Available online at www.sciencedirect.com
ScienceDirect
Forest Policy and Economics 8 (2006) 762–773
Forest Policy and Economics
www.elsevier.com/locate/forpol

An analysis of productive efficiency and innovation activity using DEA: An application to Spain's wood-based industry

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Abstract

This paper intends to analyze the relationship between productive efficiency and innovation activity in Spain's wood-based industry. The methodology includes two levels of analysis. First, a non-parametric technique (data envelopment analysis, DEA) is applied with several inputs and outputs associated to economic and financial data. In a second stage, a logistic regression model explores the relationship between the property of efficiency and innovation activity indicators. This approach is used to analyze a set of firms in the following sectors: lumber and wood products, pulp and paper and wood furniture. Results do not show the existence of significant links between firm's efficiency and innovation activities. This outcome is consistent with a low firm priority toward R&D as a means to achieve competitiveness and an innovation strategy followed by many Spanish firms based on the acquisition of embodied technology available in international markets. In order to improve competitiveness in the long run, efforts should be made by Spanish wood-based firms to increase their production of in-house technologies.

Keywords: Production efficiency; Data envelopment analysis; Logistic regression; Innovation activity; Wood-based industry

1. Introduction

The Spanish forest sector science and technology (S&T) system has been transformed substantially in recent years. The funding, the organization and the institutional structure of research are substantially different today from those existing two decades ago. Drastic changes have also occurred in the amount of resources dedicated to research and development

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doi:10.1016/j.forpol.2005.06.004

(R&D), as well as in the performance of the forest sector S&T system.

Since the mid nineties, Spanish S&T policy discourse has been leaning toward a more innovation-centered approach with an increasing emphasis on the development of technologies and the application of knowledge at the expense of the creation of knowledge. A resulting outcome has been the introduction of modifications in the program composition and budgetary distribution of the National R&D Plan in order to enhance the promotion of innovation activity in the enterprise sector. In addition, new public–private partnerships initiatives have emerged in recent years (CICYT, 1999; Sanz-Menendez, 2003).

Budgetary increases along with institutional reforms have produced a positive impact on the scientific results of the forest sector S&T system. In the period 1987–1999, the annual average rate of growth of the number of forestry items in the Science Citation Index (SCI) published by Spanish authors was 20.69%, higher than in most developed countries (SCI search, 2004). The evolution of these items is shown in Table 1. However, the technological results of the Spanish forest sector S&T system are still far behind its scientific achievements. During the period 1987–1999, Spain accounted for only 3.17% of the number of forestry and wood product patent applications submitted to the Spanish Patent Office (*Oficina Española de Patentes y Marcas, OEPM*), lagging behind main European countries. Moreover, the proportion of Spanish patents has decreased throughout the same period (see Table 1).

Table 1
Forest Science items in SCI published by authors of Spain and patent applications submitted to the Spanish Patent Office (OEPM), 1987–1999

Spanish SCI items		Patent applications	
		Foreign	Spanish
1987	11	429	34
1988	11	508	44
1989	23	583	45
1990	20	899	44
1991	37	869	38
1992	69	948	32
1993	56	878	34
1994	64	1013	33
1995	94	1036	30
1996	100	1113	32
1997	121	1479	26
1998	117	1759	18
1999	127	1697	9

Source: OEPM and SCI search (SCI, 2004).

The weak technological results of the Spanish forest sector S&T system can be partially attributed to some unintended effects of R&D funding and evaluation policies (Jiménez-Contreras et al., 2002; MCYT, 2003). Possibly, a more important factor is the persistent barriers to technology innovation characterizing the Spanish industrial sector. After more than two decades of Government innovations policies and technology transfer programs (see Sanz-Menendez, 2003), recent studies indicate a low entrepreneurial priority toward R&D and other innovation activities as a means to achieve competitiveness (COTEC, 2004). This situation is particularly severe in the wood-based industry.

According to the National Institute of Statistics (INE), in 2001 the gross value added (GVA) of Spanish wood-based industry was 10,600 million € amounting to more than 10.6% of Spain industrial sector GVA (INE, 2002). However, in terms of R&D the relative importance of the wood-based industry within the industrial sector was lower than its economic proportion. In 2001 R&D expenditures in the wood-based industry were only 1.3% of total industrial R&D expenditures in Spain. In the same year the number of researchers in the wood-based industry represented only 1.7% of the total number of researchers working in the industrial sector (INE, 2002). In 2002, the share of total expenditures in innovation activity in the wood-based industry, excluding R&D, with respect to the whole industrial sector was 3.89%. This figure is slightly more favorable than that of R&D expenditures, but still relatively low (INE, 2002). Spanish wood-based industries R&D intensity (percentage of R&D expenditures on sales) during 1998–2001 was only 0.003% (ESEE, 1998–2000). This is an extremely low figure when compared with other countries. For example, Globerman et al. (1999) indicate a R&D intensity in the range of 0.4–1.0% for a variety of countries.

The Spanish wood-based sector is made of mostly small (less than 20 workers) and medium firms (between 20 and 50 workers). In 2003, a commercial survey taken at 5517 wood-based enterprises showed that 88.86% of the firms surveyed were small and medium enterprises with less than 50 workers. At least a minimum level of financial effort is required to set up R&D and innovation activities and this thresh-