limited extent beyond which fear of losing out to rival action hampers the innovative initiative. This is consistent with Kamient & Swartz and Dasgupta & Stiglitz's findings which point to the negative effect of excessive competition on innovative activities.

iii) *Market Failures*.

The well-known contribution made by traditional Neo-Classical Theory lies in describing the way in which factors such as time and uncertainty (not just economic but regarding markets or rivals and above all technology), lumpiness and non-appropriability, determine market failures vis-à-vis technology.

On the dynamic side of market failures, processes that may not be seen as optimum from the short-sightedness eagerness for short-term benefits may indeed be viewed as such from the point of view of the learning process. In other words, ***diffuse advantages*** may go unnoticed in the short-term but materialize in using existing learning potential.

Recognizing market failures has important conceptual implications, since the market price signals and private profitability estimates made by agents on the basis of these, may not be suited to grasping the potential impact of technological innovation. This has far-reaching consequences for the methodological aspects of innovation activity measurement, since the market price may be an inappropriate yardstick for measuring the contribution of innovation activities, which would be exclusively valued on a short-term basis which would not reflect the dynamic opportunities opened up by technological innovation.

iv) *Technological Change and Growth*

The first aspect that should be stressed in connection with the Neo-Classical Theory of Growth is its conception of technical change as an exogenous phenomenon, despite Kaldor's criticism, Solow's annexation of technical progress into vintage models and Arrow's *learning by doing*. In this way, the methodology for measuring technical change by drawing distinctions between displacements *of* the production function and displacements *on* the production function became popular.

The fact that this exogenous view has been superseded has given rise to the discussion of the problem of the vehicle for technical change. Different versions of the theory of endogenous growth (such as Grossman and Helpman's) shift the emphasis from the creation of fixed capital to that of human and knowledge capital. This is more consistent with current approaches which stress the role played by organizational factors and learning while growing. Grossman and Helpman both see technical change as the driving force behind investment. For them part of the growth attributed to capital accumulation in fact derives from innovation. As a result of their position, they believe that physical capital accumulation comes about in response to knowledge accumulation.

The Evolutionist View of Technical Change (EVTC)

This viewpoint takes a step in the right direction by recognizing that the conditions for the development of technical change are determined by uncertainty and the existence of externalities and increasing dynamic returns (path-dependency with positive feedback). Market failures therefore demand (and justify) institutional compensation.

The next step (which Schumpeter was unable to take owing to his adherence to the marginalist framework) arises from the evolutionist view of the firm/technology relationship, which breaks with the framework of competitive equilibrium and questions the notion that such conditions for technical change would be departures from this balance. Evolutionists focus analysis on such departures especially where learning and capability building processes are concerned.

EVTC salvages two elements from the Schumpeterian tradition. First is the technology/firm unity arising from the fact that technological knowledge is considered idiosyncratic, often tacit, costly and slow to acquire. Its acquisition moreover depends on previously acquired capabilities. This is in keeping with a view of firms as collective learning organizations.

Second is the idea of a central economic agent, which points both to the leading role of the businessman and the network of relationships in which the interactive learning process takes place. Unlike the traditional neo-classical view, this conception does not consider technological knowledge as generally applicable information that is easily reproduced, available through a pool of recipes (or shelves of '*blueprint*'). Instead, firms employ differentiated technologies influenced by internal innovation processes, which cumulatively construct the history of firms on their own technological base. Technology does not come free as it requires specific knowledge that the firm has accumulated through learning processes determined by that knowledge (Dosi 1988). Firms have tacit skills inasmuch as they know how to produce, and not all of them will act identically in gaining access to the same information. The innovative process is uncertain (rather than a mere lack of information), though the degrees of appropriability and levels of opportunity may vary (indeed they do) throughout sectors.

The evolutionist view has important **implications**, most notably: i) heterogeneity; ii) the specificity of the capabilities required; and iii) the extension of the innovative agent to the institutional network.

i) *Heterogeneity* among sectors is basic in the technology/industrial structure relationship. It is difficult to analyze overall technical change because technological opportunity is not the same for all sectors, there being different demand patterns implying differences in innovation factors.

Pavitt suggests classifying sectors along the lines of the different levels of technological opportunity, the degree of appropriability and the different kinds of demand dynamics. The first group would be 'science-based' (with good opportunities for new paradigms, appropriation mechanisms, product innovation through formal R&D). The second would be 'scale-intensive' (process and product innovation, vertical integration into complex systems, high appropriation and large size). The third would be 'specialized suppliers' (product innovation, knowledge, appropriation through specialized knowledge), and lastly, 'supplier-dominated' (process innovation via differentiated knowledge and inputs as well as incremental innovation, low appropriability and small size).

ii) The *specificity* of capabilities is a consequence of a combination of the heterogeneity of innovative processes with the tacit, specific and idiosyncratic nature of knowledge. This specificity is revealed by the fact that EVTC considers the firm as a collective learning organization, which marks its special nature. The complete task of generating capabilities in order to assimilate technology is stressed by this view (especially by Lall) in its analysis of competitive capabilities and in the dichotomy (introduced by Dosi) between knowledge and information, where knowledge is understood as the whole set of procedures, know how, capabilities, and so on, which are accumulated by firms, and not just the mere availability of technological information.

iii) The innovative agent should not be analyzed solely in connection with firm structure, but also through *interrelationships* between firms, and between them and other organizations and institutions within the National System of Innovation (NSI). Advanced by evolutionists, this concept is crucial in analyzing and measuring technical change since it stresses the central role played by interactions among agents in fostering learning by facilitating knowledge flow.

In this regard, the notion of NSI, together with the roles played by the business sector and government agencies, underscores the role of the education and training sectors as well as of organizations providing technological services (and economic and organizational consultancy) and the financial system. It thus involves the whole spectrum of organizational and institutional capabilities bearing on an economy's technological dynamics.

Networking, or the fabric of interactions between NSI components, is as an essential ingredient in development, both in the system as a whole and in each of its elements, which is in keeping with the crucial importance assigned to knowledge and organizational learning in the new techno-economic paradigm. In effect, the dynamization of the knowledge/information flow depends on the communication between the system's components, while the strengthening of inter-institutional links is fuelled by co-operation between them.

Finally, the development of the concept of a National System of Innovation reflects the replacement of the lineal view of supply push by that of dynamic interaction in problem-solving (a shift from basic research to innovation and R&D being integrated into the remaining elements of the value chain). This new concept places the business sector at the center of this interaction and *networking*, in the latter's attempt to strengthen its competitive positioning.

2.2 DEFINITIONS

2.2.1 The Oslo Manual definitions

In this section we set out the Oslo Manual's definitions of what it considers Technological Product and Process Innovation, Innovation Activities and the Innovative Firm.

2.2.1.1 Technological Product and Process (TPP) Innovations

This concept refers to the technological implementation of new products and processes or their significant improvement, either as a result of the diffusion of technological knowledge or R&D investment generating novelties at firm level. According to the Oslo Manual, technological innovation of products and processes covers methods which change a firm's actions, with the exception of any methods under the heading of Organizational Innovation, comprising the introduction of changes in organizational structure, implementation of advanced managerial techniques and implementation of changes (either new or substantial) in the firm's corporate stance. It should also be distinguished from other variations in production and/or processes, such as insignificant or non-original changes in the firm. These variations include abandoning a specific process in the production or marketing of a product, simple capital replacement, changes resulting exclusively from the modification of factor prices, product differentiation, or those arising from cyclic changes.

Product innovation can be looked in two ways. Firstly, as a technologically new product, in other words, a product with significantly different technological characteristics from previous ones. Such a product may be the result of the implementation of radically new technologies, or of the combination of existing technologies and new uses, or indeed it may also originate in new knowledge. Secondly, as a technologically improved product. Improvements can be made by using parts or materials that perform better or, in the case of a complex product consisting of a number of integrated technical sub-systems by partial changes to one of these sub-systems.

Process innovation is the adoption of new or improved technological production methods including product delivery methods. It may comprise changes in equipment, production organization or a combination of the two. It may also be the result of the application of new knowledge. These technological methods may be implemented either to produce or deliver technologically improved products, something which would not be possible with conventional production methods, or to improve the production or delivery of existing products.

Technological innovations of products and processes can be new at world or firm level, or in the context of the market where the firm operates or a given geographical area. For the Oslo Manual, measurement should, at least, seek to cover "novelties at firm level"

2.2.1.2 TPP Innovation Activities

Innovation activities include all the scientific, technological, organizational, financial and commercial decisions and developments performed in a firm, including investment in new knowledge, which are intended to, or in practice do, lead to the implementation of technologically new or improved products or processes. It is true that not all innovation activities bring about real innovations, but all real innovations should certainly be considered as a result of the firm's overall innovative activity.

Acquisition and generation of new knowledge relevant to the firm:

- *Research and experimental development*: This includes creative work undertaken systematically in order to increase a stock of knowledge. Generally, the most significant experimental stage is constructing and testing a prototype; that is, an original model including all the technical characteristics and performance of a new product or process.
- *Acquisition of disembodied* technology *and know-how*. This includes the acquisition of external technology in the form of patents, non-patented inventions, licenses, disclosures of know-how, trademarks, designs, patterns and computer and other scientific and technical services related to the implementation of TPP innovations, as well as the acquisition of packaged software not listed elsewhere.
- *Acquisition of embodied technology*: Acquisition of machinery and equipment with improved technological performance (including integrated software) connected to technological product or process innovations implemented by the firm.

Other preparations for production:

- *Tooling up and industrial engineering: C*hanges introduced in the production, quality control procedures, methods, standards and associated software required to produce the technologically new or improved product or use the technologically new or improved process.
- *Industrial design n.e.c.:* Plans and graphs aimed at defining procedures, technical specifications and any operational features necessary for the production of technologically new products and the implementation of new processes.
- *Other capital acquisitions*: Acquisition of any buildings or machinery, tools and equipment (with no improvement in technological performance) required for the implementation of technologically new or improved products or processes, *for example, an additional molding or packaging machine to produce and deliver a technologically improved CD-ROM player*.
- *Production start-up:* This may include product or process modifications, retraining staff in new techniques or in the use of new machinery, or any trial production not already included in R&D.

Marketing for new or improved products

Activities related to the launch of technologically new or improved products. These may include preliminary market research, market testing and launch advertising, but will exclude the building of distribution networks to market innovations.

2.2.1.3 The Innovative Firm

Following the Oslo Manual, this concept is applied to firms that have succeeded in turning innovative activities into effective innovations. Indeed, firms who by the end of the period under examination have implemented innovative activities which are still underway or were finally aborted, are not considered innovative.

2.2.2 Contributions to and reflections on the definitions to be adopted by the Latin American Manual. Technical change in developing countries and innovative activities.

Some of the conceptual and methodological problems we have pointed out regarding the traditional view of technical change become even more significant in analyzing these processes in developing countries due to the specificities they exhibit.

Here, it is necessary to stress the importance that prior accumulation of local capabilities has for the process of knowledge absorption, as well as the impact of characteristics like opportunities for diffusion, adaptation, and incrementation, which are closely linked to these problems.

By addressing these topics we will be able to justify methodological options which, although coinciding with advances in the Oslo Manual such as the subject approach and the chain-link model[3], nevertheless endeavor to overcome certain limitations in the Oslo Manual over tackling the particular characteristics of innovation activities in developing countries.

2.2.2.1 Local capabilities and absorption

Both the evolutionist view and the empirical analysis of technical change in developing countries (particularly, the works of Katz, Teitel, Lall and Pack, among others) have stressed the fact that the ability to absorb technological knowledge is severely restricted by prior accumulation of local capabilities. This explains the differences between the process of technological accumulation in developing countries and the process of mere assimilation and selection of technologies described by the neo-classical view, which, no doubt, has far-reaching implications for the way in which technological input should be measured.

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[3] As has been seen previously, these approaches are in opposition to object, lineal and supply push approaches, all of which lead to a 'black box' view between research as input and successful innovation as output.

Katz too refers to the dichotomy between sectors producing standard commodities and those producing limited quantities of differentiated products. He does this to account for the different ways the various sectors effect technical change, both in terms of capability accumulation and technological knowledge absorption, adjustment, and adaptation to the corresponding markets. This author has recently gone back to the question by stressing the different technological capabilities of different sectors in the current transformation of techno-organizational paradigms driven by commercial openness and economic globalization.

2.2.2.2. Innovative activity in the Developing Countries

The definition of innovation adopted by the Oslo Manual limits this category's application to the development of new products and the implementation of new processes. However, for the analysis of technical change in developing countries, this criterion, as well as being excessively narrow, neglects precisely what these countries are most interested in, namely, the analysis of activities and efforts undertaken by firms with a view to improving their technological pedigree. This suggests a need to introduce the concept of **Innovating Activity Management (IAM),** which takes in not only innovation in a narrow (Oslo Manual) sense, but the set of activities constituting so-called "Technological Effort" too, including what the Oslo Manual calls "Innovation Activities".

The premises from which the Proposed Concept of Innovating Activity Management is derived are as follows:

1) The replacement of the linear model with a *'feedback'* complex, where the intermediate elements gain in importance over R&D.
2) The significance of monitoring, assessment, adoption, technology adaptation by productive units (insofar as they determine the pace and form of technological diffusion and transfer into the productive structure), as well as that of technological capability requirements to develop these activities (requirements that together with those activities determine the absorption capability of this structure).
3) The particular features that these processes take on in developing countries, which define the diffusive, adaptive and incremental nature of technical change there.
4) The nature of investment and the conditioning or determining status that the generation of such capabilities has, in terms of both innovative activity and the pursuit of higher productivity and efficiency.
5) The importance of reconversion mechanisms such as organizational modernization and investment aimed at incorporating technical change, insofar as they are aspects of innovative activity and the accumulation of capabilities required to perform this activity. Also, the dual nature of reconversion mechanisms, both as vehicles for technical change and determining factors in increasing productivity and efficiency.
6) The subsequent pivotal character that investment designed to incorporate technical change has for innovative activity, as well as the importance of investment conditions as conditions for innovative activity.

Thus, new concepts, or new applications of existing concepts emerge. Definitions are given below:

A) Innovation

- *a) TPP innovation*

Technological product and process (TPP) innovations include technologically new products and processes, as well as significant technological improvements in products and processes. A technological innovation in products and processes is considered to have been implemented if it has been introduced into the marketplace (product innovation) or has been used in a production process (process innovation).

A **technologically new product** is a product whose technological characteristics or intended uses differ significantly from those of previously produced products. Such innovations may involve radically new technologies, be based on combining existing technologies in new contexts, or be derived from the use of new knowledge. **A technologically improved product is an existing product** whose **performance** has been significantly enhanced or upgraded. A simple product may be improved (in terms of performance or cost) by upgrading its components or materials, or a complex product consisting of a number of integrated technical sub-systems may be improved by partial changes to one of the sub-systems.

Technological process innovation is the adoption of technologically new or significantly improved production methods, including product delivery methods. These methods may involve changes in equipment or the organization of production or a combination of both, or even derive from the use of new knowledge. The methods may be intended to produce or deliver technologically new or improved products that cannot be produced or delivered with conventional production methods, or even to enhance basic production or delivery efficiency of existing products.

- *b) Organizational innovation*

Changes in the way the firm is organized and managed; changes in the organization and management of the production process; incorporation of significantly modified organizational structures and implementation of new or substantially modified strategic corporate orientations.

- *c) Marketing innovation*

Marketing of new products. New methods of product delivery. Changes in packaging.

- ***B) Innovation activities***

Under this heading comes any action taken by a firm which aims to implement any concepts, ideas and methods necessary for acquiring, assimilating and incorporating new knowledge. Such action brings about a technical change in the firm, though this change may not necessarily be a strict technological innovation reflected in the firm's performance.

- *1) Research and Development*

This comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge: knowledge of man, culture and society, and the use of the knowledge stock to devise new applications. It may also include the development of prototypes and pilot plants. An R&D project may involve basic, strategic or applied research, or experimental development.

- *2) Innovation efforts*

  Design, embodied and disembodied technology, marketing and training. It includes the accumulation of physical capital as well as other forms of capital like human (including managerial) capital and knowledge (including informational) capital.

  - *a) Design, installation of new machinery, industrial engineering, and production start-up*

    Plans and diagrams aimed at defining procedures, technical specifications and operational features required for the introduction of innovations. Acquisition of buildings or machinery, tools, and equipment (with no improvement in technological performance) needed to implement innovations. Production start-up may include modifying a product or a process, training staff to employ new techniques or using new machines, as well as any pilot production not included in R&D.

  - *b) Acquisition of embodied technology*

    Acquisition of machinery and equipment with improved technological performance (including integrated software) linked to the innovations implemented by the firm.

  - *c) Acquisition of disembodied technology*

    Patents, non-patented inventions, licenses, disclosures of know-how, trademarks, designs, patterns and computer and other scientific and technical services related to the implementation of TPP innovations, as well as the acquisition of packaged software not listed elsewhere.

  - *d) Organizational modernization*

    Efforts aimed at introducing changes into the organization of the production process designed to cut back dead time, waste, process time and the like, all this with an existing production line. This means modifying the production line layout (using the same existing machinery and equipment), improving plant's physical distribution, outsourcing, Just-in-Time methods, and quality circles, among other.

  - *e) Marketing*

    Activities related to launching a technologically new or improved products, including preliminary market research and launch advertising.

This also includes activities designed to enhance opportunities for penetrating specific market segments through changes in product presentation or delivery methods.

- *f) Training*

  Training on topics closely related to the main technologies used in the firm's production process. These technologies may be soft (management and administration) or hard (technology of production processes). They are highly complex (though this is not evident), and demand a highly specialized training staff.

2.3 MEASUREMENT CONCERNS

The Oslo Manual discusses two elements on this topic: 1) the measurement reference framework, including goals, sources, and obstacles; and 2) innovation indicators, placing emphasis on impact indicators. After presenting both these elements, some contributions to and reflections on the creation of a Latin American Manual are discussed.

2.3.1 Measurement reference framework:

2.3.1.1 Aims

1) Technological:

- To develop new products and markets
- To imitate innovative leading producers
- To adapt existing technologies to the needs of the firm
- To create incremental developments in existing techniques
- To modify the production methods of existing products

2) Economic:

On the one side, product innovations including:

- Replacing products being phased out
- Extending product range, both inside the main product field and out
- Developing environmentally friendly products
- Maintaining or increasing market share and open up new markets (widening coverage or choosing new domestic targets)

On the other side, process innovations including:

- Improving production flexibility
- Lowering production costs by reducing unit labor costs, cutting excessive material and energy consumption, reducing product design costs and production lead time
- Improving product quality
- Improving working conditions

- ❖ Reducing environmental damage

<u>2.3.1.2 Information Sources</u>

1) Internal:

In-house R&D, marketing, monitoring of technological development, labor-force and production description.

2) External:

External sources are divided into **market or commercial** sources (competitors, acquisition of embodied technology, acquisition of disembodied technology, suppliers of equipment, materials, components and software); **educational or research institutions** (higher education institutions, governmental research institutes, private research institutes); **generally available information** (patent disclosures, professional conferences, meetings and journals, fairs and exhibitions).

<u>2.3.1.3 Factors affecting innovation activities:</u>

1) Economic: excessive perceived risks; cost too high; lack of appropriate sources of finance; pay-off period of innovation too long.
2) Business: insufficient innovation potential (R&D, design, etc.); shortage of skilled staff; lack of information on technology; lack of information on markets; innovation expenditure hard to control; resistance to change in the firm; deficiencies in the availability of external services; lack of opportunities for co-operation.
3) Other reasons: lack of technological opportunity; lack of infrastructure; no need to innovate due to earlier innovations; weakness of property rights; legislation, norms, regulations, standards, taxation; customers unresponsive to new products and processes.

2.3.2 Innovation indicators

Three types of indicators are considered: a) impact indicators; b) diffusion indicators and c) cost and expense indicators.

<u>2.3.2.1 Impact indicators</u>

In order to value and measure the impact of a given kind of innovation on the performance of the firm, various indicators can be used:

- ❖ Proportion of sales and exports created by technologies for new products introduced onto the market during the last three years (percentage weighted by firms' sales), including technologically new products sold during the last three years; technologically improved products sold during the last three years; and technologically unchanged products, or those subject only to product differentiation, that have been produced with updated production methods during the last three years;

- ❖ Results of innovative effort: firms have to assess the success of the technological effort regarding their sales performance (domestic or foreign), profits, access to new markets, share in traditional markets. Assessment is carried out with reference to two periods, those corresponding to the first and the last portion of the three years assessed (over the t and t-2 periods).
- ❖ Use of productive factors: This indicator measures the way in which the technological innovation of products and processes has led to changes in the production function through the use of the factors (use of manpower, material consumption, energy consumption and utilization of fixed capital).

2.3.2.2 Diffusion indicators

In order to map innovation activities and thereby obtain a picture of the links involved, as well as the diffusion level of advanced technologies, the following topics are suggested:

User sectors

It is theoretically possible to classify innovations according to three criteria. This is based on the level we wish to assess diffusion from: the sector corresponding to the producer's principal economic activity; the technological group to which the innovation belongs; or the probable sector of use.

Survey of the use of advanced technologies in manufacturing processes

Several countries have conducted surveys on the use of certain new technologies in manufacturing processes, and in one case, in the service sector as well. Such surveys cover an important dimension of diffusion, namely, to what extent innovations in the form of new embodied technology are used in production. Many OECD members have also conducted specialized surveys in connection to the manufacturing sector and focused their inquiry on applications of microelectronics.

Surveys on manufacturing technology used to ask for information on the current use, future use or lack of use of certain technologies. This experience proved that these surveys are easy to analyze and internationally comparable. It is also possible to design analogous surveys for certain branches of industry.

The problem lies in creating a list of advanced technologies, recognized as such by the branch of industry in question, but not so advanced as to be inapplicable. The technologies included should have enough volume of use to generate statistics on current and future use within a branch of industry which provide useful information for policy-makers. The list should focus on certain well-defined specific technologies. Broad categories such as biotechnology or information technology for example, are not likely to be helpful.

Negotiations on international comparison systems are a further source of trouble. There are three elements here: the list of technologies; general agreement on the industrial classifications used, or the use of an internationally accepted industrial classification; and the application of coverage criteria.

Current and future use of technologies may be linked to other subjects related to innovation. Inquiries into whether technological innovation has been used to increase productivity or facilitate use provide information on a plant's tendency to innovate in.

Managerial practice innovation is linked to the use of technology. A manufacturing firm serving a customer and willing to offer just-in-time (JIT) delivery, may wish to improve its quality control or total quality system to reduce the rejection rate of the parts it produces. As part of its effort to enhance quality, it may adopt the statistical process control (SPC) system, and consequently use automatic sensors in the production process. The client firm may, in turn, use an automated control and data acquisition system such as SCADA (Supervisory Control and Data Acquisition), and both firms may be hooked up to each other by a computer network.

Through the surveys it is also possible to inquire about hindrances to innovation, since questions may be asked about the availability of highly qualified or trained staff, or the funds to be devoted to technology acquisition or employee training.

It is believed that surveys on technology use are a relatively direct method of obtaining information about any innovation diffusion relevant to policy-making. Although it is possible to include such surveys in broader surveys on innovation, they are also useful as an independent source of information on industry and commercial policies. They are, moreover, reproducible and internationally comparable.

The conduct of surveys on technology use should be encouraged, and where appropriate, such surveys should be incorporated into the broader context of surveys on innovation.

2.3.2.3 Expenditure indicators

The approach adopted here is the *subject approach*, which means including innovation activity expenditure during any given year: rather than excluding expenditure on aborted or ongoing projects, and including expenditure corresponding to prior periods, expenditure on technological innovation of products and processes for the current year is included, whether this is implemented, potential or aborted. This approach suggests four classifications:

1) *Bottom-up or top-down method:* according to whether interest is focused on amount of expenditure per kind of innovation activity, or on the sum total of innovation expenditure.

2) *Breakdown by type of expenditure***:** including those listed as current and capital expenditure. Current innovation expenditure includes labor costs and other current costs, while capital expenditure includes expenditure on land and buildings, instruments and equipment, and computer software purchased or used in TPP activities. The concept of intangible investment should be included in expenditure on innovation. This concept refers to current spending aimed at developing the firm and expected to yield returns over a period longer than the year during which expenditure has been incurred. Intangibles include non-routine marketing, training, software and other similar items, in addition to current expenditure on R&D. Investment on intangibles comprises elements that are not included in current investment on technological innovation. For example, only training in connection to the introduction of technologically new products and processes is listed as TPP innovation expenditure, while expenditure on training in general is considered to be investment in intangibles. Expenditure corresponding to TPP innovation also includes tangible investment, such as capital expenditure on R&D, acquisition of new machinery and equipment related to TPP innovations. Investment in intangibles is closely linked to

the concept of innovative activity since it refers to current spending on preparing a firm's structure for technical change in various respects.

3) *Breakdown by type of innovation activity:* included here are R&D expenditure; expenditure for the acquisition of disembodied technology and know-how; expenditure for the acquisition of embodied technology; expenditure for tooling up, industrial engineering, industrial design and production start-up, as well as other expenditure for pilot plants and prototypes not already included in R&D; expenditure for training linked to TPP innovation activities; and marketing for technologically new or improved products.

4) *Breakdown by source of funds:* It is important to know the origin of the funding of innovation expenditure in order to assess, for example, the role played by public policy and internationalization in the innovation process. The following classification by source of funds is suggested:

List of funding sources:

- Own funds
- Funds from subsidiary or associated firms
- Funds from other business enterprises
- Public funds (loans, subsidies, etc.)
- Funds from supranational or international organizations (European Community, etc.)
- Other sources.

For a number of questions relating to policy and research, it is sufficient to collect information on the use (or lack of use) of each source of funding, rather than request an estimate which will most likely be inaccurate. Thus, the questionnaire load on firms will be lessened and the answer rate increased. Lack of response will also be avoided.

To evaluate the role of government procurement in innovation, it is useful to know whether or not a firm participates in (regional, national or international) government procurement related to innovative products and processes. This may provide a useful substitute for a detailed breakdown as per funding source.

2.3.3 Contributions to and reflections on the creation of a Latin American Manual: conditions and impact.

The attempt to relate the analysis of innovative activity in developing countries to reconversion efforts undertaken by firms in order to meet the new conditions generated by globalization and economic openness has three basic consequences for methodology:

1. The necessary inclusion of organizational aspects in innovation analysis, since organizational modernization seems to be a crucial mechanism in reconversion.
2. The need to consider the decision to innovate as an investment decision: investment conditions are decisive for the accumulation of the capabilities required by reconversion efforts, in which context innovation takes place.
3. The importance of accounting for the impact of innovative activities in terms of the goals of firms, such as productivity or competitiveness increases.

In terms of conditions, emphasis is laid on the need to take into account both the heterogeneity of business strategies (including innovative activity) and the pivotal role played by investment in such strategies while, in terms of impact, it is laid on the importance of including the aspects linked to productivity increase and strengthening competitive position in output analysis.

2.3.3.1. Investment conditions and Industrial structure

Bearing in mind that innovative activity is an integral part of business strategy and that investment decisions play a pivotal role in this strategy, it follows that **investment conditions have a strong bearing on the decision to innovate.** The macroeconomic scene faced by firms is crucial, since the entrepreneur faced by adverse demand and profitability conditions will not invest. Rates of exchange and interest rates, such as have been recorded in our region during recent years, may make any discussion on innovative activity futile as investment conditions can kill off innovation at birth.

As for reconversion efforts designed to achieve a competitive edge, two processes stand out: **organizational modernization and investment aimed at incorporating technical change.** The complementary nature of these two mechanisms should be noted. Organizational modernization can be seen as a early stage of reconversion, focusing on mechanisms such as labor rationalization and management reorganization, in every department from production to marketing. These forms of disembodied technical progress are necessary and open up significant short-term possibilities, particularly as regards productivity growth (as they mean reductions in input flow per product unit). They are also relatively autonomous compared to embodied technical progress, since their most common manifestations (such as "just in time" and "total quality management") can be implemented through various hard technologies.

However, as a long-term reconversion mechanism organizational modernization has its limitations. In fact, both the culmination of the above processes and the maintenance of the competitive positioning achieved by them require investment aim at incorporating technical change. On the one hand, market-generated product and process requirements, as well as new technology supply, make it necessary to invest in systems, machinery and equipment incorporating those developments. On the other hand, the dynamic interaction of market requirements and innovation generation subjects firms to incessant readjustment, on pain of being excluded from the competitive process.

The differential response as per types of actors/firms is a result of the various different (generally) economic and (specifically) technological conditions faced by firms and sectors: reconversion emerges as a response to economic openness, which varies according to firms due to both differences in accumulated capabilities and to the various ways they are affected by modifications to the incentive structure.

2.3.3.2. The impact of innovative activity

From the point of view of business strategies, innovative activity is viewed as being aimed at gaining a competitive edge through, say, the reduction of costs via productivity increases. Any measurement of innovative activity output in the region' countries should include an assessment of this activity's impact on the central variable of business strategy, namely, competitiveness.

Similarly, as has been discussed in section 1.1, many factors affect competitiveness apart from productivity increase, a problem further complicated by the fact that, as a consequence of the multidimensional nature of this concept, diverse indexes are used to express the various dimensions; shifts in these indexes are not biunivocally related, due to the complexity of the factors involved.

This brings with it implications for the measurement of innovation and its impact in that, although the measurement of technical change on the input side has severe limitations, the output side also poses difficulties: if productivity growth is chosen, an indicator will be affected by factors such as those of the "X efficiency" and organizational modernization type, while if competitiveness is chosen, the indicator will, along with productivity, instead be affected by factors such as flexibility (in terms of the strategic dimension) and infrastructure (in terms of the systemic dimension).

2.3.3.3. Troubleshooting

The first issue is whether to measure input or output. In either case, the following three points should be taken into account:

1. Both options pose difficulties for conducting research.
2. These difficulties tend to be more serious in Developing Countries.
3. It is difficult to establish a relation between them.

On the first point, the most common (R&D) input measure has its limitations for measuring innovative activity. Indeed, since the Frascati Manual, the bias introduced by this measurement against other highly important enterprises in the innovative activity carried out by firms has been criticized. Measurements on the output side are confronted with the problem of inventiveness or innovation, as well as the questionable measurement of inventiveness through patents, a measurement in which, as the relevant literature stresses, not all patents correspond to major inventions nor are all major inventions patented. This means that there are sectors in which major innovations are not patented and the counting of patents does not discriminate against secondary innovations.

The second point refers to the fact that when analyzing diffusive, adaptive and incremental technical change, expenditure on R&D is an even more limited measurement and the relationship between inventiveness and innovation is even more problematic.

On the last point, the performance of input in terms of output depends on various factors, some of which are stressed below when underlining the importance of sector/firm heterogeneity, which is also underlined in the Schumpeterian Hypothesis.

Developing countries pose some additional problems. One of these relates to definitions. As has already been mentioned, the Schumpeterian categories of inventiveness, innovation and diffusion are not very appropriate to conditions of incremental, adaptive and diffusive technical change, which is the norm in developing countries. Instead, the different applications of concepts such as innovation activities and technological development do indeed seem relevant.

Another, though widespread, complication becomes particularly important under the conditions of reconversion for competitiveness that globalization and commercial openness impose: the way in which cross-sector differences determine the processes of technical change in each sector, in such a way that this sectorial heterogeneity becomes a central component in analysis. In the case of developing countries up against this process, the different sectors affected react differently to the changes that have been introduced in the incentive system. More specifically, Latin America has been subjected to a process of market liberalization and currency revaluation, which will determine the way the readjustment process will develop for different types of goods (tradable goods, for example).

Another crucial duality related to the previous point, is that demand structure is fundamental in accounting for the way reconversion in Latin America has taken place in each individual case. Some analysts, like Sutton, insist on the difference between light consumer products, durable consumer products, investment goods and capital goods in order to understand demand dynamics.

Finally, in terms of the type of dynamics of reconversion and competitiveness, it is important to identify the type of competitive and reconversion strategy characterizing each sector or different segments in a sector. This enables one to analyze its innovative activity appropriately. No analysis can be carried out if sector and firm specificities are abstracted. In addition to Pavitt's classification (of dynamic technological opportunities for demand and their appropriability) there are others that are, broadly speaking, relevant for the creation of a typology that will enable us to conduct a more proper analysis of technical change by taking into account firm and sector specificities. This is the case when looking at company structure (whether the unit is a multinational, a large conglomerate, a large family firm or a small firm) where the way technical change proceeds within a firm can be very different. According to which products and processes are involved, the way reconversion takes place should at least be equally understood in terms of the duality between large-scale standard production and differentiated short-series products.

3 WHAT SHOULD LATIN AMERICAN INDICATORS BE MEASURING?

3.1 The Concept of Technological Capabilities

There is a fairly widespread belief that technological innovation activities are concentrated in developed countries and their results the creation of technologies to be incorporated into ‘production capability’ (the stock of capital goods and operating know-how required to manufacture the existing goods with productive efficiency). Developing countries there are only diffusion processes of the technologies from the developed countries. It is also believed that firms in developing countries are able to gain access to innovations, either free of charge or otherwise, but without difficulty assimilating them and putting them to efficient use.

On the basis of this analysis, the conclusion might be reached that the only indicators relevant to an assessment of the level of technological modernization in developing countries are imports of capital goods, direct foreign investment flow and disembodied technology transfer (licenses, know-how, and so on).

However, the distinction between innovation and diffusion as two distinct activities taking place sequentially, is a highly questionable one (López & Lugones 1997). Though ‘radical’ innovations are unlikely to emerge in developing countries, empirical evidence reveals that technology diffusion involves continuous (generally incremental) technical change aimed at adapting acquired technologies to the specific context of their application, and at attaining higher levels of operating efficiency. Such activities are important for at least two reasons: i) through the accumulation of minor innovations, significant productivity increases can be had and ii) because of differences in resource endowment, input type and quality, local tastes, and so on, it is always necessary to adapt (to some extent ‘idiosyncratically’) imported technologies for their use in the local environment.

In other words, it is necessary to undergo learning processes because there are tacit elements in technologies, and their basic principles are not always clearly understood. Technological change at firm level should then be seen as a continuous process of knowledge absorption or creation, partly determined by external inputs and partly by past accumulation of skills and knowledge. The concept of technological learning precisely refers to any process that reinforces the ability to generate and manage technical change.

These intangible resources are becoming increasingly important as a reflection of the heightening of the ‘knowledge intensity’ in industrial production. Although inputs for certain kinds of technical change (capital goods, engineering services, and so on) can generally be purchased in the marketplace, this is not the case when the aim is to generate continuous incremental changes in existing factories. Here, the technology user must play a proactive role and have the relevant skills to do so.

It is useful, then, to study innovative processes in developing countries on the basis of “technological capabilities” (Dahlman et al. 1987, Lall 1992). Most firms in developing countries, either completely or partially, master “production capabilities”, including productive management (the ability to monitor and improve the operation of installed plants, or production engineering), procurement and use of the information required to optimize operations, maintenance and repair of physical capital, and the discovery of new uses and markets for current products.

Only a fraction of firms in the developing countries have acquired ‘investment capabilities’. These include project management (the organization and monitoring of the activities involved in installing and expanding productive capability, or project engineering), provision of the information required to make the technology operational in a specific context (detail studies, basic and detail engineering), purchase of any necessary equipment and services, abilities to implement start-up and reach predetermined operational standards, training of the workforce, and prefeasibility studies.

Lastly, an even smaller number of firms have acquired ‘innovation capabilities’, which consist in creating new technical possibilities and putting them into economic practice. This term covers inventiveness and innovation activities, and embraces improvement of existing technologies. **Most innovative activity in developing countries consists of minor innovations (modification or improvement of existing technologies). However, such minor innovations may lead to significant growth in productivity in certain cases.**

Likewise, there are relatively few firms with ‘linkage capabilities’, that is, the capabilities required to receive (and pass on) information, experience and technology from components and raw material suppliers, subcontractors, consultancy firms, service firms and technological institutions. Such capabilities have an impact not only on the firm’s productive efficiency and innovation capability, but on the intensity of technology diffusion at a macroconomic level and the degree to which industrial structure is reinforced.

3.2 Innovation as a social and interactive process

There is growing consensus that innovation is a social and interactive process (López & Lugones 1998). This implies an emphasis on establishing reliable, durable channels of communication both within the firm itself and with external agents (suppliers, customers, competitors, universities, research institutes and the like). Moreover, the diffusion of innovations among economic agents and the feedback thus created, make it possible to improve on the original innovation and increase the number of potential users. From this point of view, it can be stated that isolation clearly works against firms’ competitive development, especially in terms of the innovation and organization of the productive process (Dini, 1996).

Within the firm itself, this suggests a need to find out whether there are rules and regulations allowing access to and diffusion of technological knowledge by the agents in the firm (workers, technicians, managersand so on) or to the accumulation of learning experience. Where links to external agents are concerned, the aim should be to enquire about the kind of network the firm is inserted in, its exchanges with the environment, the regulations governing interrelations between formally independent agents, and so on.

The relationships, links and complementarities a firm establishes with other agents can take on different forms (link user-producer, clusters, industrial districts, subcontracting relationships, strategic-technological alliances, and so forth). They may also have different goals, such as obtaining and exchanging technological and market information, undertaking joint innovation efforts, joint exploitation of market opportunities. In this sense, links with suppliers, subcontractors and technological institutions which make it possible to receive (and transmit) information, experience and technology are as important as the knowledge of user needs, which is one of the main paths to technological change. The user-producer relationship depends on the existence of a continuous flow of (quantitative and qualitative) information between both parties, and on furthering co-operation and mutual trust.

The rapid shift in the world economy toward “knowledge-based societies” enhances the importance of inter-firm technological connections and linkages, and makes the survival and development of the various different agents increasingly dependent on their inclusion in wider networks of knowledge and innovation creation and diffusion. In the developing countries, the weakening and rupture of industrial linkages suggests limitations that mainly affect opportunities for exploring innovation, which in turn decreases the options available in the specialization and differentiation of products, the most suitable strategic path for regional producers of manufactured goods.

However, these limitations manifest themselves very differently according to the type of firm involved. Larger firms and, particularly, transnational subsidiaries have more chance of overcoming these weaknesses or failures in domestic markets through their integration into global and/or regional production and trade networks. Belonging to such networks enables such firms to compensate for shortcomings in the local environment, procure foreign services, products and knowledge, and obtain accurate and updated information on markets and technological change. In addition, they have support from a global administrative, managerial and marketing structure.

This trend (which makes undeniable economic sense) implies a dual process of exclusion. On the one hand, only part of the productive apparatus can gain access to international networks; the rest, because it lacks access to these networks, is left at a competitive disadvantage. On the other hand, goods and service suppliers who are replaced by imported supply find their markets restricted and their links severed, and this narrows the range of opportunities open to them to overcome their limitations. In other words, firms excluded from this process increasingly lag behind international standards of efficiency, quality and cost, and this brings about a vicious spiral of high company mortality rate (with a knock-on effect on employment levels), lowers average productivity rates (with a knock-on effect on income) and weakens the network of linkages and complementarities.

At the micro level, the main exclusion suffered by the firms that do not successfully incorporate themselves in global production and trade networks, lies in their reduced chances of gaining access to the most dynamic trends in the exchange of information, experience, knowledge and capabilities. Exchange is vital to technical progress, the acquisition of technological mastery and the development of new organizational and productive capabilities. Firms outside it are left to act in spheres where the incentives provided by links to and relationships with suppliers and customers, and their chances of appropriating externalities, are very different. This pushes them further out of the dynamic circuit.

Consequently, the definition of innovation indicators for developing countries should provide ways of assessing the extent to which connections and linkages are present in the field of innovation and technological learning, define the nature of these links, identify involved (or excluded) agents, ascertain the efficiency of existing information channels, and so on. In other words, the existence of "organized markets" (Lundvall 1992) should be examined or, failing that, the ways firms seek to substitute for them should be ascertained.

3.3 External Sources and Endogenous Technological Effort

In the relationship between external sources and domestic innovative efforts, different ways of importing technology have different impacts upon local technological development (Lall 1992). Passive confidence in external sources can lead to the stagnation of local technological capabilities.

For example, the fact that transnational firms do not perform R&D activities locally may have negative consequences. It should be remembered that subsidiary firms in developing countries generally receive the benefits of R&D activities conducted in the parent firm and, consequently, have no innovative capability beyond the efficient production of the goods they manufacture. Meanwhile, externalities generated by the presence of transnational firms do not depend solely on the complexity of the product they manufacture and its target market. They also depend on things like local firms' absorption capacity, whether they are suppliers or competitors of subsidiaries, the receptor country's industrial and technological infrastructure, and the policies of the country to maximize infrastructure.

As for technology transfer through licenses, patents, and so on, even if foreign knowledge acquisition were taken as the main recipe for technological change, it would be necessary to undertake learning tasks requiring the development of a capability for technical assimilation, adaptation and minor innovation, and even organizational and institutional adaptation. It can therefore be said that the development process demands complementation between the technologies generated in developed countries and the endogenous efforts made by firms located in the developing world.

In practice, however, there may be situations in developing countries in which excessive confidence in external sources turns out to be harmful to the process of technological learning. There is thus a need to distinguish cases where foreign technology is incorporated into active learning processes founded on existing capabilities of adoption and adaptation of transferred knowledge, from those where a firm depends exclusively on external sources and lacks both accumulated capabilities and an autonomous technological maturation plan.

In this sense, the acquisition of embodied technology through capital goods imports reveals an antagonsim which should be given serious consideration wherever possible. In principle, importation of equipment, both in the event of new projects and enlargements or of updating existing facilities, frequently leads to adaptation and learning effort which merits being identified and valued as action that increments technological capabilities.

Nevertheless, the scope of such an effort depends largely on the technological choice made by the firm when purchasing equipment, not so much in terms of quality, price and performance, but of the contribution the acquisition means in a real approximation to international standards of product and process engineering in a firm's specific operational field. Essentially, this depends on the scope of the technical leap and transformation of methods, procedures and practices triggered off by a purchase.

Frequently, when smaller firms have taken a decision to update, they receive confusing signals on account of 'market failures' (the segmentation of the financial market, say), the existence of strong externalities, or poorly managed policies and instruments. These lead a firm to choose the apparently less risky way of updating existing equipment, but by walking the same technological path instead of undertaking deeper technological change in processes and/or products, which undoubtedly implies risks, but may be the only effective way of approaching improved international practice (McKinnon, 1973 and 1991). As a result, in the event of enlarging and updating existing plants, the adaptive and learning effort undertaken will be greater when capital goods imports originate in an intention to introduce quite radical technological change.

3.4 Organizational Innovations

Organizational concerns are being paid increasing attention to as key factors for appropriate innovative management in private firms. It is therefore essential to take them into account when conducting surveys on the region.

If the innovation is to yield a successful commercial result, the generation or adoption of an innovation involves not only a 'technical' process, but also requires complementary assets which firms do not always have at their disposal. Also, incorporation of the so-called 'new technologies' (especially those related to microelectronics) demands concomitant organizational changes in firms, in order for the technology to be used efficiently from an economic and technological point of view.

There are thus arguments suggesting that the weight of organizational concerns should be stressed where innovation indicators are concerned. Specifically, It will be important to inquire into the adoption of work and production methods associated with *Toyotism*, which go well beyond the famous 'just.-in-time' or 'total quality control or management' systems and imply a complete redefinition of decision, information and incentive structures at firm level (Aoki 1990, Coriat 1991).

3.5 Training

Not all company training activities by can be considered as technological innovation activities. The Oslo Manual suggests taking into account only those related to the implementation of a technologically new or improved product or process. However, the important role played by training in strengthening learning and knowledge accumulation opportunities for Latin American firms points to the suitability of including a specific chapter in the regional studies devoted to surveying the action taken by firms with respect to this, as well as the resources involved.

Demands regarding the qualification and training of human resources arise from various sources. On the one hand, in a context of ever-accelerating technological change, the operation of complex systems and instruments (especially, those connected with microelectronics) is increasingly required in most manufacturing activities.

Firms also depend on human resources to not only select, adopt and adapt technologies successfully provided by other agents, but to develop minor internal innovations. Technological change is, in addition, a continuous and interactive process in which active participation and the ability to create, diffuse and/or absorb the ideas of all the members of the firm help the process to be speedier and more successful.

Similarly, the condition for modern organizational techniques in productive processes (increasingly considered to be a key factor if firms are to compete successfully in the marketplace) to be suitably implemented, is to have human resources capable of taking part in operation control, helping in unforeseen problem-solving activities, suggesting and implementing ideas to improve processes and products, interacting with other members of the organization and with agents from other firms and institutions, and participating actively in quality and environmental management.

3.6 Quality management, environmental management and innovation capabilities

A increasingly important concern in defining a firm's levels of competitiveness is its quality management. Again, the methods of production and work originating in Japan have brought about the most considerable progress in this field. These methods are enshrined in the concept of total quality management. In this approach, rather than emphasizing 'quality control' and the most suitable systems to put it into practice, the firm's organization as a whole is completely rethought. In particular, organigrams tend to become more horizontal in that they allow for the participation and continuous learning of the firm's members and facilitate dynamic and positive interaction with suppliers and customers.

The same happens with environmental management, which is on the increase as both markets and government regulations tend to reward environmentally friendly firms. There is also agreement that efficient environment management depends on its being integrated into the firm's other activities. The emergence of cost-effective solutions to environmental problems particularly depends on innovative capabilities accumulated by the firm. In other words, environment management should be associated with the processes of technological and organizational change developed within the firm as a whole (López 1996).

Any selected indicators should therefore include references both to quality management and to environment management since they both reflect specific dimensions of a firm's accumulated technological capabilities, while also being key factors in defining competitiveness in current wave of technological and organizational innovations related to Toyotian practices, the accelerated introduction of microelectronics into the workshop and the demise of development paradigms based on the intensive use of natural resources.

4 CONCLUSIONS

The preceding chapters are aimed at identifying the specific desired characteristics of **innovation indicators** for Latin America. With this in mind, we have tried to identify the major characteristics that make the processes of technological change in our countries different from those that take place in the more developed economies.

The Second Part of the Manual is devoted to the **instruments** and **procedures** that will ensure that the exercises of innovation activity measurement conducted in each country lead to results that are both reliable and regionally and internationally comparable. Attaining this goal depends largely on designing surveys that take account of the specific regional characteristics of innovative processes as well as the particular features of the firms and markets which they affect.

In what follows, we will introduce our main conclusions on the characteristics that Latin American innovation indicators should possess.

4.1 The Coordination of Innovation and Business Strategies

Three basic concerns deserve to be stressed:

a) Innovative activities performed by firms should be analyzed through their coordination with strategies devised by firms to obtain a competitive edge and thereby take advantage of the opportunities for increased profitability and growth provided by the specific markets in which they operate. The strategies depend on the way firms react to new demands imposed by the economic openness and globalization, which is closely linked to accumulated technological capabilities (the more extensive the capabilities, the greater the chances of taking advantage of opportunities.

b) Given that the efforts of Latin American firms have largely been centered on **organizational modernization and investment aimed at incorporating technical change, the** analysis of innovative activity will have to pay particular attention to those concerns.

c) The factors **determining** investment decisions and the **conditions** under which investment is made should also be given close attention, since both have a decisive impact on a firm's chances of performing innovative activities.

4.2 Advantages and disadvantages of the Oslo Manual

The Oslo Manual's primary advantage in the analysis of technological change in the Developing Countries, is the adoption of the subject (as against the object) approach. In this approach, the firm's activity, rather than the amount of innovation, is the key thing to be measured.

Another positive side of the Oslo Manual is its reference to the chain-link (as against the linear) model. This shows how technological activity permeates all the activities in a firm and does not simply restrict itself to R&D. As in the Frascati Manual, this concern is reflected in the fact that the R&D component is no longer placed at the center of Innovation Activities and such an emphasis is particularly appropriate to Developing Countries.

Three **weaknesses** regarding the Oslo Manual's application to Latin America should, however be pointed out:

1. ***Ambiguity concerning organizational changes:*** Excluding organizational change (or including it only if it generates 'measurable' changes in production or sales) is a serious methodological restriction (ambiguity) in the analysis of innovative activities. Generally speaking, but even more so in Developing Countries, action aimed at organizational modernization is closely linked to efforts leading to reconversion and competitive company strategy and (more importantly) forms part of the conditions required to bring about technical change.

2. ***The problem of novelty:*** In terms of a definition of novelty, the difficulties Developing Countries face in developing a new process or product that at a global level are obviously immense. This suggests a need to add other levels of analysis such as novelty at sectorial level, at national level and at regional level, as well as novelty at the level of the firm.

3. ***A narrow criterion:*** The narrow concept of innovation adopted in the Oslo Manual fails to sufficiently stress the importance of analyzing innovation activities (in the broad sense). **As a result of this, the process of firms accumulating capabilities for creating and using knowledge is not given due weight. As we have said, we believe this concern to be vital to the development of innovation processes in the region**.

   It is true that by concentrating measurement efforts on TPP Innovation, the Oslo Manual takes a more manageable path in terms of the quantities involved. However, on introducing the complex of 'innovation activities', procedures become more complicated.

   Under the conditions of diffusive, adaptive and incremental technical change which are typical of the Developing Countries, applying such a narrow concept is not conducive to accomplishing one of the guiding purposes of measurement exercises in Latin America, namely, to identify firms that are actively involved in technological change and are making promising headway in 'Innovative Activity Management', regardless of their results (or 'objective innovations'), and also to identify the main hurdles that innovative processes have to confront in the region.

   The technological conduct of firms not only has important consequences for their individual performances, but serious implications for each country's development path, as stated in Chapter 1. Furthermore, the identification of potentially innovative firms and the characteristics and restrictions of the National Systems of Innovation is a crucial foundation for policy-making and the design of support instruments.

SECOND PART:

OPERATIONAL CONCERNS

OPERATIONAL CONCERNS

In the first part of this Manual, we referred to the particular features of Latin American firms and the markets they operate in. These features posit the need to adopt regional criteria for the definition of indicators both suitable for analyzing the specificity of innovative processes taking place in the region and at the same time capable of ensuring regional and international comparability.

From an instrumental or operational point of view, this dual goal for information surveys on the technological behavior of Latin American firms to collect reliable data on regional specificity while still ensuring the international comparability of the results, suggests the difficult task of consistently combining the Oslo Manual recommendations on the one hand, with the closest attention to local idiosyncrasies and concrete experiences obtained through the exercises conducted in the region on the other.

5 HOW TO MEASURE: CONSTRUCTING THE INDICATORS

5.1 Procedures

- Joint surveys with government agencies for economic statistics
- Surveys by mail
- Customized partial mail surveys tailored to the firm
- Customized surveys
- Simultaneously surveys on productive activity performance

In order to establish reliable survey procedure, seven things should be taken into account: the rate of expected answers, a guarantee of statistical secrecy, the imperative to answer, database handling and access, access to physical surveys, information debugging and available budget. The procedure used should attempt to optimize all these criteria. All procedures have advantages and disadvantages.

The guarantee of secrecy in surveys conducted by official statistics and national survey agencies advise that any field work be conducted by these institutions regardless of the degree of involvement they may have in earlier stages of design or later stages of analysis of the information obtained.

In certain countries, the participation of national statistics agencies is no guarantee of the imperative to answer. Similarly, depending on the degree of credibility, respectability and seriousness of the institution handling the survey, statistical secrecy can be guaranteed even without these agencies' participation.

In the (quite likely) case that the resources available for the survey make it impossible to cover all the firms in the group under analysis, it is advisable to select a sample which is as similar as possible to those used in other periodical surveys conducted by these agencies, so as to facilitate cross-referencing and complementation of information from various different surveys. Conducting innovation surveys jointly or simultaneously with other surveys also helps such an aim to be achieved. Cross-sample agreement is not given by like sample sizes or their stratification, but comes rather from firms being the same ones in the various different surveys.

If joint operations are to be conducted, surveys on productive activity performance and evolution are particularly suitable. In fact, the Oslo Manual explicitly advises that survey forms be kept short and sweet in order to maximize the rate of effective answers. Nevertheless, this depends what aspects are to be surveyed.

When joint operations are conducted, it is important to bear in mind that statistics agencies may take several years to process the information and that, by the time information on innovation becomes available, it may well be useless.

If one of the main intentions is to establish cause-and-effect relationships between any action taken by firms regarding technological innovation and their performance in the marketplace (competitiveness), it will (often) be necessary to involve a specific body to construct indicators which account for firms' evolution in the period in question. Indeed, unlike developed countries, Latin American statistical systems frequently lack the necessary information on firm performance, or they cannot provide it in the form needed to establish analytically valuable correlation, or the institution in charge of providing the information does so behind schedule (over 3 years late in many of the region's countries).

This undoubtedly makes survey forms longer and more complex, which in turn increases the burden on those involved in field work, namely, survey-takers and surveyed firms. In such cases (when the required information on firm performance cannot be obtained by any means other than an innovation survey) the goals of operational simplicity and fluidity are detrimental to the analytical potential of the measurement exercise.

The rate of expected answers basically depends on how the survey is taken and whether answering is obligatory. Firms tend to prefer to answer customized surveys but the cost of such surveys is higher than any other method. In general, a firm's culture and attitude toward surveys also affect the answer rate. In particular cases, the length and complexity of the form are key factors if a high answer rate is to be obtained: the shorter and simpler the form, the higher the answer rate.

Experiences in Latin America show varied results in this regard. Although procedures differed widely and most forms were long and complex and answering was not imperative, similarly high answer rates were obtained in different countries (Sutz 2000).

Every survey procedure or method has its strengths and weaknesses. Mail surveys have the advantage of being less costly but instead require a well-designed form to make the respondent's task easier.

A half-way house between customized and mail surveys is the so-called 'customized partial mail survey'. Here, survey-takers visit firms, personally show them the forms and explain how to complete them. Then, both survey-taker and firm agree on a date for the form to be handed in. Meanwhile, a team from the agency in charge or any other institution involved in the operation may provide telephone assistance for any queries from the firms surveyed. This method yields a suitable answer rate and also provides the surveyed firms with an appropriate help line for any queries.

In the event of the survey being conducted by a national statistics agency (be it jointly or otherwise) it is important to take into account the degree of database handling and access the team in charge of analyzing results have, as well as the degree of access to the completed forms. Both aspects are fundamental when debugging and validating information.

To obtain high-quality answers, choosing the right interlocutor is perhaps more important than the survey procedure itself. Interlocutors can vary according to the kind of form: whether it is mainly qualitative or includes numerous questions on innovation expenditure. The firm itself is suggested to decide who will answer the questions once it has been told what objectives are being pursued by the survey.

5.2 Samples

- Group v. representative, expandable sample
- Expansion factors
- Standard error
- 3 or 4 ISIC digits
- Sectors
- Unit of analysis

A second concern when designing a survey is the sample. This can be either the complete group subjected to measurement (a census-type survey) or a representative, expandable sample. Because of time, cost and simplicity, a representative sample is generally chosen. Several criteria are considered in selecting a sample: representativeness (by either size or sector), need or willingness to include specific sectors or firms of particular interest for the country. For example, in order to ensure that each sector is well-represented, it is usual to include the largest firms (either according to their production or their added value) in each sector. IN this way, the sample is certain to represent a high percentage of industrial GDP. Should it be wished to assess a specific public policy toward particular firms, beneficiaries of government programs may be included in the sample. The other firms are normally selected at random.

The best-known sampling techniques are simple random sampling, stratified sampling and simple clustering. The technique commonly used is stratified sampling, which is generally based on firm and sector sizes. It is in any case advisable to include regional elements in the stratification so that further analyses may be carried out at regional level. A corresponding expansion factor should be established for each stratum according to the number of units in each category.

The stratification technique consists in grouping similar firms (by size, activity sector, location and so on) and selecting a subset of firms to be included in the sample. The representativeness assigned to each of the subsets in terms of which grouping they belong to, will provide the indexes to be used in calculating total expansion. Obviously, this procedure implies considerable effort in preparing the survey, unless the preparation has already been done for previous surveys.

It is also usual to establish a minimum quantity of employees as a criteria in selecting the firms to be included in the sample. This varies country to country but is mainly due to cost-benefit considerations. Although there are many micro-firms, only a very few of them actually undertake innovation activities[4]. For this reason, it is necessary to include a large number of these firms in order to attain representativeness. Nevertheless, in terms of survey results, the information obtained is likely not to be significant. These firms can be

[4] With the exception of technology-based firms, such as those devoted to software development or biotechnology, which tend to be small especially in terms of employee numbers.

included in the sample as 'default' firms that are of special interest to each country. This makes it possible to avoid leaving out small, innovative technology-based firms.

In any case, regardless of who selects the sample, it is important to know or to be able to obtain the expansion factors (in order to translate sample data into data representing the complete group), as well as being informed of whether these are added value or frequency factors.

The size of the sample depends on three variables: available budget, maximum accepted standard error and desired representativeness (2, 3, 4 or 5 ISIC digits). The available budget conclusively limits the number of firms to be surveyed, especially if the survey is customized: the more firms, the higher the cost. The degree of representativeness also influences the size of the sample: if the desired representativeness is 2 ISIC digits, then the number of firms to be included will be fewer than in the case of 3 or 4 digits. And finally, the fixed parameter of maximum accepted standard error determines the number of firms needed in each sample stratum.

For reasons of regional comparability, the representativeness of a sample should be at least 3 and ideally 4 ISIC digits.

Sample selection is of the utmost importance in designing a survey. It should be assigned to specialist (individuals or institutions) in the field. But it is essential the team in charge of coordinating the survey define the basic criteria and are conversant with the details of the selection process because such information will be vital when debugging, processing and analyzing the information obtained.

Innovation surveys, both in the developed world and in Latin America, have been applied to the industrial manufacturing sector. Innovation surveys in the service sector have more recently been conducted in developed countries and the experience of British Columbia, Canada, where several innovation surveys in traditional and high technology manufacturing, natural resource-based and service (tourism) sectors have been taken. The Oslo Manual claims that innovation surveys can be applied to any sector, be it industrial, service (commerce, banking, tourism, etc.) or natural resource-based (agricultural industry, mining, etc.) provided they are tradable goods sectors. Nevertheless, there does exist some bias in favor of industrial manufacturing.

In this respect, the available evidence suggests it is advisable to survey not only the manufacturing sector but the service sector too, because important innovative efforts are being made there at both global and regional levels. This means significantly extending the group to be surveyed, though this group is already fairly extensive in several countries in the region. It may therefore be advisable to conduct surveys which sample firms that are representative of the respective (industrial and service sector) groups.

Finally, another important concern to be born in mind when designing survey samples is the unit of analysis, which can either be a firm or an establishment. This primarily depends on the unit of analysis normally used by the national statistics agency. Annual industrial surveys, for example, survey establishments. For an innovation survey, the firm is considered the ideal unit of analysis because, first and foremost, technological and competitive business strategies are generally devised at firm rather than establishment, levels. Secondly, innovation activities (particularly, R&D) are performed by firms, although other activities and decisions, such as purchase of machinery and equipment, take place at the establishment level.

To favor comparability in measurement exercises performed in the region, an attempt should be made to consider firms as units of analysis. If samples are selected by establishment, then the establishment will be asked to answer on behalf of the firm as a whole, or the information obtained from establishments belonging to one firm should, if possible, be gathered later. In any case, a certain degree of flexibility will be necessary to accept cases in which surveys apply to establishments.

5.3 Indicators

- qualitative
- quantitative
- simple
- complex

Measurement of firms' innovative activity expenditure entails significant difficulties. The main problems are linked to the difficulties faced by firms in answering quantitative questions. These difficulties generally (but not exclusively) relate to the size of firms surveyed: smaller firms tend to argue that certain flaws in their records prevent them from being more accurate in their responses, especially if questions involve accessing data from earlier financial years in order to record variable evolution or make temporal comparisons. In the case of larger firms, several departments usually have to participate in the completion of information requests, and this situation causes further complications.

Even so, it is still advisable to pay special attention to estimates of expenditure on innovation since this offers a greater chance of measuring the scope of activities and making comparisons, be they temporal, sectorial, regional or by kind, and in addition of contrasting efforts against results.

Although purely qualitative surveys can give rise to valuable academic studies or research that may even influence policy-making decisions, policy-makers will rarely accept measurement exercises lacking in quantitative information, especially where private expenditure on innovation and R&D is concerned. This information is particularly important in connection with initiatives funded by governmental agencies.

To construct indicators of firms' (expenditure and employment) efforts in innovation activities, it is important to have certain basic data on economic performance available when talking about production. This includes total or production employment, sales and gross investment.

5.4 Classification according to specificities by kind of firm

- Size
- Capital source
- Sector
- Geographical location
- Innovative 'attitudes'

Firms exhibit specific traits and marked differences according to development, size, capital source, sector and geographic location. Their technological conduct and attitude toward innovation can also determine their performance in the marketplace. In any case, it is interesting to sort results by grouping on the basis of the suggested classifications so that we can draw comparisons and specify differences.

Over the last decade, a strong increase in direct foreign investment flows has been registered, from which several Developing Countries have benefited. This increase in direct foreign investment presumably entail an increase in intra-firm technology transfer. Surveying the characteristics that this transfer will assume may therefore be of great analytical importance. It is equally vital to gather information on the technological effort made by subsidiaries in Developing Countries, as well as on their links and relationships with local agents (suppliers, customers, etc.). To analyze the impact exerted by direct foreign investment, it is important both to identify the proportion of foreign capital in the firm and to find out if it is a transnational subsidiary. The adoption of a standardized percentage of foreign capital for the firm to qualify as a transnational is not recommended since each country applies different criteria in defining this category.

Small and medium-sized businesses face quite a significantly different scenario. On the one hand, they find it difficult to profit from the greater opportunities for acquiring foreign inputs, parts and components that economic openness and regional integration agreements provide because, to take advantage of such opportunities, they should have precisely the kind of international links and relationships that these firms lack. Such relationships are increasingly important in performing successfully in increasingly globalized economies but there are many cases where the supply offered by small and medium-sized businesses is being threatened and frequently replaced by foreign providers.

This lack of international links, together with the greater difficulties faced by small and medium-sized businesses in adapt to the new game rules because of their relatively higher exposure to 'market failures' and weaker productive, administrative and commercial structures have led these firms to adopt 'defensive' strategies (Chudnovsky et al. 1994, Kosacoff 1993) rather than initiatives aiming to take action that seeks deeper transformations in production and technology.

Small and medium-sized businesses' actions in the field of innovation are characterized by informality (a predominance of intangible assets and use of resources simultaneously devoted to other tasks) and incrementally ('on the hoof' problem-solving and introduction of changes or modifications) in an attempt to reduce the kind of risk and uncertainty, not to mention fixed costs, inherent to innovative activities.

A third case for analysis is that of large independent national firms, as well as those forming part of large national corporate groups. In terms of the impact of the changes introduced onto the competitive scene through structural reform, these firms seem to be more akin transnational, at least as far as their chances of riding out 'market failures' and establishing international links are concerned.

Thus, firm size is a variable that should be taken into account when analyzing technological innovation. However, the choice of parameters for measuring size is a subject that requires debate. This parameter could be the number of employees (the most generally used), assets, invoice volume (sales), or a combination of all of them. We suggest that parameters to determine size and rank be defined, following standard practice in each country, by taking into account that size characteristics vary according to the sector involved.

Regarding innovative action by these firms, the attempt to update through acquiring technology (either embodied or disembodied) seems to be prevalent throughout the region, where different associations with international firms, including significant interest in partnerships, are resorted to. Nevertheless, there is a significant lack of information concerning the endogenous efforts these firms make or could be capable of making to adapt and improve products and processes and develop new technological capabilities.

To classify innovative attitudes at least three categories are suggested, namely, innovative firms, potentially innovative firms and non-innovative firms. Regarding the concept of 'innovative firms', so as to favor international comparisons it is advisable to adopt the criteria set by the Oslo Manual, according to which an innovative firm is one that has introduced TPP innovations during the period in question, that is, the firm has developed **successful** innovation activities and therefore **introduced (at firm level) technologically new or improved products, processes, or a combination of both.** Given differences between the markets of developed and Developing Countries, where competition conditions are extremely different, what can be considered new for one firm in a developing country can be very different from the same thing for a firm in a developed country. For this reason, it is advisable to specify whether the market supplied by the firm is local, national or international.

However, Latin American measurement exercises should also try to identify firms that have developed innovation activities (regardless of results obtained) and those that have not developed innovation activities at all and therefore have not attempted to innovate (Sutz, 1999). This would make it possible to account for innovation as a process rather than as a result in a period of time.

According to this, surveying firms' innovation activities aims at identifying their technological conduct as well as the evolution of capability accumulation.

Potentially innovative firms, then, are those that have carried out innovation activities that have been aborted (have not yielded results), or that are currently developing innovation activities that have not yet been translated into effective innovations. Non-innovative firms, on the other hand, are those that have not carried out innovation activities at all and have not attempted to innovate.

The approach of innovation systems has been mainly oriented toward national systems, although in practice it has been observed that, rather than there being a single national system, there are many regional systems. The relationships established between firms and their (immediate) environment plays a very important role, which varies from country to country. This is why it is vital to gather information concerning geographical location, in order to be able to analyze different conducts in each regional innovation system and cross-regional differences within a country.

Regarding the location of firms, if the unit of analysis is the firm and not the establishment some problems may arise, bearing in mind that the firm may be located in the capital but also have establishments in different regions of the country. It is therefore advisable to collect basic information on firm's different establishments.

5.5 Period comprised by the survey and frequency of surveys

Both regional and international experiences seem to suggest that it is advisable to conduct a comprehensive preliminary survey comprising all aspects linked to technological innovation, as well as to firms' performance and evolution in the marketplace during the last five years (unless this information is available by other means). This can be repeated every five or six years and supplemented by a brief, simple survey conducted every year or every two years in order to monitor a selected set of innovation indicators.

In Chapter 7, a standard common form will be introduced, providing the basis for surveys taken every five or six years. It is a lengthy and complex form, which includes both qualitative and quantitative dimensions and seeks to record changes in mid-term trends. The Appendix includes what has been called the basic form, an instrument intended to collect quantitative information, especially that relating to (innovation) expenditure indicators. We suggest conducting such a survey yearly or every two years.

It should be emphasized that the basic form is not enough in itself to characterize innovation behavior and dynamics. This means that the two forms are not different forms that can be applied simultaneously, but rather that the basic form is to be used more frequently than the comprehensive one. They are not alternative but rather complementary. However, to carry out surveys only every five or six years is not enough as it is necessary to collect quantitative information periodically in order to construct temporal series, bearing in mind that firms are not likely to provide information on innovation activity expenditure dating back more than 3 years.

It is recommended that the form be tested before applying it to the whole sample. Thus, if need be, it will be possible to correct questions, instructions or definitions that are not clear or raise queries.

5.6 Validation and information debugging criteria

In practice, all innovation surveys are incomplete regardless of what survey method or procedure they use. It is therefore extremely important to draw distinctions in lack of response (missing values). When designing the form and constructing the database, lack of response to a question due to lack of knowledge on the respondent's part or to the fact that the question does not apply, should be distinguished from lack of response due to a reluctance to answer. It is also important to define the procedures to be followed to obtain the missing information, whether through a further interview or by replicating information obtained from firms with a similar profile.

It is thus advisable to define validation and information verification criteria. The form must allow for information consistency tests both in terms of quantitative and qualitative information. This Manual does not attempt to set out general or common criteria for this process but rather stresses the importance and need for this task.

6 A SET OF INDICATORS

6.1 FIRM IDENTIFICATION

- Firm name, address, telephone number; fax number, e-mail and www.
- Manager, contact name and position held.
- 3 or 4 ISIC digits.
- Three main products and respective sales share.
- Geographical location.
- Year of firm was set up in the country.
- Capital source: national – foreign (country), foreign investment period (0-10 years, 10-20 years, over 20 years).
- Multinational subsidiary.
- Type of ownership (co-operative, government, family, worker share, etc.).
- Number and location of establishments.
- Does the firm belong to a national conglomerate?[5]

6.2 ECONOMIC PERFORMANCE

(The following indicators are to be obtained, where possible, from previous surveys)

- Sales: products manufactured by the establishment; products manufactured by third parties; share of innovated products.
- Investments: gross investment and investment in machinery and equipment (or in embodied technology).
- Total employment by qualification and salary level; differentiating between production and administrative employees (as a percentage of the total).
- Staff stability (by rank).
- Exports: total and innovated product exports.
- Imports: inputs, machinery and equipment, other.
- Gross earnings, operating profits and pre-tax profits.
- Market share.
- Production value.
- Use of installed capacity.
- Average cost of a representative product.

[5] It is important to determine whether the company belongs to a conglomerate, since further on it is asked if any of the innovation activities carried out by the company are conducted jointly with other firms belonging to a conglomerate.

6.3 INNOVATION ACTIVITIES

Expenditure and frequency indicators

- Weighed up the importance of all activities and specifying the allotment of resources to each of them (as a percentage).
- Existence of an R&D, quality control, engineering or design laboratory or department and employees working in such activities.

6.3.1 R&D

- Development of research projects.
- R&D employment level (as per qualification and salary level).
- In-house investment in R&D (distinctions should be drawn between staff, equipment and other expenditure).
- External investment in R&D.
- R&D results: new products, prototypes, new process, pilot plants, other.

6.3.2 Innovation effort

6.3.2.1 Embodied technology

- Capital goods implying technological change in the firm and linked to new products and processes.
- Hardware (specify whether for production or administrative use).

6.3.2.2 Disembodied technology

- Licenses and technology transfer (patents, brands, industrial secrets, etc.).
- Consultancies (production, products, productive system organization, organization and management, finance, marketing).
- Software (specify whether for production or administrative use).

6.3.2.3 Training

- Technological training linked to new processes and products.
- Management and administrative training in: management areas, administrative skills, information technologies, industrial security, quality control.
- Number of skilled employees, as per level of qualification and number of training hours.

6.3.2.4 Organizational modernization

- Organizational modernization (i.e., strategic planning, quality circles, total quality, benchmarking, administrative process reengineering, other).

- Production process modernization and management (i.e., changes in the physical organization of the plant, vertical or horizontal disintegration, JIT, production process reengineering, quality circles, benchmarking, other).
- Total quality systems (anchoring and control).
- Environment management systems.

6.3.2.5 Design

- Product design.
- Industrial process design.
- Process engineering.

6.3.2.6 Marketing

- New forms of distribution and marketing.
- Effort devoted to marketing innovated products.

6.4 INNOVATION RESULTS

Frequencies by type of improvement

- Product innovation by degree of novelty (new or improved, novelty at the firm, national market and international market levels). Specify if change introduced affects the major product characteristics.
- Process innovation by degree of complexity. Specify if change introduced is central to the process.
- Organizational innovation (for example, vertical disintegration of relations, organizational streamlining, organizational leveling, greater participation in decision-making, interaction among departments).
- Marketing innovation (new distribution channels, changes in customer service, changes in packaging).
- Weighing up investment assigned to product, process or organizational innovation (including commercial innovations).
- Positive, neutral or negative impact of the introduction of process, product and organizational innovations with the following foci: profitability, cash flow, market share, competitiveness, productivity, environment, service quality, labor relations.
- Impact of the introduction of process, product and organizational innovations with the following foci of economic performance: a) increase of sales and/or exports on account of new and improved products; b) cost cuts due to process innovations; c) change in the use of production factors (labor, raw material and inputs, energy, fixed capital).
- Environmental impact of product, process and organizational innovations on: water, atmosphere, soil, landscape, waste products.
- Patents applied for and obtained, both in the country and abroad.
- Technology licensing (specify country).

- Firms with certified processes.
- Firms with certified products.

6.5 INNOVATION GOALS

- Classifying the main five goals pursued by the firm through the innovation.
- Market goals: maintaining current market, widening current market, opening up new markets.
- Cost reduction goals: unit labor cost, input consumption, energy consumption, rate of return reduction, inventory reduction.
- Quality associated goals: enhancing product quality, improving work conditions, lessening environmental impact.
- Product associated goals: replacing obsolete products, widening current line of products, opening up new lines, introducing environmentally sound products.
- Production associated goals: production flexibilization, deadtime reduction, environment management improvement (cleaner or more eco-efficient production).
- Opportunity exploitation: public policies, new scientific-technological knowledge and new materials.

6.6 SOURCES OF INNOVATION INFORMATION

Specify if national or international

- Classifying the five main sources of innovation ideas (internal and external).
- Internal sources: R&D department, executives, production employees and other departments.
- External sources: related firm, parent firm, competitors, customers, suppliers, university, research or technological development center, consultants or experts, other firm, shows, lectures, fairs, magazines and catalogues, databases.

6.7 INNOVATION FUNDING

- Funding sources: the firm itself, related firms, parent firm, government, commercial banking, international co-operation (national or international, public or private)

6.8 RELATIONSHIP WITH THE NATIONAL SYSTEM OF INNOVATION

Links to science and technology institutions or other agents in the National System of Innovation and other country agents

- Frequencies by type of linkage (the kind of link depends directly on the object of the linkage): tests, analysis and metrology; search, technological and market information processing and analysis; seminars and training courses; R&D projects; organizational change support; technical support for technological or environmental problem-solving, product and process design.

- Frequencies by agent or institution (regional and sectorial analysis is recommended): public and private research institutes, public and private universities, related firms, parent firm, other firms, consultants, equipment suppliers, test laboratories, public or private technical training institutions, linkage or intermediation institutions.
- Causal object/actor relationships.
- Degree of satisfaction obtained from links and link assessment: periodicity or frequency of links; achievement of objectives; deadlines and budgets.

6.9 FACTORS AFFECTING INNOVATION

- Rating the following factors as affecting innovation positively, neutrally, or negatively:
- Business or microeconomic factors: innovation capabilities, availability of trained employees, resistance to change, labor defection, innovation risk, payback period, innovation costs.
- Market or mesoeconomic factors: market size, market structure, marketing, sector dynamism, consumer response to new products and processes, opportunity for co-operation, technological opportunity, technological dynamism, need to innovate, funding costs, funding availability, imitation risks.
- Macro- and metaeconomic factors: information on markets, information on technologies; law, regulations, standards, taxes; public institutions, institutions related to science and technology; physical infrastructure; copyright system; labor laws and regulations; quality of basic worker training; training costs; training center quality; availability of training centers.

6.10 ASSESSMENT OF PUBLIC POLICIES ON INNOVATION, SCIENCE AND TECHNOLOGY AND COMPETITIVENESS

The following list is an illustration of some of the concerns questions could be asked on:

- Knowledge of institutions belonging to the national science and technology system and innovation system: national agencies of science and technology, innovation and public science and technology funding, technological centers, etc.
- Knowledge of governmental programs supporting R&D and innovation; supporting small and middle-sized firms, encouraging competitiveness, supporting university/firm co-operation, human resources training, etc.
- If the firm has gained access to any such program, assessment of the programs in general and the service received.
- If the firm has not gained access to any such program, specify reasons.
- Type of public policy supporting innovation that would be welcomed.

7 STANDARD COMMON FORM

FIRM IDENTIFICATION

1) Firm identification number (sample)
2) Tax identification number (standardized in the country)
3) Firm name
4) Address, city, state/department
5) Telephone number and fax number
6) E-mail
7) Web site
8) Name of the firm's chief executive
9) Name and position of the interviewee
10) Telephone number and fax number
11) E-mail
12) 3 or 4 digit ISIC classification of the firm
13) Identify the 3 main products of the firm and its sales share
14) Year of the firm was set up in the country
15) Specify number and location of the firm's establishments
16) Specify if the firm belongs to a national conglomerate
17) Percentage composition of firm capital
    a) National
    b) Foreign (specify country of origin)
18) Multinational firm subsidiary
19) Period of greatest foreign investment
    a) During the last 10 years
    b) Between 10 and 20 years
    c) More than 20 years
20) Specify type of ownership: co-operative, governmental, family, worker share, other.

ECONOMIC PERFORMANCE

(Where possible, the following indicators are to be obtained from other surveys.)

21) Sales value of products manufactured by the establishment and products manufactured by third-parties.

22) Sales share (value) of innovated products during the last 20 years[6].

23) Market share.

24) Production value.

25) Total export value.

26) Exports share (value) of innovated products over the last 20 years.

27) Gross earnings value, operating profit value and pre-tax profits.

28) Total employment by qualification level (number of employees).

   a) Basic education

   b) Technical training

   c) Graduate studies

   d) Post-graduate studies

29) Average monthly salary according to levels of qualification (basic education, technical training, graduate studies and post-graduate studies).

30) Percentage distribution of employees (production and administration).

31) Value distribution of the payroll (production and administration).

32) Specify percentage labor turnover according to levels of qualification (basic education, technical training, graduate studies and post-graduate studies).

   a) Less than 1 year

   b) Between 1 and 3 years

   c) Between 3 and 8 years

   d) Over 8 years

33) Value of imports:

   a) Inputs

   b) Machinery and equipment

   c) Other

34) Value of investment:

   a) Gross

   b) Machinery and equipment

35) Productive asset value.

36) Utilized installed capacity (%).

37) Average cost of a representative product.

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[6] This period is not defined as it depends on how frequently surveys are taken. The selected period should allow for the construction of temporal series.

INNOVATION ACTIVITIES

38) Does the firm engage in any of the following innovative activities? If the answer is YES, rate from 1 to 7, 1 being the highest. Choose 0 for activities the firm does not carry out.

a) R&D

b) Embodied technology acquisition

c) Disembodied technology acquisition

d) Training

e) Organizational change

f) Design

g) Marketing

39) Specify percentage of resources allotted to the following innovative activities:

a) R&D

b) Embodied technology acquisition

c) Disembodied technology acquisition

d) Training

e) Organizational change

f) Design

g) Marketing

40) Determine which special units or departments exist in the firm and the number of employees in each.

Unit – laboratory – department	*Existence*	*No. of employees*
R&D		
Design		
Quality control		
Engineering		

Research and Development (R&D)

41) If the firm has conducted research and development projects during the last 20 years, state number of employees working on R&D, average monthly salary and time devoted to these tasks.

Level of qualification	*No. of employees*	*Time devoted (%)*	Average monthly salary
Basic education			

Technical training			
Graduate studies			
Post-graduate studies			

42) How much has the establishment invested in in-house R&D?
   a) Staff costs
   b) Equipment
   c) Buildings
   d) Inputs
   e) Other

43) How much has the firm invested on external R&D contracts?

44) What results have R&D projects yielded?
   a) New products
   b) Prototypes
   c) New processes
   d) Pilot plants
   e) Patents
   f) Publications in indexed or international journal

Innovation efforts

Embodied technology

45) What volume of the firm's investment in capital goods has led to technological change and new products and processes during the last 20 years?

46) What is the country of origin of this technology?

47) How much has the firm invested in hardware over the last 20 years? (Specify if used for production or administration).

Disembodied technology

48) How much has the firm invested in licenses or technological transfer agreements such as patents, brands, industrial secrets over the last 20 years?

49) What is the country of origin of this technology?

50) How much has the firm invested in consultancies over the last 20 years?

51) Specify areas of application of consultancies:
   a) Production
   b) Productive system organization
   c) Product design
   d) Firm management

e) Finance

f) Marketing and distribution

52) What is the country of origin of the consultant or the consultancy firm?

53) How much has the firm invested in software over the last 20 years? (Specify if used for production or administration).

54) What is the country of origin of the software?

Training

55) If the firm has implemented technological training programs during the last 20 years, state the objectives of these programs:

a) Innovation and improvement of productive processes.

b) Product development, improvement and design.

56) Specify the average number of training hours received under those programs.

57) Has the firm implemented management and administration training programs during the last 20 years?

58) Indicate the areas the programs addressed:

a) Managerial

b) Administrative skills

c) Information technologies

d) Industrial security

e) Quality control

59) State the average number of training hours received under these programs.

60) State the firm's investment in technological and managerial training, as well as the number of trained employees according to level of qualification (basic education, technical training, graduate studies, post-graduate studies).

	Technological training	***Managerial training***
Expenditure (per year)		
Number of trained employees by level of qualification: • Basic education • Technical training • Graduate studies • Post-graduate studies		

Organizational modernization

61) Has the firm implemented organizational modernization programs during the last 20 years? (Specify which.)

62) Has the firm implemented programs to modernize production processes and management during the last 20 years? (Specify which.)

63) Has the firm implemented quality control and assurance programs during the last 20 years? (In which areas?)

64) Has the firm implemented environment management programs during the last 20 years? (In which areas?)

65) How much has the firm invested in organizational modernization activities? (Differentiate each category.)

Design

66) Specify the investment made by the firm in product design, industrial processes and industrial engineering over the last 20 years.

Marketing

67) Has the firm implemented new forms of distribution and marketing during the last 20 years?

68) Has the firm undertaken efforts relating to marketing of innovated products during the last 20 years?

69) Specify expenditure incurred in marketing activities.

INNOVATION FUNDING

70) State percentage of funds used by the firm to perform innovative activities according to funding sources.

   a) Own resources

   b) Related firm resources

   c) Parent firm resources

   d) Other firm resources

   e) Government

   f) Commercial banking

   g) International co-operation

INNOVATION RESULTS

71) Has the firm introduced new or improved products in the marketplace during the last 20 years?

72) These products are new for:

   a) Your firm

   b) The national market

   c) The international market

73) Does innovation affect the main product features?

74) Has the firm introduced new or improved processes in the plant during the last 20 years?

75) Is innovation central to the process?

76) Has the firm undergone organizational innovations during the last 20 years? (If so, indicate which.)

77) Has the firm introduced marketing innovations during the last 20 years? (If so, indicate which.)

78) Specify percent distribution of resources (human and financial) allotted to innovation of products, process and organization (including marketing).

79) What impact has the introduction of process, product and/or organizational innovations had on the following concerns?

a) Profitability

b) Cash flow

c) Market share

d) Competitiveness

e) Productivity

f) Environmental impact

g) Service quality

h) Labor relations

80) What impact has the introduction of process, product and/or organizational innovations had on the firm's economic performance?

a) Increase in sales and exports due to new and improved products

b) Cost reduction due to process innovation

c) Change in the use of production factors (labor, raw material and input, energy, fixed capital).

81) Have product, process and/or organizational innovations had any positive impact on any of the following concerns?

a) Water

b) Atmosphere

c) Soil

d) Landscape

e) Waste Products

82) Has the firm requested patents either in its country or in foreign countries during the last 20 years? (If so, specify countries.)

83) Has the firm obtained patents either in its country or in foreign countries during the last 20 years? (If so, specify countries.)

84) Has the firm licensed technologies during the last 20 years? (If so, specify countries.)

85) Does the firm have certified processes? If the answer is YES, state the entity (and country) that issued the certification and the corresponding date.

86) Does the firm have certified products? If the answer is YES, state the entity (and country) that issued the certification and the corresponding date.

INNOVATION GOALS

87) Rate the main five goals pursued by the firm throughout the innovation from 1 to 5, 1 being the highest.

a) Market goals:
   - Maintaining the current market
   - Widening the current market
   - Opening new markets

b) Cost reduction goals:
   - Unit labor cost
   - Material consumption
   - Energy consumption
   - Decrease rate of return
   - Inventory reduction

c) Quality associated goals:
   - Enhancing product quality
   - Improving work conditions
   - Lessening environmental impact

d) Product associated goals:
   - Replacing obsolete products
   - Widening current line of products
   - Opening new lines of products
   - Introducing environmentally sound products

e) Production associated goals:
   - Production flexibilization
   - Deadtime reduction
   - Improving environmental management (cleaner or ecoefficient production)

f) Opportunity exploitation:
   - Public policies
   - New scientific and technological knowledge
   - New materials

SOURCES OF INNOVATION INFORMATION

88) Rate the main five sources of information (in-house and external) used by the firm from 1 to 5, 1 being the most important.

a) In-house R&D department

b) Production department

c) Sales and marketing department of

d) Other department

e) Executives of the firm

f) Other related firm

g) Parent firm (if the firm is multinational)

h) Customers (national or foreign)

i) Competitors

j) Suppliers (national or foreign)

k) University, research or technological development center (national, international, public, private)

l) Consultants, experts (national or foreign)

m) Fairs, lectures, shows

n) Magazines and catalogues

o) Databases

RELATIONSHIP WITH THE NATIONAL SYSTEM OF INNOVATION

89) Indicate the frequency with which your firm contacts the different agents of the NSI by type of object of the co-operation or association agreements reached during the last 20 years. Also, specify the degree of satisfaction with each agent (totally satisfactory, adequate, inadequate, totally unsatisfactory).

Type of co-operation agreement objects:

- Essays, analysis and metrology
- Technological and market information search, processing and analysis
- Seminars and training courses
- R&D projects
- Product and process design
- Organizational change consultancy
- Technical help for technological or environmental problem-solving

Agents or institutions are:

- Public and private universities

- Public and private research and technological development centers
- Technical training institutions
- Test laboratories
- Intermediation bodies
- Suppliers
- Related firms
- Parent firm
- Other firms
- Consultants

Object / Agent	Tests	Information	Training	R&D	Design	Technical assistance	Organizational change consultancies	Degree of satisfaction
University								
Technological center								
Technical training institute								
Laboratories								
Intermediation entities								
Suppliers								
Related firms								
Other firms								
Parent firm								
Consultants								

90) For each co-operation and association object, indicate how much the firm has invested during the last 20 years and in what percentage the proposed goals have been achieved and the assigned schedule and budget been complied with.

Object	Tests	Information	Training	R&D	Design	Technical assistance	Organizational change consultancies
Investment							
Objective achievement %							

Schedule compliance %							
Budget compliance %							

FACTORS AFFECTING INNOVATION

91) Rate the following factors affecting innovation positively, neutrally, or negatively:

a) Business or microeconomic factors:
- ♦ Innovation capabilities
- ♦ Availability of trained employees
- ♦ Resistance to change
- ♦ Labor defection
- ♦ Risk of innovating
- ♦ Payback period
- ♦ Innovation costs

b) Mesoeconomic or market factors:
- ♦ Market size
- ♦ Market structure
- ♦ Marketing
- ♦ Sector dynamism
- ♦ Consumer response to new products and processes
- ♦ Opportunity to co-operate
- ♦ Technological opportunity
- ♦ Technological dynamism
- ♦ Need to innovate
- ♦ Funding costs
- ♦ Funding availability
- ♦ Risk of imitation

c) Macro or metaeconomic factors:
- ♦ Information on markets
- ♦ Information on technologies
- ♦ Laws, regulations, standards, taxes
- ♦ Public institutions
- ♦ Science and technology institutions
- ♦ Physical infrastructure

- Copyright system
- Labor laws and regulations
- Quality of basic worker training
- Training costs
- Training center quality
- Availability of training centers

ASSESSMENT OF GOVERNMENTAL POLICIES ON INNOVATION, SCIENCE, TECHNOLOGY AND COMPETITIVENESS

APPENDIX – SUGGESTED BASIC FORM

FIRM IDENTIFICATION

1) Firm identification number (sample)
2) Tax-payer identification number (as standardized in the relevant country)
3) Firm name
4) Address, city, state/department
5) Telephone number and fax number
6) E-mail
7) Web site
8) Name of the firm's CEO
9) Name and position of the interviewee
10) Telephone number and fax number
11) E-mail
12) 3 or 4 ISIC digit classification of the firm
13) Identify the firm's 3 main products and sales share
14) Year of firm was set up in the country in question
15) Specify number and location of the firm's establishments
16) Specify if the firm belongs to a national conglomerate
17) Percentage composition of firm capital
    a) National
    b) Foreign (specify country of origin)
18) Multinational subsidiary
19) Longest period of foreign investment
    a) During the last 10 years
    b) Between 10 and 20 years
    c) More than 20 years
20) Specify type of ownership: co-operative, government, family, worker share, other

ECONOMIC PERFORMANCE

(The following indicators are to be obtained, where possible, from other surveys)

21) Sales value of products manufactured by the establishment and products manufactured by third-parties
22) Sales share (value) of innovated products during the last 20 years.
23) Market share

24) Production value

25) Total exports value

26) Exports share (value) of innovated products during the last 20 years

27) Gross earnings value, operating profit value and pre-tax profits

28) Total employment by qualification level (number of employees)

   a) Basic education

   b) Technical training

   c) Graduate studies

   d) Post-graduate studies

29) Average monthly salary according to levels of qualification (basic education, technical training, graduate studies and post-graduate studies)

30) Percentage distribution of employees (production and administration)

31) Value distribution of the payroll (production and administration)

32) Specify percentage labor turnover according to levels of qualification (basic education, technical training, graduate studies and post-graduate studies)

   a) Less than 1 year

   b) Between 1 and 3 years

   c) Between 3 and 8 years

   d) More than 8 years

33) Value of imports:

   a) Inputs

   b) Machinery and equipment

   c) Other

34) Value of investment:

   a) Gross

   b) Machinery and equipment

35) Productive asset value

36) Utilized installed capacity (%)

37) Average cost of a representative product

INNOVATION ACTIVITIES

38) Does the firm engage in any of the following innovative activities? If the answer is YES, rate from 1 to 7, 1 being the most important. Choose 0 for any activities the firm does not perform.

   a) R&D

a) Embodied technology acquisition

b) Disembodied technology acquisition

b) Training

c) Organizational change

d) Design

e) Marketing

39) Specify percentage of resources apportioned to the following innovative activities:

a) R&D

c) Embodied technology acquisition

d) Disembodied technology acquisition

b) Training

c) Organizational change

d) Design

e) Marketing

40) Specify which special units or departments exist in the firm and the number of employees in each.

Unit – laboratory – department	*Existence*	*No. of employees*
R&D		
Design		
Quality control		
Engineering		

Research and Development (R&D)

41) How much has the establishment invested in in-house R&D?

a) Staff costs

b) Equipment

c) Buildings

d) Inputs

e) Other

42) How much has the firm invested in external R&D contracts?

Innovation efforts

Embodied technology

43) What has the volume of the firm's investment on capital goods implying technological change and associated to new products and processes been during the last 20 years?

44) What has the amount of the firm's investment on hardware been during the last 20 years? (Specify if used for production or administration)

Disembodied technology

45) What has the amount of the firm's investment on licenses or technological transfer agreements, such as patents, brands, industrial secrets been during the last 20 years?

46) How much has the firm invested on consultancies during the last 20 years?

47) How much has the firm invested on software during the last 20 years? (Specify if used for production or administration)

Training

48) State the investment made by the firm on technological and managerial training, as well as the number of trained employees, according to their level of qualification (basic education, technical training, graduate studies, post-graduate studies).

	Technological training	***Managerial training***
Expenditure (per year)		
Number of trained employees by level of qualification: • Basic education • Technical training • Graduate studies • Post-graduate studies		

Organizational modernization

49) How much has the firm invested on organizational modernization activities? (Differentiate among programs oriented to the firm as a whole, the productive process, quality control and environmental management.)

Design

50) Specify the investment made by the firm on product design, on industrial processes and on industrial engineering during the last 20 years.

Marketing

51) Specify expenditure incurred in on account of marketing activities.

INNOVATION FUNDING

52) State percentage of funds used by the firm to carry out innovative activities according to fund sources.

a) Own resources

b) Related firm resources

c) Parent firm resources

d) Other firm resources

e) Government

f) Commercial banking

g) International co-operation

INNOVATION RESULTS

53) Has the firm introduced new or improved products in the marketplace during the last 20 years?

54) These products are new for:

a) Your firm

b) The national market

c) The international market

55) Has the firm introduced new or improved processes in the plant during the last 20 years?

56) Has the firm achieved organizational innovations during the last 20 years? (If so, indicate which.)

57) Has the firm introduced marketing innovations during the last 20 years? (If so, indicate which.)

58) What impact has the introduction of process, product and/or organizational innovations had on the following concerns?

a) Profitability

b) Cash flow

c) Market share

d) Competitiveness

e) Productivity

f) Environmental impact

g) Service quality

h) Labor relations

RELATIONSHIPS WITH THE NATIONAL SYSTEM OF INNOVATION

59) Indicate the frequency with which your firm contacts the different agents of the NSI by type of object of the co-operation or association agreements that have been reached during the last 20 years. Also, specify the degree of satisfaction as to each agent (totally satisfactory, adequate, inadequate, totally unsatisfactory).

Type of co-operation agreement objects:

- Essays, analysis and metrology
- Technological and market information search, processing and analysis

- Seminars and training courser
- R&D projects
- Product and process design
- Organizational change consultancy
- Technical help for technological or environmental problem-solving

Agents or institutions are:

- Public and private universities
- Public and private research and technological development centers
- Technical training institutions
- Test laboratories
- Intermediation entities
- Suppliers
- Related firms
- Parent firm
- Other firms
- Consultants

Object / Agent	Tests	Information	Training	R&D	Design	Technical assistance	Organizational change consultancies	Degree of satisfaction
University								
Technological center								
Technical training institute								
Laboratories								
Intermediation entities								
Suppliers								
Related firms								
Other firms								
Parent firm								
Consultants								

ASSESSMENT OF GOVERNMENT POLICY ON INNOVATION, SCIENCE, TECHNOLOGY AND COMPETITIVENESS

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