



Linking public support, R&D, innovation and productivity: New evidence from the Spanish food industry



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ABSTRACT

This research provides novel empirical evidence of the relationship between public support for R&D, firms' R&D expenditure, innovation and productivity in the Food and Beverage (F&B) industry. The empirical framework relies on a modified version of the Crépon–Duguet–Mairesse (CDM) model, applied to a sample of 541 Spanish firms over the years from 2008 to 2011 (1910 observations). The first step in our model shows a great impact of public funding; firms receiving national funds invested 54% more in R&D than firms without this type of public support. The share of workers with a degree, and cooperation among firms are also relevant for engaging in R&D in the F&B industry. The second step points out the significant role of R&D expenditure for product and organizational innovation, while we did not find any significant effect for process innovation. The final step reveals that innovation output influences productivity with an elasticity of 0.29 for the innovation variable. Other significant factors affecting labour productivity are the size of the company, investment intensity, international competition, and having foreign participation of over 50% in the company.

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Introduction

Empirical research on the relationship between public support for research and development (R&D) activity, private R&D expenditure, innovation and firm productivity contributes to identifying actions and policies in order to improve the competitive position of companies. This is particularly relevant in the Food and Beverage (F&B) sector where, despite being classified as a 'low research intensive industry' because of its reduced R&D-to-sales ratio (García-Martínez and Briz, 2000),¹ R&D is required to obtain food products with specific characteristics demanded by consumers, such as quality, safety, ease of use and storability. Moreover, the sector has to deal with the challenges of developing new technologies, using fewer chemicals and taking care of the environment (Rollin et al., 2011).

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¹ The data available for 2011 show that the R&D/sales ratio of the Spanish F&B sector is 0.19%; the majority of economic activities in the Spanish manufacturing industry presents a considerably larger ratio (e.g. Computer, electronic and optical products: 1.9%; Chemicals and pharmaceutical products: 1.7%; Motor vehicles and other transport equipment: 1.6%; Manufacture of textiles, leather and related products: 0.5%, etc.). The R&D/sales ratio of the Spanish F&B is similar to the European average, but lower than for the US (0.5%).

R&D activity usually leads to the development of new products, to the introduction of new machinery for processing and the adoption of new ways to reorganize management; product, process and organizational innovations that contribute to satisfy the demand of the consumer, help a more efficient production and meet environmental regulation. Additionally, these innovations are considered one of the most important factors to reduce costs, which will in turn enhance competitiveness in both national and international markets (Grunert et al., 1997; Rama and Von Tunzelmann, 2008). In this paper we look into the causes explaining why some firms decide to invest in R&D and to what extent, and particularly we focus on the role of public support in this process. Furthermore, we link R&D, innovation and productivity by providing empirical evidence of two different roles of R&D activity in the F&B sector at company level. On the one hand, we analyse the direct effect of R&D – along with other inputs – for stimulating product, process and organizational innovation. On the other hand, we enquire into the factors enhancing productivity through the generation of these three different types of innovations. The paper intends to answer the following research questions: What is the role of public funding in driving the firms' R&D decision and intensity? To what extent does investing in R&D promote innovations in the F&B industry? What other determinants – in addition to R&D – are

crucial in stimulating innovation activities? What kind of innovation is more beneficial in terms of productivity? What other sources of productivity are relevant for food firms?

The Spanish context is particularly useful for this analysis because the F&B industry in this country is one of the most important sectors of the national economy. With 457,000 employees, the F&B industry accounts for 19.6% of employment and 19.2% of the gross domestic product (GDP) in the Spanish manufacturing industry. At the same time, the sector shows a great dynamism: since the onset of the economic crisis up to the last available information (2008–2011) the whole sector has grown in Spain by about 3.6%; in contrast, manufacturing industry has decreased by 7.1% and the contraction of the whole economy has reached 4% in terms of GDP.

Our empirical framework for analysing the two roles of R&D relies on the Crépon–Duguet–Mairesse (CDM) model of R&D, innovation, and productivity (Crépon et al., 1998). These authors developed a model involving several equations in which R&D effort explains innovation and the latter explains productivity. The model has been subsequently modified or extended, including several additional aspects (e.g. Antonietti and Cainelli, 2011, consider the role of urbanization; Hall et al., 2013, focus on information and communication technology, etc.) or suggesting methods for its estimation (e.g. Huergo and Moreno, 2011). We estimate a version of the CDM model developed by Griffith et al. (2006) that uses product and process innovation dummy variables as the measures of innovation output. Our empirical model is similar to Griffith et al. (2006) but it includes organizational innovation (along with product and process innovation) and it is properly adapted to the specificities of innovation surveys in Spain and the F&B sector. Many researchers have applied this methodology to different contexts but, due to the unavailability of data, there are few who undertake the analysis of specific industries. For this research, we count on a panel of roughly five hundred Spanish food firms, observed in the period 2008–2011. The main advantage of our data set is that it contains a large set of firm-level variables about R&D activity, product, process and organizational innovation, along with other relevant variables including capital investments and labour productivity.

This paper contributes to the literature in two ways: first, some authors claim that more research is required on drivers of innovation and types of innovation in the F&B industry due to its specific characteristics and effects in terms of generation of employment (e.g. Avermaete et al., 2003; Menrad, 2004; Baregheh et al., 2012). Others (e.g. Traill and Meulenbergh, 2002) call for further insights into innovation orientation and its link to organizational performance. However, research on types of innovation within the food sector has been largely focused on both product and process innovation (e.g. Avermaete et al., 2004; De Jong and Vermeulen, 2006; Ma and McSweeney, 2008; Capitanio et al., 2009, 2010; Triguero et al., 2013).² Our paper examines organizational innovation along with the more studied product and process innovation in the frame of the CDM model. Second, none of the previous empirical papers investigating the relationship between R&D, innovation and productivity has dealt, to our knowledge, specifically with the F&B industry.

The paper is organized as follows. Section 'R&D, innovation and productivity in Food industry' summarizes the literature relevant to this paper. Section 'Model' establishes the model for analysing the R&D–innovation–productivity relationship. Section 'Data, variable descriptions, and descriptive statistics' explains the data sources, describes the variables and examines some patterns of R&D, innovation and productivity in Spanish F&B firms.

Section 'Results and discussion' presents and discusses the results from the CDM model. We briefly summarize the conclusions in the final section.

R&D, innovation and productivity in food industry

It is well known that not all firms are engaged in R&D activity and this is particularly true in the food industry, in which a distinctive feature is the fact that the sector presents a low R&D intensity, while at the same time this sector produces a significant number of innovations (Grunert et al., 1997; Harmsen et al., 2000; Capitanio et al., 2009). This imbalance between a low R&D expenditure and a high production of innovations can be explained through several facts. Firstly, the European F&B industry is dominated by small and medium firms, which means that in practice, many innovations are first developed by smaller companies that may lack the scientific, engineering and management know-how to commercialise their own technology (Fryer and Versteeg, 2008). Secondly, firms in the F&B sector are viewed as operating in a mature and relatively low technology area (Grunert et al., 1997), where the most important way of innovating is by investing in equipment and capital goods, which means that the ratio of R&D to sales is generally low. Thirdly, a great number of innovations in the food industry are improvements to new food products or variations of existing products (Baregheh et al., 2012); that is, the advances in technology are more incremental than radical, and this may be due to conservative consumer behaviour and aversion to new food products (Galizzi and Venturini, 1996; Grunert et al., 1997). Fourthly, F&B firms are exposed to external sources of knowledge including business relationships, a well-developed inter-industry network or purchasing equipment and materials. As a result, food firms take advantage of external knowledge and might have no need of generating this knowledge through internal R&D expenditure. For example, the F&B sector captures external knowledge from multiple scientific and technological sectors such as pharmaceuticals, chemicals and agriculture (Connor, 1988; Galizzi and Venturini, 1996; Wilkinson, 1998); the machine tools and the electrical product sectors (Johnson and Evenson, 1999); nanotechnology (Sanguansri and Augustin, 2006; Sastry et al., 2010) or biotechnology (Levidow, 2002; Carew, 2005). Obviously, the acquisition of this knowledge is not solely a matter of exposure; some degree of absorptive capacity is necessary for the acquisition of external knowledge. Moreover, many innovations in the food industry are produced by applying and transferring knowledge from other sectors, which means that the food industry brings to the marketplace the benefits of research conducted further upstream (García-Martínez and Briz, 2000; Traill and Meulenbergh, 2002).

The previous literature suggests that several variables influence the R&D capacity of the F&B firms (their size, as most of them are small or medium firms; their capacity to absorb external knowledge, etc.). Along with these factors that characterize the food industry and partly explain its low R&D intensity, there are other variables pointed out in the general literature on R&D determinants that also might help to shed light on why F&B firms decide to carry out R&D activities and to what extent. The main theoretical argument relies on the fact that the firm productivity level directly impacts upon the firm's profit, and the firm will be able to influence its future productivity through its investments in R&D (Roberts and Vuong, 2013). Several theoretical models have been put forward to explain the firm's optimal choice of R&D, which will differ depending on changes to either the costs or benefits of R&D, non-linearity, heterogeneity and uncertainties in the R&D process (Aw et al., 2008, 2011; Roberts and Vuong, 2013). Empirical studies have accounted for these factors in identifying several types of determinants that can be broadly categorised in

² The work by Minarelli et al. (2015) is an exception. The authors apply non-parametric analysis to study other types of innovation such as market and business organization innovation in the Italian food sector.

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