

## Chapter 13

# Identifying Nanotechnological Systems of Innovation: Developing Indicators as a Tool to Support Nanotechnology Innovation Policy in Brazil

**Flávio J. M. Peixoto**

*Brazilian Institute of Geography and Statistics, Brazil & Federal University of Rio de Janeiro, Brazil*

### **ABSTRACT**

*Developments in nanotechnology have drawn the attention of governments, industry, academia and the public for their potential industrial benefits and their future trends within the innovation domain. The perception that nanotechnology promises important changes holds a rare opportunity to policy-making in its early stages. Understanding nanotechnology innovation process represents a crucial element for designing and implementing relevant, coherent and adequate innovation policy. This chapter proposes the development of an analytical framework to investigate nanotechnology paths. Results suggested that what has been generically labeled as ‘nanotechnology’ actually comprises a set of different, but complementary, technologies that may be represented as particular ‘nanotechnological systems of innovation’ to be used for analytical and policy designing purposes. The study attempts to contribute for the development of nanotechnology innovation indicators aiming to provide policy-makers with helpful data to support innovation policy design and foster nanotechnology development in Brazil.*

### **INTRODUCTION<sup>1</sup>**

Innovation surveys are generally set up to provide information to policy-makers and researchers to have a better understanding of innovation processes. With the data collected, indicators are to be designed to unfold particular features of the innovation processes that shall allow policy-makers to run more accurate diagnoses in order to enable the shaping of a more adequate innovation policy. In practice, innovation indicators are conceived to measure the level of innovative activity as performance indicators, as well as the amount of financial and human resources devoted to innovation activities as input indicators. These

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surveys are normally carried out based on the subject approach, i.e. to provide information concerning the innovative behaviour of the firm, not a specific innovation or set of innovations.

With the rising of a new potential revolutionary technology it becomes evident the necessity to better understand it, as well as its innovative process. When this technology is not concentrated in only one industry, but in several economic activities, affecting them in different ways, one may call it a general purpose technology, or a set of general purpose technologies, such as the case of nanotechnology.

Nanotechnology is a term that represents a set of technologies, with different innovation processes, that share in common the ability to manipulate atoms and molecules at the nanometric scale in order to build structures and devices with new properties and functions. Thereby, understanding nanotechnology requires a broader comprehension about distinct technological systems of production and innovation.

It is expected that such (nano)technological systems of innovation have different and specific dynamics, requiring innovation policies also to be as specific as possible in order to comply with those specificities in order to be more efficacious.

In Brazil a set of actions and instruments were introduced in the last decade to build the initial structure and foster innovation in this new emerging field. As partial results policies have achieved important outcomes and were essential for the first developments of nanotechnology.

Two main features prevailed in nanotechnology innovation policy in Brazil: i) Policy placed a strong emphasis on the scientific side of nanotechnology (supply side); and ii) Policy was generalist, i.e. considering nanotechnology as a single technology rather than a set of technologies.

In this regard, strategies and instruments had not been planned to assist specific sub-areas and application fields in which nanotechnology evolves, acknowledging the multiplicity of research/engineering approaches. This scenario not only indicates that nanotechnology innovation processes were then poorly understood by policy-makers, but also data available about innovation in nanotechnology were still incipient.

Therefore, the design of indicators that may better reflect nanotechnologies' specific features are necessary and still to be made. These indicators should not only explore the innovative behaviour of firms as whole (subject approach) but also their behaviour concerning nanotechnology activities, and the specificities of each nanotechnology innovation process (object approach).

This chapter aims to discuss the importance of considering the two main approaches of innovation survey to conduct a nanotechnology innovation survey in order to provide more meaningful data to policy-makers to design and implement more adequate innovation policy to nanotechnology in Brazil.

The chapter is organised in six sections beyond this introduction. The following sections will briefly present the main features of nanotechnologies that could be used to form a single definition, highlighting the importance of analysing nanotechnology as a set of technologies (section 2), and then propose and highlight the relevance of analysing the distinctive nanotechnologies innovation processes through the lens of technological system of innovation perspective (section 3). Section 4 presents the two main approaches normally used to carry an innovation survey, presenting their advantages as well as their limitations. This section will also present the proposed integrative approach of innovation survey to carry out a nanotechnology innovation survey. Then, section 5 will briefly present the main results of the application of this method by proposing the building blocks of nanotechnological systems of innovation as a useful tool to understand innovation processes and dynamics in different nanotechnologies. Finally, some innovation policy implications and a future agenda are discussed from the introduction of this framework.

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