



Evaluating research efficiency within National R&D Programmes

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ABSTRACT

Relying on efficiency analysis, we evaluate to what extent policy makers have been able to promote the establishment of consolidated and comprehensive research groups to contribute to the implementation of a successful innovation system for the Spanish food technology sector, oriented to the production of knowledge based on an application model. Using data envelopment analysis techniques that allow calculation of a generalized version of the traditional distance function model for productive efficiency, we find pervasive levels of inefficiency and a typology of different research strategies. Among these, in contrast to what has been assumed, established groups do not play the pre-eminent benchmarking role; rather, partially oriented, specialized and “shooting star” groups are the most common patterns. These results correspond with an infant innovation system, where the fostering of higher levels of efficiency and the promotion of the desired research patterns are ongoing.

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1. Introduction

Efficiency analysis has been applied in many fields, but there are fewer examples of its application to study the socioeconomic impact of public R&D policies (Batterbury, 2006; Chelimsky, 1998; Cozzens, 2002), despite its relevance to evaluation studies (Cook and Sciolli, 1972; Cozzens, 2003; Joyce, 1980; Pedersen, 1977; Shapira and Kuhlmann, 2003). This stream of work has been addressed mainly to the design of efficiency measures related to university teaching and research activities, e.g. Beasley (1990, 1995) and Cherchye and Vanden Abeele (2005). We develop these ideas, focusing on the role played by particular public R&D instruments and policies—specifically the R&D projects financial scheme within the Spanish Food Technology Programme (SFTP).

In our efficiency analysis we introduce data envelopment analysis (DEA) techniques necessary to implement Chavas and Cox's (1999) generalized distance function. The generalized distance function allows for enhancement of outputs and contraction of inputs at the benchmark frontier, defined by the performance of the leading research groups. Analysis of efficiency rankings allows us to characterize different categories of research groups and their individual direct roles in generating a multidimensional output

mix¹ that contributes to the relative success of policy in shaping a comprehensive Spanish Food Innovation System (SFIS).

This work contributes to the literature by illustrating the benefits of using another critical and relatively neglected function of evaluation research, namely efficiency, which in our case is aimed at contributing to the policy learning process by providing policy makers with information on how well research programmes measure up to their particular targets.

In 1986, Spain's central administration took the decision to fully institutionalize public support for research and development (R&D) and innovation activities. Within the Spanish R&D Plan, many public actions have been introduced to foster activities in public research organizations (PRO), technology institutes and business firms. All of these actions or R&D Programmes, have their particular sectoral objectives, but share a common goal of *better articulation* of the Spanish innovation system (CICYT, 1988), i.e. the creation of a system in which the different agents involved in the innovation process – mainly public R&D managers, research groups operating in technology centres and universities, and private firms – are closely related through supportive networks (Lundvall, 1988, 1992). The R&D Programmes were accompanied by several financial tools, addressed to achieving the above-mentioned goal, which, for R&D projects, provided financial support for research groups in

¹ We provide a thorough description of this “multidimensional research output mix” later in the paper; however, it can be characterized as the output of R&D projects in terms of training (measured as completed PhD theses and trained people), science and technology (ISI articles and registered patents) and socioeconomic output (R&D contracts).

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PROs to carry out applied research, embodied mainly in international scientific publications, scientific personnel training, patent applications, etc., which are seen as the most relevant measurable outputs.

In this article we show how research groups supported by the SFTP have indirectly contributed to this objective by generating a multidimensional research output mix (Godin and Gingras, 2000; Tasse, 2003). The efficient performance of these groups within the innovation system is paramount as they are the providers of new knowledge that eventually should have commercial value for the private sector, and should orient public R&D managers towards the most suitable allocation of public funding for research to enable business firms to benefit from the knowledge created, enabling them to generate innovations to increase wealth and employment across the whole economy.

We evaluate the SFIS by focusing on the performance of public research groups, normally embedded in research and technology institutes and universities, in fulfilling this knowledge generation and diffusion role—see Olazarán et al. (2004) for a general introduction to the historical roles of research groups in the Spanish R&D system. We adopt an efficiency analysis methodology, which enables us to identify the output production performance of different types of research groups and to check whether it represents a multidimensional, balanced and comprehensive output mix (Menrad, 2004). This methodological approach has proved valid when analyzing performance within the Spanish innovation system, as Revilla et al. (2003) show for a particular policy instrument known as concerted projects—i.e. collaborative partnerships between companies and public research institutions. Their main result is that large organizations perform better than smaller ones as a result of increasing returns to scale, and therefore the larger the companies and research centres involved in a partnership, the higher the synergy that can be expected from it.

The paper is structured as follows. Section 2 discusses the methodological approaches proposed in the literature to justify public intervention in R&D activities when trying to shape a successful innovation system based on the expected multidimensional and comprehensive roles of research groups. This is followed by a discussion in Section 3 of the institutional framework that characterizes the Spanish innovation system (IS). In particular, we look at public managers – in charge of the design and implementation of R&D policies, and research groups – responsible for the execution of research activities that will contribute to the system. Section 4 introduces the efficiency measure adopted in this research, and shows how it is rendered operational by exploiting the generalized distance function and the specific DEA techniques that allow the calculation of productive efficiency. Section 5 presents our results, outlining and discussing the particularities of the data. Section 6 concludes with an overall assessment of the degree to which Spanish R&D policy and instruments have succeeded in promoting different patterns of research groups contributing to the establishment of a SFIS.

2. Public policies and the promotion of research

Arguments in the Economics of Science and Technological Change that favour public intervention are mainly responding to two opposite streams within this literature: the neoclassical, and the structuralist-evolutionary. According to the former, the justification for public intervention rests on the existence of market failures; production of new knowledge is associated with positive externalities and, thus, public R&D policies are justified (Arrow, 1962). The latter approach sees knowledge as an imperfect good that does not satisfy the usual characteristic of non-excludability (David et al., 1994). If we accept the non-rival nature of knowl-

edge, then the agents generating it will be able to appropriate only a small fraction of the social benefit produced, and it will be necessary to foster R&D activities at above optimal market level to justify public policies supporting these activities. This approach is linked to the systemic view of the innovation process in which the concept of IS is used to justify the existence of different agents and the relationships among them, to carry out innovation activities (Freeman, 1987; Lundvall, 1992). Within a structuralist-evolutionary approach, R&D public policies, to an extent, respond to the need to strengthen the role and involvement of IS agents (Lipsey and Carlaw, 1998; Metcalfe, 2002).

We rely on the concept and terminology of the IS articulation introduced by Rip and Nederhof (1986), to measure and test the capacity of the SFIS to establish a network of fluent and continuous knowledge flows among public and private agents. This articulation and concept is in line with Gibbons et al.'s (1994) description of the change over in scientific knowledge production from mode I to mode II and the subsequent role of relationships among agents to generate new and economically productive knowledge. Using benchmark efficiency analysis methodology we assess whether the SFTP has succeeded in promoting multidimensional output from the Spanish research groups, in terms of a focus on different research dimensions to ensure the transition to mode II knowledge production, while at the same time strengthening their relationships with private firms within the IS. In this context, and taking into account that diversity and specialization are key aspects of every IS (Jacobs, 1998), we assume different sets of research groups in terms of an efficient research output mix, with each playing a particular and meaningful role within the SFIS. To enable the participation of these different groups and to ensure the emergence of new path breaking groups in line with policy objectives, we need an appropriate management and allocation of R&D funds. It has been acknowledged that in the initial stages of any IS, and in order to maximize its future success, R&D and innovation policies should be aimed at establishing multiple new research groups or providing “seeding”, to afford a mix from which comprehensive and leading groups will emerge (Gerchak and Kilgour, 1999). The research question we address is: to what extent have R&D projects financed by SFTP become tools suited to the promotion of the productive efficiency in multidimensional research groups?

3. The institutional framework of the SFTP

The SFTP was launched in 1988 as part of the 1st National R&D Plan, and has continued to be an element of all its subsequent announcements. The financial support it receives represents around 5% of the National R&D Plan budget (Jiménez-Sáez, 2005). Thus, the importance of evaluating the SFTP in order to assess whether and to what extent its original objectives have been achieved is evident. Based on the resources devoted to the SFTP, the evaluation in this study could serve as a model for the other programmes within the Plan. Also, this analysis will complement other analyses and evaluations in this context (Acosta Ballesteros and Modrego Rico, 2001) and will contribute to filling the gap in Spanish R&D public policy evaluation.

The SFTP was defined in 1988 as a:

systematic group of research and development projects oriented towards the encouragement of research, technology innovation and development in the Spanish Food Technology sector. It is co-ordinated and complemented by other actions among which the training of specialized personnel² and the

² The SFTP originally included in the training of specialized personnel two different outputs: young researchers (grant holders) finalizing their PhD (thesis writing)

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