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### **Research Policy**

journal homepage: www.elsevier.com/locate/respol

## The point of view of firms in Minas Gerais about the contribution of universities and research institutes to R&D activities

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#### ARTICLE INFO

Article history: Received 13 March 2009 Received in revised form 3 July 2012 Accepted 17 July 2012 Available online 9 August 2012

JEL classification: O30 L60

Keywords: National System of Innovation Interaction between firms and universities Cluster analysis Research and development in Minas Gerais

#### ABSTRACT

The purpose of this paper is to analyze the interactions between firms, universities and research institutes based in Minas Gerais, Brazil. The theoretical standpoint is the innovation system of developing countries. Multivariate cluster analysis is used, more specifically, the Grade of Membership method, to group firms with similar characteristics and evaluate their pattern of interaction with universities and research institutes. The main results show that the highest rates of interaction are found among firms that manufacture chemical products, cellulose, paper and paper products, followed by those engaged in the extraction of metallic and non-metallic minerals.

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#### 1. Introduction

This paper discusses the contribution of universities and research institutes to research and development (R&D) activities performed by firms in Minas Gerais, based on a pilot project entitled "MG Survey", conducted in 2005. Its overall objective is to analyze the interactions of Minas Gerais firms with universities and research institutes from a business viewpoint. To achieve this objective, the firms in Minas Gerais that most use the services of universities and research institutes were located. The sampling for analysis was based on their size, origin of their capital, existence and location of R&D activities. The next step was to verify the types of information sources and the scientific disciplines that are considered most important by the firms.

From a theoretical standpoint, the concept of a National System of Innovation (NSI) is used to organize the discussion. Although this concept was developed to examine the institutional structure of developed countries, references will be made to the NSI of immature or developing countries, as is the case of Brazil.

In terms of applied economics, the MG Survey database is used to analyze the point of view of the firms about their interactions with universities and research institutes. Multivariate cluster analysis was chosen to classify groups of firms according to their profiles, pursuant to the similarity of their characteristics. The firm typology used, which will be explained in Section 4.2, considers three major groups or profiles. The main results found in this paper indicate that two profiles group firms which show interaction with universities and research institutes, while the third profile groups firms with weaker interaction with these institutions.

In addition to the introduction, the paper has four more sections. The second presents the theoretical framework. The third section



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puts in context the position of industrial and innovative firms in Minas with regards to Brazil as a whole. The fourth deals with methodology and is sub-divided into three items: database, analytical model and result analysis. Finally, the fifth section presents the main conclusions.

#### 2. Theoretical background of National System of Innovation and interactions of firms with universities and research institutes

The background for this discussion is the idea of the National System of Innovation (NSI). This key concept for evolutionary economy, no doubt more closely related to empirical evidence and appreciative theories (Nelson, 1998), was introduced with works by Freeman (1987) and Nelson (1993). The NSI is understood as a set of articulated factors, capable of promoting development, in a Schumpterian sense, through the creation, expansion and maintenance of an innovative environment, in a historical process. This process is non-reproducible either in time or in space, and results, generally unpredictable, in which institutions, markets, consumers, firms and the government are the main players and the interactions among them define the dynamics of the system.

In a similar articulation, Abramovitz (1989) uses the term "social qualification" to designate the social elements that identify, enhance and limit the potential of less developed countries to reach the levels of productivity found in leading countries. The educational content, the industrial and commercial characteristics, the financial organization and the capabilities for adaptation of this institutional arrangement are some of the main elements that determine the social qualification of countries. Specifically, this last notion of adaptability points to interaction between social qualification and the existence of technological opportunities, which could determine the potential of a technologically less-developed country to catch up to the leading ones. Thus, it should be considered that this potential for growth is high when the country is technologically less-developed; however, it will be even greater when, if in addition to being technologically less-developed, the country is socially advanced.

It is worth noting the differences expected between the innovation systems in advanced and in developing countries. In fact, evolutionary theory is focusing its attention on the issues relating to NSI in less-developed countries in what Albuquerque (2007) defined as a theoretical development which began with the Globelics network and the Catch-Up Project (Nelson, 2004). According to the author, "... the evolutionary development (and the researchers working within the NSI concept) turned to the periphery" (Albuquerque, 2007).

Therefore, it should be recognized that the elements that make up an NSI are present and act in a significantly different manner when developed and devolving countries are compared. Two elements that serve to explain this differentiation, for the purposes of this paper, are firms and institutions.

Nelson and Sampat (2001) draw attention to the fact that the term institution has been used to designate different things, inside and outside economic studies, according to the investigation performed, and they propose a definition of institutions that would be useful in dealing with economic questions; that is, "social technologies." The authors noted that, according to their definition, not all social technologies can be seen as institutions, but rather, only those that become a reference for actions and expectations, given their objectives and the environment in which they are inserted.

In line with this idea, universities, as institutions, play a crucial role. Nelson (1996) emphasizes their importance as the engine of modern capitalism, as a repository of public technological and scientific knowledge. This brings up a point which, according to Nelson himself, neither the Schumpterian model, nor more recent works at the same level of abstraction, were capable of understanding in its complexity; that is, the inter-relations between technology and science.

Nelson's argument is that academic science departments are important for technological progress insofar as they train scientists and engineers, who will be used by industry, and due to the studies they produce; in other words, for the knowledge they create (Nelson, 1996). On the one hand, this makes it possible to recognize the almost exclusive role that universities play in the formation and training of highly qualified workers. However, on the other hand, it makes it possible to recognize the production of knowledge, scientific advancement, as a key piece in technological progress and, of course, the privileged, though not exclusive, position of universities in this sense.

However, it must be said that other institutions, such as institutes and research centers, or even corporate laboratories, to a certain degree, execute the functions of training and production of knowledge, similarly to universities, and can often be treated in an equivalent manner, at least in regards to these two points.

Upon investigating the motives that lead firms to invest in research, Rosenberg (1990) concluded that the interactions and feedback between S&T are so strong that the firms begin to invest in basic science as a way to participate in a broader information network. In fact, the way that firms found to stay connected to this network is by doing research. Basic research is essential to monitor and evaluate the scientific and technological development performed out of the firm. Even if a considerable part of the research is done at the universities, firms need a team of internal researchers to at least absorb the knowledge created in other centers. Thus, the idea that knowledge, once created, does not cost anything and is accessible to anyone who wants to enter the market is incorrect, because "frequently substantial research capacity is required to understand, interpret and evaluate the knowledge that was placed on the bookshelf" (Rosenberg, 1990, p. 171).

In a specific note on the Brazilian case, the "relative underdevelopment of national business" (Lemos, 1988), can be related, on the one hand, to the low involvement and little experience of firms with the implementation of search routines, quantified by low participation of the productive sector in national R&D spending. On the other hand, with the poor preparedness of these firms to face more rigorous selection processes. To illustrate this point, note that according to the Main Science and Technology Indicators (OECD, 2009), R&D expenses in the United States reached 2.68% of the GDP in 2007, while countries like Germany, France, Japan and China invested 2.54%, 2.08%, 3.44% and 1.49% of the GDP, respectively, for the same year. In comparison, according to the Ministry of Science and Technology, (MCT, 2011) Brazil spent only 1.07% of its GDP in 2007 and 1.24% in 2009. During these years, the business sector was responsible for 0.5% and 0.59%, respectively.

A fundamental aspect for the purposes of this paper is to observe how the scientific and technological dimensions interact in developing countries. To this effect, Bernardes and Albuquerque (2003), suggest the existence of interaction regimes between science and technology related to the economic performance of countries. The NSIs are classified by them according to their maturity, whereby the mature innovation systems are characteristics of the developed countries, while the immature systems characterize the developing countries. In a mature NSI, the interaction between science, technology and economic performance takes place in all senses, generating positive feedback between scientific production (measured by papers indexed by the Institute for Scientific Information -ISI), technological production (measured by patents granted by the United States Patent and Trademark Office - USPTO), and national income (measured by GDP), all in per capita terms. On the other hand, in an "immature" system, these interactions occur only from

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