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BUSINESS STATISTICS

**MEASURING INNOVATION IN BRAZIL: PROBLEMS, ACTIONS AND
CHALLENGES**

Note by the Brazilian Institute of Geography and Statistics

I. ABSTRACT

1. Many studies, since Schumpeter, have presented the importance of innovations in the performance of enterprises and, consequently, in the competitiveness and growth of countries. While the international experiences of measurement of this phenomenon refer to the 1950s, in Brazil the first survey with national coverage aimed at understanding and measuring the innovative capacity of the Brazilian enterprises was the Technological Innovation Survey carried out by the Brazilian Institute of Geography and Statistics in partnership with the Ministry of Science and Technology.

2. The purpose of this paper is to tell the story of Research and Development and Innovation Statistics in Brazil and the main difficulties and challenges faced by Technological Innovation Survey to measure and analyze the innovative process in Brazilian enterprises.

3. The Technological Innovation Survey (PINTEC 2000) is a pioneer survey which introduced new methods of collection in the Brazilian Institute of Geography and Statistics (IBGE). With three editions already published and preparation underway for the fourth edition, PINTEC has become the main source of information on the innovative activities in Brazilian enterprises.

II. INTRODUCTION

4. Although the idea of what is nowadays considered innovation is remote, in only the last few decades a concept of innovation has been disseminated and, consequently, been used by managers in the public and in private sectors.

5. Between the 1950s and 1980s, science and technology policy in developed countries was based on a linear vision of innovation, which considered that investments in R&D projects would be the driving force in the achievement of the objective of stimulating economic development and, particularly, the technical progress of the economy. During this period, statistics on R&D started to be produced. In 1963, the OECD published the first version of the Frascati Manual, for the standardization of collection practices, treatment and use of statistics on R&D.

6. In the 1980s, studies achieved important progress on the understanding of the innovation process, resulting in the revision of the concept of innovation: innovation has started to be considered a systemic process, which includes other activities of the enterprise besides R&D, as well as the flows of knowledge which result from the interaction of the enterprise with other actors in the national system of innovation. This has resulted in new requests for information, in order to intensify studies on the innovative process and on the factors which affect it, as well as to support planners in designing, monitoring and evaluating policy for the promotion of innovation. However, there was a lack of reliable standardized international methodologies which could guide statistical surveys in the measurement of innovation in its diverse aspects, particularly those related to other features of innovative process that were not related to R&D.

7. The first edition of the Oslo Manual was published in 1992 and was developed by OECD in cooperation with the Nordic Industrial Fund. This manual has become the main international guide for the collection and interpretation of data on innovation. Since 1992, this manual has been adopted as the reference for the first Community Innovation Survey - CIS I, carried out by the member countries of the European Union, as well as for CIS II and surveys carried out by other countries. The second edition of the Oslo Manual, published in 1997, introduced among its improvements the expansion of its guidelines for the service industries sector. The Oslo Manual, which is currently in its third edition (2005) and has included in its revision questions that are not related to technological innovations, is widely used in the innovation surveys carried out in the five continents, including PINTEC.

8. In Brazil, enterprise innovation has only been included in the agenda of industrial and technological policy since the second half of the 1990s. Until then, as a result of the intense participation of the Public sector in the Brazilian economy, the policy to support the scientific and technological development was conducted to increase the supply of technological goods and services such as:

(a) Public universities and agencies of promotion of research and scholarships to increase the qualification of human resources;

(b) Research institutes to attend the needs of technological services for enterprises and R&D centers in state-owned enterprises of strategic sectors such as oil, electric and nuclear energy, telecommunications, aircraft industry, steel industry, mining and quarrying, biotechnology applied to agriculture, etc.

Consequently, the information used to monitor such policy came from the administrative registers produced by the governmental institutions.

9. The great changes that have occurred in the Brazilian economy between 1990 and 1998 - such as opening up of trade, inflation and fiscal deficit control through severe monetary and fiscal policies, and the process of privatization of state-owned enterprises with the disarticulation of the research centers - have induced the revision of the instruments of promotion of technological development. In this period, a survey was conducted by the National Association of Research, Development and Engineering of Innovative Enterprises (ANPEI) to measure R&D in a panel of about four hundred enterprises¹ and another survey was conducted to identify the development of innovative activities in the manufacturing sector of São Paulo State, the Survey of São Paulo Economic Activity – 1996.

10. In the following years, the public policy for science and technology has included the dimension of enterprise technological innovation, providing a set of instruments to encourage investment in innovative activities in enterprises. The instruments were similar to those available for this purpose in the developed countries.

11. PINTEC was born in this context, with the objective of identifying and measuring the innovation activities developed by the national private sector, thus providing information to analyses on the performance of the sectors covered by the survey and for the monitoring and evaluation of policy. Carried out by IBGE, with the support of the Sponsor of Studies and Projects (FINEP) and the Ministry of Science and Technology (MCT), PINTEC was initiated in 2000 to collect information for the period 1998-2000, and was followed by PINTEC 2003, 2005 and 2008, the latter still in progress.

12. Although PINTEC is a successful experience, with an extensive use of its data by the academic community, enterprises and the Brazilian government, many difficulties have been faced in the planning and collection stages of the survey. This paper intends to present the main problems faced by PINTEC and how the survey turned them into challenges.

III. PROBLEMS AND ACTIONS

13. The main problems to identify and measure the innovative process are related to the fact that innovation is a rare and complex phenomenon with dispersed information at the level of the enterprises.

¹ These data had been used for the Ministry of Science and Technology to represent the R&D of the private enterprises in years nineteen nineties.

A. Rare phenomenon

14. The international recommendations suggest a survey with a comprehensive coverage of activities² for enterprises with 10 or more employees. In the Brazilian economy, there are a significant number of small enterprises. Technological innovation for products and processes (TPP) presents a strong correlation with the size of the enterprises and is concentrated in certain industries. These industries, in turn, are concentrated geographically. Such characteristics determined the decisions related to the scope and sample of PINTEC.

15. Due to budget restrictions and considering the objectives of the survey, IBGE in the definition of the activities to be covered by PINTEC gave priority to those activities which are the most technologically intensive in the Brazilian economy. Thus, the current scope of PINTEC³ includes all enterprises in the national territory with a legal existence that are considered active in the Central Business Register of IBGE, with ten or more employees and, according to ISIC revision 3.1, are coded in the activities of mining and quarrying; manufacturing; telecommunications; computer and related activities and research and development.

16. A study based on the results from PINTEC 2005 and from Community Innovation Survey IV of Spain, Italy, France, Norway and Sweden - for sections C, D, E, I, J and divisions 51, 72, 73 and groups 74.2 and 74.3 of ISIC Revision 3.1 - indicates that the activities covered by PINTEC represent around 89% of the expenditure with R&D and approximately 83% of the total expenditure of the enterprises with innovative activities. Therefore, to investigate data on expenditure in R&D for the enterprises with activities not covered by PINTEC, IBGE intends to use information available in the Fiscal Register of Legal Entities in order to reduce the respondent burden.

17. Concerning the sample, the Oslo Manual presents the random sample technique as the one that has proved to lead to reliable results. This technique is used in the official Brazilian business surveys for measuring economic phenomena that are, in general, common to all enterprises (number of employees, wages, value of the sales, etc.). The basic difference between innovation surveys and other business surveys is the fact that not all enterprises will be involved in innovative activities during the period considered.

18. Thus, the central hypothesis in which PINTEC sample design is based is that innovation is a rare⁴ phenomenon. Considering that it is a phenomenon that does not happen in all the selected units, the adoption of traditional sample design (generally random sampling stratified by localization, activity and size of the enterprise) could result in samples that would not adequately represent the fraction of the population of enterprises who had implemented innovations. This concern has determined the choice of working with a non-proportional stratified sample for the

² Sections C, D, E, F, G, H, I, J and K from ISIC Revision 3.1

³ PINTEC 2000 and 2003 have collected information only for sections C and D of ISIC Revision 3.1, as shown in Table 1.

⁴ In manufacturing (sections C+D), for example, PINTEC 2005 has showed that only 33.4% of about 91 thousand enterprises had implemented innovation of products and/or processes.

activities of manufacturing, telecommunications and computer related activities⁵. It has also indicated the necessity to previously identify in the register a selection of those enterprises which have greater probability to be innovative in order to increase the sample fraction for this subgroup and then to improve the precision of the estimates.

19. Considering the impossibility of a previous operation of screening, information from many sources⁶ are used to generate two groups of indicators:

(a) The main ones, which provide reliable indications that the enterprise has developed some innovative activity; and

(b) The secondary ones, which provide moderate evidence of innovative activity.

Table 1

Number of enterprises in PINTEC target population and sample

Activities ISIC Rev. 3.1	Target population				Sample			
	2000	2003	2005	2008 ⁽¹⁾	2000	2003	2005	2008 ⁽¹⁾
Mining and quarrying and manufacturing	72.005	84.262	91.055	106.820	11.044	11.337	13.575	14.955
Telecommunications			393	691			141	97
Computer and related activities			3.811	4.196			618	587
Research and development			42	65			42	65
Total	72.005	84.262	95.301	111.752	11.044	11.337	14.376	15.645

Source: IBGE, Technological Innovation Survey 2005.

(1) - Estimated Data

20. The first level of stratification of the target population of PINTEC is defined from these indicators, and the definition of three strata: a certainty stratum and two sample strata, differentiated according to the degree of uncertainty with regard to the presence of the phenomenon in study. The certainty stratum is formed by all manufacturing enterprises with 500 or more employees, service enterprises with 100 or more employees and those that present at least one main indicator and, in manufacturing, the enterprises with eight⁷ or more secondary indicators. The eligible sampled strata are composed by the manufacturing enterprises with a number of secondary indicators inferior to eight and service enterprises with some secondary indicator. Finally, enterprises without any indicator are placed in the non-eligible sample stratum and represent 20% of the total number of sampled enterprises.

⁵ The activity of R&D is collected through census survey due to the small number of enterprises in the business register.

⁶ Business registers which had benefited from tax incentives for R&D, from subvention and subsidized funding for innovation, patents database and from contracts for technology transfer, etc.

⁷ There are inclusions, a posteriori, of enterprises in the certainty stratum, due to the small number of enterprises in the population.

21. In a second level of stratification of the population, the geographic localization (the five geographic regions of Brazil and 14 selected States) and the economic activities are taken into consideration. The sample selection in each final stratus is carried out through an independent procedure, with the probability of selection proportional to the square root of the number of employees, to reduce the influence of big enterprises. The final size of PINTEC samples for 2000, 2003 and 2005, as well as the respective target populations, are presented in Table 1 on the previous page.

B. Complex phenomenon with scattered information at the enterprise level

22. The definition of what constitutes an innovation presents a set of difficulties for a statistical survey. When enterprises innovate, they are engaged in a complex set of activities with multiple results. The innovation processes vary greatly among enterprises, as well as among industries and, at least in the Brazilian case, the majority of the enterprises do not have a centralized “innovation management” system. Consequently, these enterprises do not have organized accounting of innovative activities.

23. There is definite improvement in comprehensive statistical surveys due to the introduction of the innovation definition (implementation of new products or new processes) and the introduction of significant organizational and marketing changes. However, there is a reasonable degree of subjectivity in these concepts and bordering cases among product, marketing, organizational and process innovation, mainly the latter two. This fact causes some difficulty in the description of what should be or should not be considered in a questionnaire that needs to be clear and concise. Manuals containing detailed instructions and examples are helpful, but they cannot be exhaustive and there is no guarantee that they will be read by the respondents.

24. The main problems that occur in the collection of data are of two kinds:

(a) Difficulty in assuring a homogeneous understanding of the questionnaire by the respondents;

(b) Expenditures with innovative activities are difficult to measure.

25. In Brazil, these problems are amplified. First, by the fact that a great number of enterprises are not familiar with the concepts and definitions adopted in the survey. Second, because the majority of the enterprises implement innovations of an adaptive, incremental character and the activities of R&D are often developed in informal structures. Considering such difficulties, and to assure standardization of the survey concepts, the method chosen for collecting information for PINTEC was interviews with all the enterprises in the sample, using CATI (computer-assisted telephone interview) or CAPI (computer-assisted personal interview) techniques.

26. The majority of countries that carry out innovation surveys use one of the following methods for data collection:

(a) The conventional post office;

- (b) A system of telephone interviews using a computer to identify the respondent of each enterprise in the sample who will receive the questionnaire, complete it and send it back using the post office or Internet.

27. Thus, the most innovative characteristic of PINTEC is related to the procedure it uses for data capture, which can be detailed as follows:

- (a) The first stage of the survey consists of the identification of the suitable respondent in the enterprise who will answer the survey using telephone monitored by a CATI system developed in IBGE. This respondent must be capable of understanding the concepts used in the survey and hold (or maintain) the required information;

- (b) When the respondent is found, the objectives of the survey are explained to him, and the Internet site where he can find information about the survey (the questionnaire, instructions, examples, results of previous surveys, etc.) is indicated. Then an appointment to begin the interview for data collection is set. For the large enterprises and also for those who request it, the questionnaire and related instructions are sent by Internet so they can prepare for the interview. But for the majority of the small and medium size enterprises, the interview begins at the moment the respondent is found;

- (c) The interviews are personal (the interviewer of IBGE meets the respondent) for the large enterprises (the ones with 500 or more employees) located in the 14 States where the enterprises are concentrated. In PINTEC 2005, approximately 900 companies were interviewed using this method;

- (d) For the other enterprises in the sample, about 13 500 in PINTEC 2005, the interviews are made by telephone.

28. For these two types of interviews, IBGE has developed electronic questionnaires with intelligent systems of data entry, which avoids asking questions that the enterprise is not required to answer; this procedure guarantees a minimum consistency for the collected information.

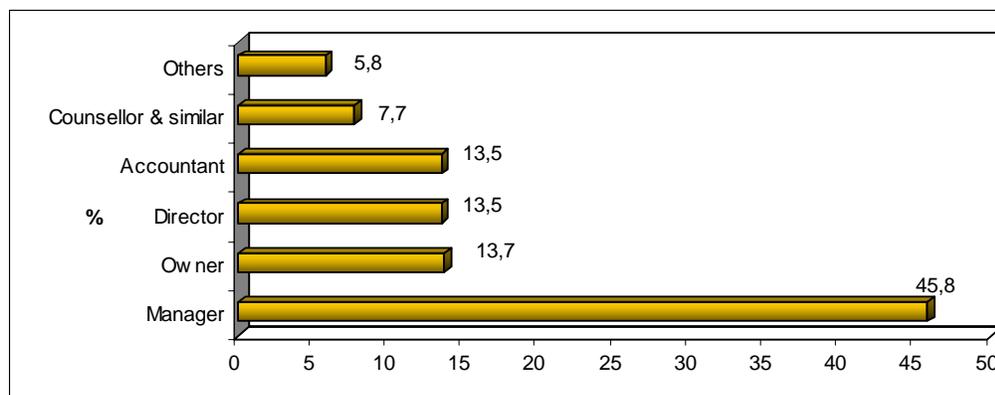
29. In the telephone interviews, the electronic questionnaire is part of the CATI; for the personal interviews, a notebook containing the same questionnaire as in CATI is used.

30. There are two different versions of electronic questionnaires, one to be used by manufacturing enterprises and another one by service enterprises. Both of them contain two types of questions: obligatory ones and facultative ones, which are only asked if the previous answers justify their demand. In other words, the electronic questionnaire is adapted to the reality of each enterprise and enables interviews with varied length of time, according to the kind of implemented innovation. A non-innovative enterprise in terms of product and/or process answers around twenty questions of the questionnaire and spends about thirty four minutes; an innovative TPP enterprise, with in-house R&D can answer up to a hundred and ninety-six questions in ninety minutes. It is important to point out that, usually, the medium and large innovative enterprises require more than one telephone call to conclude the questionnaire, mainly because of the estimation of the expenditures in innovative activities and of the staff in R&D.

31. There are several advantages in using this method of collection. It allows a more homogeneous understanding of the questions asked and also enables a continuous quality control of the procedures regarding how questions are asked and the given answers. This is due to the fact that this method uses two editing stages for the variables during the phase of the execution of the survey⁸. The editing of the data collected during the completion of the questionnaire points out inconsistent or discordant information, enabling the interviewer to correct possible errors or to justify the answers. The final editing of completed questionnaires gives the supervisors a better follow-up of the interviewers' performance and enables the perception of systematic errors and their correction, and avoids duplication of errors. Sometimes, this second stage of editing requires a second interview with an enterprise in order to clarify doubts or to correct errors.

32. Another positive aspect is related to the respondent of the survey. Table 2 shows the good results reached in the scheduling stage of PINTEC, to locate and then to interview the persons with knowledge of the innovative strategy of the enterprise: more than 80% of the survey respondents held positions with power to make decisions such as: owners, directors, managers, advisors of the leadership, etc.

Table 2

Respondents of the survey

Source: IBGE, Technological Innovation Survey, 2005

33. It is necessary to mention the reduced quantity of non-response which occurs mainly in the quantitative questions, like the topics on the expenses with innovative activities and with staff in R&D - around 100 in a total of 14 376 enterprises. In that it refers to the non-response of an enterprise, Figure 1 shows that the rate of refusal to answer in the survey is low in manufacturing (1.13%) and a little higher in the enterprises in the sample for services (4.48%), but that they are still considered to be at an acceptable level.

⁸ An additional editing procedure is used for aggregates which includes the comparison of the collected data with data from other sources and with results from previous years.

Figure 1
Distribution of enterprises according to collecting situation

Collecting situation	Manufacturing ⁽¹⁾ Plants (%)	Service Plants (%)
Operating/Implementing	93.63	85.11
Closed down/Not operating with information	2.43	3.29
Closed down/Not operating without information	0.69	1.84
Not operating at the industry surveyed	0.15	0.79
Moved to unknown or non-existent address	1.86	4.08
Impossibility of providing information	0.10	0.40
Refusal	1.13	4.48

Source: IBGE, Technological Innovation Survey, 2005.

(1) - Mining and quarrying, and manufacturing

34. Finally, an aspect always mentioned and pointed as disadvantageous with respect to this method is the cost of implementing it. In the Brazilian case, where there is no tradition in using the post office for surveys, only two alternatives were considered: to carry out the survey through the collection of data combining CATI and CAPI methods, but with a strong predominance of the CATI, or to collect the information using only CAPI method. Considering the continental dimensions of the country, this second alternative revealed to be much more expensive and this justified the adopted decision. PINTEC turned to be the first survey of IBGE carried on through the use of CATI method.

IV. FUTURE CHALLENGES

35. The third edition of the Oslo Manual brought new challenges to the innovation surveys of a large scope, in particular with reference to the organizational and marketing innovations and to the extension of the concept of innovation process.

36. For example, it is not an easy task in comprehensive surveys to understand the role of the organizational structures and practices in improving the quality and efficiency of work or in promoting the exchange of information, the learning and use of new knowledge by the enterprise and through the interaction with other enterprises and public institutions. This can be either because of the variety of methods that the enterprises may use to reach such results, or because of the fact that they might be tacit knowledge.

37. To resume, as the definitions of organizational and marketing innovations are less well-established than the ones concerned with technological innovations for products and processes, one of the challenges for innovation surveys is to better define the delimitations of these concepts, aiming at a more homogeneous understanding of the questions in the questionnaires and therefore, a better quality of the data collected.

38. Another challenge is related to the need to bring more stability to the concepts and to the core question guidelines in innovation surveys, in order to enable the respondents to acquire more familiarity with the questionnaire, to enable the comparison of time series of the survey's

results and to reach a higher level of harmonization of the results of innovation surveys carried out by different countries.

39. Finally, it is worth mentioning that it is necessary to create conditions to develop comprehensive analyses on the impact of the innovation in the performance of enterprises, through linking the data from the innovation surveys with data from other statistical sources.

40. Nowadays, important information from the annual business surveys and from administrative registers from international trade such as employees, wages, sales, costs, expenditures, added value, total assets, exports and imports are included in the PINTEC database in order to allow to study the impact of innovations on the performance of enterprises. To increase the analytical capacity of the survey by turning it into a sub-sample of the annual structural business surveys is the challenge that PINTEC 2008 intends to achieve.

41. The dissemination of this enlarged database to be used in analyses and specific surveys carried out by researchers or by public policy makers was the determinant factor for the extensive use of PINTEC by Brazilian society. PINTEC data can be obtained through special tabulations or through access to microdata, on the condition of following the rules of statistical confidentiality.

V. REFERENCES

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