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Innovation in the Spanish Food & Drink Industry

Marian Garcia Martinez[a,*,1], Julian Briz[b,2]

[a]*Department of Agricultural Economics and Business Management, T.H. Huxley School, Imperial College at Wye, Wye, Ashford, Kent TN25 5AH, UK*
[b]*Department of Agricultural Economics, Polytechnic University, Madrid, Spain*

Abstract

This article examines the innovative performance of the Spanish Food & Drink Industry (F&DI). Results highlight the 'evolutionary' rather than 'revolutionary' nature of innovation activities in the Spanish F&DI. However, the adoption of 'defensive/imitative' strategies by Spanish F&D manufacturers raises important questions given the current manufacturer-retailer relationship with an increasing emphasis on innovation by food retailers when accepting/rejecting new products. The paper stresses the importance of in-house technological capabilities in innovation performance with a higher probability for Spanish F&D firms to be 'truly' innovative the higher their technological autonomy level.

1. Introduction

The Food & Drink Industry (hereafter F&DI) is an example of how scientific developments can rapidly manifest themselves in technological changes in the production and consumption of commodities (Strak, 1989). Since technological change in the F&DI is largely technology-based rather than science-based, innovative performance is poorly related to R&D intensity. The F&DI is typically classified as a '*low research intensive industry*' accounting for one of the lowest R&D-to-sales ratios of any industrial sector (Sandven & Smith, 1993; Connor & Schiek, 1996). Moreover, the pace of technological change in the F&DI, measured by the number of patented inventions, seems less dynamic than other manufacturing sectors (Christensen et al., 1996).

* Corresponding author. Tel.: +44-20-75942962, ext. 562; fax: +44-20-75942838.
E-mail addresses: M.Garcia@wye.ac.uk (M. Garcia Martinez), jbriz@eco.etsia.upm.es (J. Briz).
[1] Lecturer in Food Industry Management.
[2] Professor in Food Marketing.

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However, empirical research has stressed the important contribution made by upstream industries to the F&DI's technological development (Scherer, 1982; Marengo & Sterlacchini, 1990; Klevorick et al., 1995; Rama, 1996; Christensen et al., 1996), showing how some industrial sectors, like the F&DI, benefit from the impact of technological progress in core sectors of high technological opportunity (i.e., biotechnology, microelectronics, computer technology) through a well-developed network of interindustry purchases and sales of equipment and materials. For the Spanish F&DI, empirical evidence shows the important contribution of national and foreign suppliers of machinery and equipment to the Spanish F&DI's technological level (Garcia Martinez & Burns, 1999). Results on the instruments used by F&D firms to acquire technological knowledge reveal the purchase of equipment as the main source of technology acquisition as opposed to information gathering procedures. Hence, the F&DI's technological inertia or dynamism should not be evaluated in isolation but in the light of the rich interplay taking place between F&D manufacturers and their suppliers (Rama, 1998).

Current developments in food retailing have further emphasized the importance of technological change and innovation for F&D manufacturers in their attempts to maintain a competitive advantage. While new product development (NPD) has traditionally derived from food manufacturers' R&D efforts, retailers, increasingly, have sought to extend their range of own label products through joint development program with their suppliers. Data for the UK market identified food retailers as the driving force behind NPD with 59% of new introductions in 1995 being own labels (Food Manufacture, 1996b). If originally, own labels were considered as a low quality alternative choice based on lower prices than branded products, nowadays, they compete on quality, technology and packaging with manufacturers' leading brands. In some countries, particularly the UK, own label products compete with the best selling branded products within each grocery category on price and consumer perception that own labels are supplied by leading food manufacturers.

The progressive growth in own label market share represents a major competitive threat for many food manufacturers. However, product sectors dominated by strong manufacturer brands and unique product lines act as a deterrent to own label developments due to high cost of entry (McMaster, 1987), and the coercive sources of power of suppliers. Retailers will be more dependent on well-known manufacturers whose products are unlikely to be de-listed, and thereby negotiation balance will be maintained. Selnes (1993) pointed out the importance of brand name in building up loyalty, and thereby the significance of marketing activities (i.e., advertising, promotion, packaging, etc.) in the process. The analysis of Rao et al. (1995) showed the importance ascribed by retailers to marketing activities and product uniqueness in accepting or rejecting new products. The study indicated the relevance of advertising and differentiation strategies as plausible alternatives open to manufacturers in order to stem the growth in own label market shares (see, also, Quelch & Harding, 1996).

It is important, however, to emphasize that a significant proportion of new food product introductions corresponds to variations of existing products rather than 'real' innovations. Ersnt & Young (1999) study on new product introductions in the European consumer goods industry revealed that out of the 5,561 new products introduced in the Spanish food industry in 1997 (in 31 product categories) only 0.4% of products could be classified as 'true new products' while the bulk of new introductions (96%) corresponded to 'me-too' products.[1] To

secure more shelf-space many F&D manufacturers have chosen to expand their range through a program of brand proliferation which has resulted in a huge number of 'me-too' products not offering any apparent consumer-relevant advantage.

Hence, in the face of increasing competition from own label products, F&D manufacturers can elect to remain passive and continue to lose market power, or to be pro-active and take the commercial initiative. A strategy open to F&D manufacturers is innovation, preferably in processes and products that have proprietary elements that can be protected (i.e., that make it difficult for the retailer to produce a "me-too" product). F&D firms seeking to supply standard products at a minimum cost are more vulnerable to retailers' demands for discounts or own label versions, while firms involved in the production and promotion of differentiated products would be able to avoid these pressures either by creating demand for their differentiated products, '*consumer loyalty*', or by developing new products. Innovation and R&D, therefore, should be considered in the light of marketing activities as strategic weapons to raise barriers to entry and fixed costs.

This paper examines the innovative performance of the Spanish F&DI. The following section describes the technological level of the Spanish F&DI in order to set up the framework, which will help to understand the results presented in this paper. Section two discusses the research methodology and section three analyses the innovative activities in the Spanish F&DI by looking at the nature and main objectives of innovation by Spanish F&D firms, as well as the main factors impeding innovation at company level. Section four examines the innovative performance of surveyed F&D firms through the analysis of their innovation output, and clusters firms according to their innovative performance. The article concludes with the implications for the F&DI of its '*defensive/imitative*' behavior given the current manufacturer-retailer relationship.

2. Technological level of the Spanish Food & Drink Industry

From a technical point of view the Spanish F&DI behaves similarly to that of other developed countries. It acquires and adapts innovative processes, mainly automation, generated in other sectors, and introduces new food products in the market. Though the Spanish F&DI allocates proportionally a greater share of its total cost to R&D in comparison to most European countries, it is still heavily dependent on foreign technological advancement, which can be seen from the elevated value of payments for technical assistance and patents, designs and brands to foreign companies. Buesa's (1992) analysis on the country of origin of patents granted in Spain over the period 1967–1986 shows the dependency of the Spanish F&DI on foreign patents, in particularly on technology generated in the US. Similarly, Caldentey (1996) using the Spanish Office of Patents and Trade Mark database, reports that of the 232 patents granted in 1992 in the food technology area, 28.4% were of Spanish origin while 71.6% came from other countries. These findings highlight the reduced importance of Spain as a source of food technology.

However, the study of Christensen et al. (1996), based on the number of foreign patents issued in the US, portrays a more dynamic picture of the Spanish F&DI over the last decades. Starting from a very low technological level, Spain's F&DI has exhibited a significant

Table 1
Size distribution[a] in the European F&DI

Country	Enterprises			Employment			Output		
	Micro & Small	Medium	Large	Micro & Small	Medium	Large	Micro & Small	Medium	Large
Ireland[b]	86.5	12.8	0.7	39.7	48.3	12.0	34.8	56.2	9.0
Greece	89.6	9.4	1.0	n/a	n/a	n/a	31.3	41.3	27.4
Sweden	95.2	3.2	1.6	23.6	21.1	55.3	22.5	24.9	52.6
Denmark	95.4	3.5	1.1	35.7	20.9	43.4	21.3	18.9	59.8
Netherlands	97.7	3.3[c]	—	45.6	54.4[c]	—	34.8	65.2[c]	—
UK	97.7	1.7	0.6	20.4	15.6	64.0	18.2	16.1	65.6
Portugal	97.9	1.9	0.2	48.3	33.9	17.8	35.5	38.1	26.4
Belgium	98.0	1.7	0.3	47.3	27.1	25.6	45.7	31.2	23.2
Italy	98.2	1.5	0.3	57.5	20.0	22.5	48.6	24.6	26.8
Germany	98.3	1.5	0.2	57.8	23.6	18.6	28.0	31.8	40.2
France	98.5	1.2	0.3	52.2	21.0	26.8	33.0	29.1	37.9
Spain	98.9	0.9	0.2	58.6	21.3	20.1	59.0[d]	31.0[d]	10.0[d]

[a] Micro & Small: 0–99 employees; Medium: 100–499 employees; Large: 500+ employees.
[b] Enterprises with greater than 3 employees.
[c] Medium and large enterprises combined.
[d] Data from National Statistical Services.
Source: Eurostat, Enterprises in Europe 3rd Report, 1994.

increase in the number of food patents between 1969 and 1994 (450%), and is among the most dynamic Western F&DIs. This growth rate is significantly higher than that for Spanish industry as a whole (112%). Moreover, the study shows that the share of patents for food related fields (i.e., equipment, biotechnology) also improved over the studied period. These findings stress again the interplay of the Spanish F&DI and its suppliers, and thereby an important interface to support in the future technological development of the Spanish F&DI. However, the industry cannot rely exclusively on national sources for its technological development, since the technological level of domestic food related industries is, in most cases, lower than their European counterparts. However, the fact that main equipment producers and chemical companies are placed in core regions of the EU limits the access of small and medium sized enterprises (SMEs) in Less Favorable Regions (LFRs) to new technological developments (Tsipouri et al., 1994).

The small average size of Spain's F&D companies constitutes one of the main barriers if the Spanish F&DI wishes to reach EU technological levels. The Spanish F&DI is becoming more concentrated as a small group of large, vertically integrated companies, namely multinationals, account for a large share of total output. However, the industry is largely a small-scale business with 99% of the establishments in 1992 having fewer than 99 employees- this proportion is twice that in the rest of the manufacturing industry. While a similar degree of fragmentation also exists across the EU F&DI, Table 1 shows important inter-country differences. For instance, output levels by firm size vary significantly among EU countries as an indication of the level of modernization of F&D firms in each country. Spain's larger firms (500+ employees) account for 0.2% of all establishments in the industry and only for 10% of total turnover, whereas large companies in Germany and the UK exhibit

Table 2
Intramural expenditure on R&D by sector and employment, 1988–1995

Sector	1988 %	1989 %	1990 %	1991 %	1992 %	1993 %	1995 %
Meat and Meat Products	14.0	12.1	10.2	14.6	13.9	16.6	22.2
Fish and Fish Products	7.4	2.0	2.9	1.6	1.5	5.5	10.3
Fruits & Vegetables	5.6	0.8	3.1	3.4	5.3	5.4	6.7
Organic Oils and Animal Fats	4.2	1.7	6.0	6.5	4.6	3.5	2.3
Dairy Products	14.6	20.5	18.3	17.5	15.2	11.3	13.0
Grain Mill Products	2.3	3.8	6.4	3.6	1.9	3.9	1.5
Animal feed stuffs	2.7	3.3	5.8	3.9	6.5	6.5	4.8
Miscellaneous food products	34.9	36.8	33.4	36.7	35.8	29.5	29.2
Beverages	14.4	19.1	13.8	12.3	15.4	17.9	9.9
Employment	1988 %	1989 %	1990 %	1991 %	1992 %	1993 %	1995 %
Less than 25 employees	4.1	4.4	8.9	3.9	2.6	5.7	3.5
25–49 employees	4.7	2.2	3.2	7.6	10.1	7.9	5.2
50–99 employees	1.5	0.8	4.6	7.9	9.1	4.3	14.9
100–249 employees	12.7	16.0	11.7	6.9	10.1	10.0	13.4
250–499 employees	12.0	17.2	17.1	20.2	22.6	29.1	28.6
500–999 employees	13.0	9.9	12.2	10.6	11.1	12.1	13.6
More than 1000	52.0	49.6	42.3	42.8	34.4	31.0	20.8
Total (Million Ptas)	5,568,974	5,362,814	5,867,148	5,951,125	7,744,754	7,440,427	8,029,144

Data for 1994 is not available since from that year INE only gathers data on basic R&D variables on even years.
Source: INE

similar shares in terms of number of establishments (i.e., 0.2% and 0.6% respectively) but account for a significant greater proportion of total output (40.2% and 65.6% respectively). In relation to other Southern European countries, widely argued as presenting similar characteristics (i.e., Italy, Greece and Portugal), all exhibit similar size distributions both in terms of number of establishments and employment. However, total turnover by larger firms in Spain shows the lowest percentage of the four. As a result, Spanish F&D firms face serious difficulties in achieving large production volumes of an homogeneous quality in order to enjoy economies of scale in production and maintain a strong bargaining position versus food retailers.

Needless to say that Spanish F&D firms vary significantly in terms of their technological level and competitive position. A significant number of Spanish F&D companies are subsidiaries of big multinationals with important corporate research centers which transfer technological developments to their Spanish affiliates. In sectors like meat products and processed fish products, Spain has important domestic companies whose technological developments come both from in-house R&D activities and acquisition of patents, largely equipment and machinery. However, the majority of Spanish F&D firms (i.e., small firms) do not perform any research activity.

Intersector differences are also important in terms of R&D expenditure (Table 2). According to the latest statistics published by the Spanish National Institute of Statistics (INE), miscellaneous food products accounted for 29.2% of total R&D efforts by the Spanish F&D industry in 1995 whereas grain milling (1.5%), organic oils and animal fats (2.3%), and

animal feed stuffs (4.8%) showed the lowest percentage on R&D expenditure. The meat sector was the only industry exhibiting an increasing trend over the studied period. Results from our previous study (García Martinez & Burns, 1999) showed how the miscellaneous and meat products sectors (both with the highest R&D expenditure in 1995 according to Table 2) exhibited the highest levels of technology autonomy. Their findings are indicative of the importance of in-house R&D activities in the level of technological development exhibited by Spanish F&D firms.

The analysis of R&D expenditure by firm size in terms of employment helps to shed light on the issue of which F&D firm size is likely to be more conducive to innovation. According to the two famous '*Schumpeterian hypotheses*', we would expect large firms and firms which posses market power to be more innovative since they can appropriate benefits more easily than smaller firms and firms in competitive markets. As Table 2 shows, R&D activity is highly concentrated on large sized firms (i.e., F&D firms with 250 or more employees accounted for 63% of all R&D expenditure in 1995). However, there are significant within-group variations. Regarding expenditure by small sized firms (0–99 employees), their contribution to total R&D has increased over the studied period at the expense of large firms, though they only accounted for 23.6% of total R&D efforts in 1995. The importance of economies of scale regarding R&D activities in the Spanish F&DI has also been pointed out by Mili et al. (1997).

3. Research methodology

This paper presents the results of quantitative research designed to analyze the innovative performance of the Spanish F&DI using postal innovation questionnaires. Limitations in the use of traditional measures of technological change (i.e., R&D and patents) have encouraged researchers to develop new innovation output indicators. Cohen and Levin (1989) argued that "*A fundamental problem in the study of innovation and technical change in industry is the absence of satisfactory measures of new knowledge and its contribution to technological progress*" (p. 1062). As a result, a prolific line of research has focused on the development of postal innovation surveys, aiming to collect descriptive and detailed information on the innovation process. According to Archibugi et al. (1994), "*direct surveys on innovation are at the moment the best possible method to acquire information on the hidden part of the innovative iceberg in industry*" (p. 12).

To enable cross-country comparisons, the Directorate for Science, Technology and Industry of the OECD set up the guidelines for innovation data collection through the document *Innovation Manual: Proposed Guidelines for Collecting and Interpreting Innovation Data (Oslo Manual)* published in 1992 (OECD, 1992). The data used in this paper come from two innovation surveys designed according to the recommendations laid down by the Oslo Manual (OECD, 1992), which makes this study suitable for international comparisons with existing and future studies into the F&DI or/and other manufacturing industries.

The applied methodology was determined by the nonexistence of an a priori database of firms classified according to their innovative activities except for references to firms with formal R&D departments, owners of patents or exporters of technology. The danger of

Table 3
Sampling profile

Sector	First Innovation Survey			Second Innovation Survey		
	Total Sample	Response Rate		Total Sample	Response Rate	
	(No. of firms)	No. of firms	(%)	(No. of firms)	No. of firms	(%)
Organic Oils & Animal Fats	46	13	*28.3*	11	6	*54.5*
Meat products	40	12	*30.0*	12	8	*66.7*
Dairy products	48	16	*33.3*	15	6	*40.0*
Processing of fruit and vegetables	40	12	*30.0*	8	3	*37.5*
Fish processing	58	13	*22.4*	12	2	*16.7*
Grain milling	22	7	*31.8*	7	2	*28.6*
Industrial baking	29	5	*17.2*	5	4	*80.0*
Sugar processing	7	3	*42.9*	3	1	*33.3*
Cocoa, Chocolate & Sugar confectionery	33	11	*33.3*	10	4	*40.0*
Animal feeds stuffs	27	10	*37.0*	10	2	*20.0*
Miscellaneous food products	22	3	*13.6*	3	0	*0.0*
Spirits distilling	30	9	*30.0*	8	4	*50.0*
Wine & Cider	39	18	*46.2*	17	9	*52.9*
Brewing & Malting	18	6	*33.3*	5	2	*40.0*
Soft Drinks	41	11	*26.8*	8	1	*12.5*
Total	500	149	*29.8*	134	54	*40.3*

achieving a low response rate by designing a complex innovation survey for the overall sample, including both innovative and noninnovative firms, suggested the need for two questionnaires. The first innovation survey provided initial insights into the nature of the innovation process in the Spanish F&DI, encouraging responses both from innovators and noninnovators. The second survey, addressed only to innovative firms, covered more specific aspects of the innovation process, including R&D activities. An additional argument for two separate questionnaires relates to the need to identify distinctive characteristics between noninnovators and their innovating counterparts as well as the main determinants of innovative behavior.

The innovation questionnaires were sent to 500 Spanish F&D companies randomly selected according to their structural characteristics in order to be representative of all size classes across 15 F&D sectors. The key sample characteristics are summarized in Table 3.

The surveys were designed to be as simple as possible and logically structured. To that end, they included clear definitions and instructions so firms could see the outcome of the surveys and the benefits to them. In order to obtain reliable and accurate information, as well as to enhance response rate, both innovation surveys were pretested. Senior managers of 7 Spanish F&D companies were selected to fill in the draft questionnaires and provide feedback on the design of the questionnaires, and the interpretation of the questions. As a result of the pilot exercise, both surveys were reduced in length. The innovation questionnaires were administered in September 1995 and April 1996 respectively. The initial mail-out contained a copy of the questionnaire and a letter from the Spanish F&D Federation

to respondents explaining the objectives of the research and requesting their cooperation. A first reminder letter with an additional copy of the questionnaire was posted four weeks after the mail-out, and a second reminder eight weeks later, which noticeably improved response rates.

Since questions were highly specialized, accurate answers could only come from key staff in the company. Hence, a special effort was made to identify appropriate respondents before the questionnaires were sent out in order to increase the response rate. Whenever possible, the basic rule was to select technical directors or R&D managers as potential respondents.

For the first innovation survey, completed questionnaires were received from 149 F&D companies, giving a response rate of 29.8% (Table 3). This is satisfactory, given the inherent problems with postal surveys, and the length and detail of the questionnaire. However, as Table 3 shows, response rate varies significantly across F&D sectors.[2] In the case of the second survey, the database was extracted from the original sample including only innovative firms. Out of the 149 respondents, 134 firms indicated that they performed innovation activities, either product and/or process innovation. Completed questionnaires were received from 54 F&D innovating companies, giving a response rate of 40.3%. This is an important response rate given the reduced sample size and, in particular, the complexity of the questions involved. While not representative of the Spanish F&DI as a whole, answers provide valuable information on inputs to, and outputs of the innovation process.

Eighty-six percent of respondents were firms with less than 500 employees (SMEs) and 64% indicated that export activities accounted for less than a tenth of their sales. In terms of capital ownership, 75% of respondents were national private companies and, to a large extent, without foreign capital in their ownership. Respondents had a long established presence in the Spanish F&DI (36% were established before the 1960s and a further 22% during the 1960s). However, 28.9% of respondents indicated that the present controllers took charge during the 1980s, and 15.4% that a change of ownership took place during 1991–1993, which underlines the wave of mergers and acquisitions affecting the Spanish F&DI.

4. Innovative activities in the Spanish Food & Drink Industry

Innovation is a major competitive force with important strategic implications for individual organizations. As Porter (1983) pointed out, technology as a strategic variable can change the competitive 'rules of the game' by influencing all the forces driving competition.

Overall, surveyed F&D firms saw innovation[3] as an important strategic element in their corporate strategy with 86.6% of respondents ranking innovation as either '*important* ' or '*of major importance*' (Table 4). Despite the importance attached to innovation, not all surveyed firms were engaged in innovation activities. Results show 89.9% of respondents undertaking innovative activities while 10.1% of firms were not involved in innovation. The analysis of the importance of innovation activities by the two groups (i.e., innovators vs. noninnovators) shows important differences. While 91% of innovative firms believed innovation to be '*important*' or '*of major importance*', 33.3% of noninnovators classified innovation '*of some importance*' or '*of no importance*' to their companies.

Table 4
Importance of innovation activities in the Spanish F&DI

	All Firms (% of firms)	Innovating Firms (% of firms)	Non-innovating Firms (% of firms)
Of major importance	*28.9*	31.3	6.7
Important	*57.7*	59.7	40.0
One more factor	*10.1*	9.0	20.0
Of some importance	*1.3*	—	13.3
Of no importance	*2.0*	—	20.0
Mean Score[a]	*1.90*	1.78	3.00

Obs.: 149
[a] 1 = 'of major importance'; 5 = 'of no importance'

4.1. Nature of the innovation activities

As pointed out, innovative activities, both product and process innovation, in the F&DI are, to a large extent, characterized by incremental rather than radical changes. Galizzi and Venturini (1996) attribute the incremental nature of food product innovation to constraints on the demand-side. Consumers are typically conservative in their food choices and may initially reject new products; thereby fundamentally radical innovations are scarce in F&D manufacturing. They refer to the term '*redundant technology*' introduced by Padberg and Westgren (1979), suggesting that at any point in time, technological opportunities are more relevant than the consumer's willingness to accept new products. As a result, F&D manufacturers respond to this attitude by introducing new food products whose attributes are generally only incrementally different from existing ones.

A well-documented area of research is the study of consumer reactions to food irradiation. Despite the potential benefits to F&D manufacturers from irradiation (Blackholly & Thomas, 1989), consumers have clearly developed a negative attitude towards irradiated food products, and thereby constrained the introduction of the technology (Henson, 1996). These views, therefore, suggest that technological change and innovation in the F&DI is determined by the role of final demand—*demand-pull*, rather than by new technology—*discovery-push.* Changing consumer taste and requirements have become the main drivers of the F&DI's expansion (Christensen et al., 1996). Consequently, consumer acceptance is essential for the adoption and diffusion of new technologies in food production and the ultimate market success of any new product developed. Research on consumer acceptability of irradiated food products showed a positive attitude towards the concept of irradiation after additional information about the process was provided (Terry & Tabor, 1988; Bruhn et al., 1986).

Biotechnology or the application of genetic engineering in food production[4] are examples where a lack of effective communication on the possible benefits that technology can provide has constrained its full utilization. Results from a series of focus groups carried out by the Institute of Grocery Distribution (IGD) revealed how participants, in general, had a positive attitude towards biotechnology based on the potential benefits to be realized in production, consumption and environment (Brown, 1996). Respondents, however, expressed their concerns about eating genetically modified (GM) foods. Similarly, a recent consumer panel

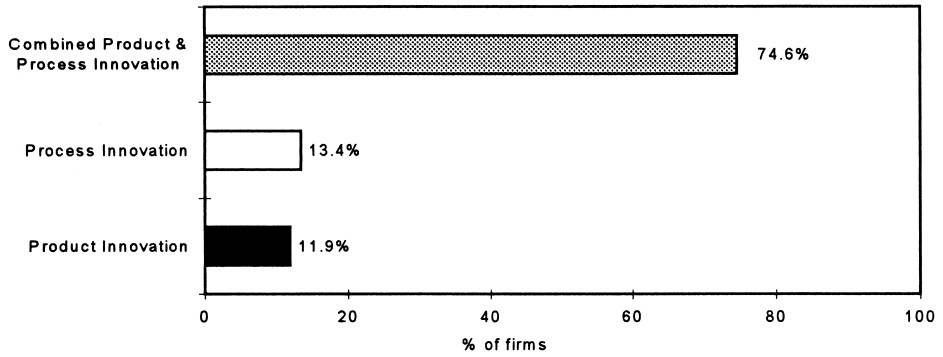


Fig. 1. Type of innovation activities.

showed how participants believed that GM foods were unnecessary and of no benefit to the customer (The Grocer, June 6 1998).

Spanish innovative F&D firms mostly introduce combined product-process innovations[5] (74.6% of respondents) (Fig. 1). For product-oriented innovation, the study distinguishes between '*major product innovation*' and '*incremental product innovation*'—both regarded as innovations *per se*, and '*product differentiation*'—not an innovation according to the Oslo Manual[6] (OECD, 1992). Fig. 2 shows how Spanish innovating F&D firms notably concentrate their product-oriented innovations towards product differentiation or incremental innovation. As pointed out, arguments based on demand constraints and consumers' conservative attitude towards food choices have been put forward to explain the incremental nature of food product innovations (Galizzi & Venturini, 1994; Christensen et al., 1996). Connor and Schiek (1996) reported similar results for the US F&DI where 74.7% of new product introductions were line extensions, 23.7% new brands and 1.5% brand extensions. Likewise, Friedman (1990) indicated that only 10% to 15% of the new products could be classified as new to the consumer, and Gallo (1995) based on 1993 data, reported that in the US only about 1 in 30 food products was truly innovative. These figures emphasize the fact that significant amount of resources are spent on introductions into already saturated markets.

However, results reported by the Spanish Business Association (Circulo de Empresarios,

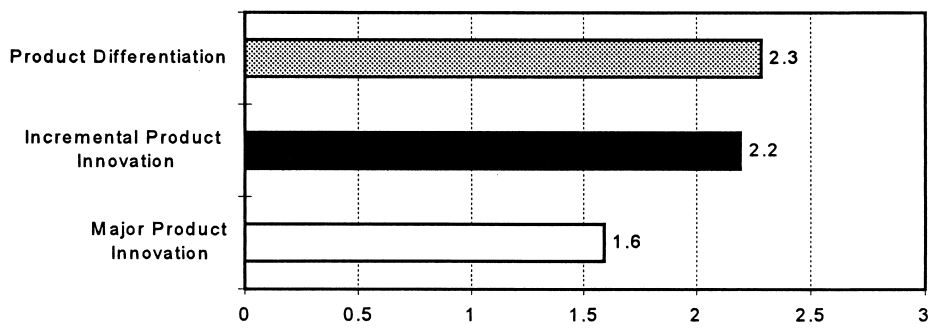
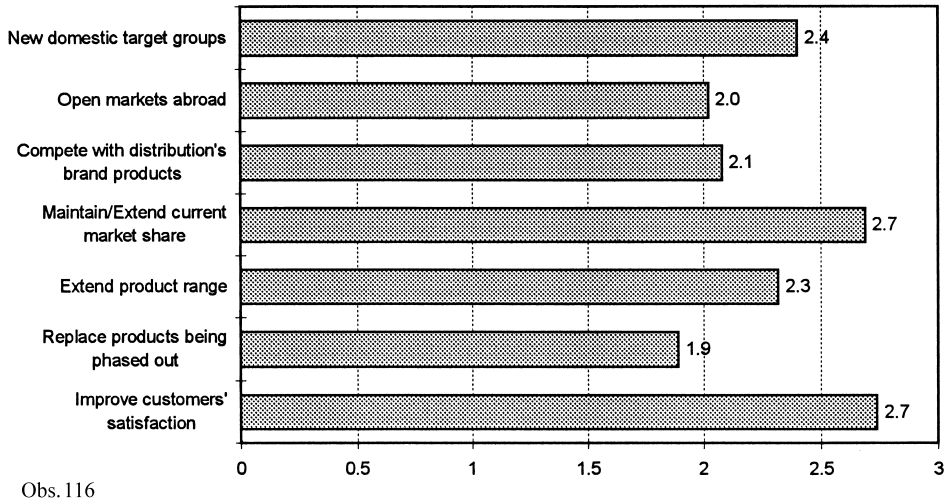


Fig. 2. Nature of product innovation activities.



Obs. 116

[1]0 = *'insignificant'*; 3 = *'very significant'*

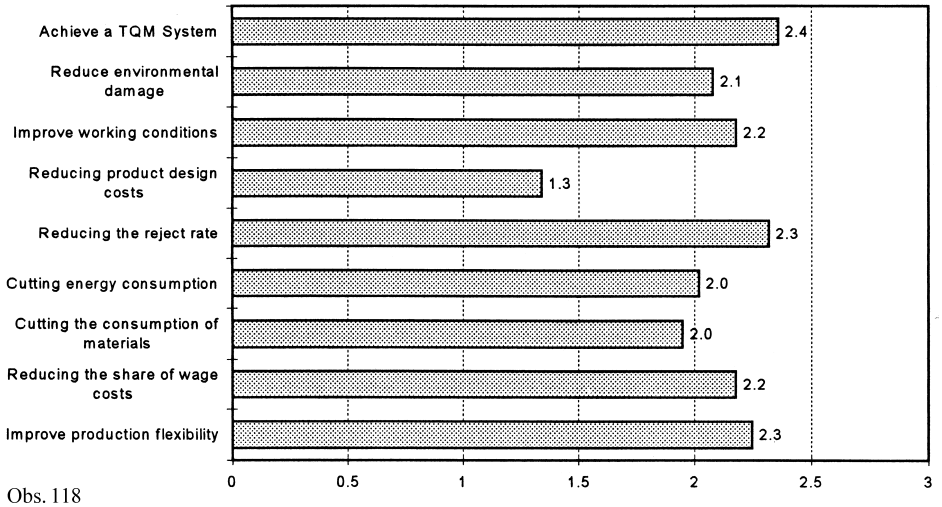
Fig. 3. Economic objectives of product innovation.

1995) for the F&D sample, pointed out incremental innovation as the main activity followed by radical innovation while product differentiation was relevant for only 7% of respondents. These results could be explained by the fact that answers came from 41 F&D companies with some of the highest turnovers in the Spanish F&DI, and probably more dependent on 'true' product innovation activities to maintain their leading positions in their respective markets.

4.2. Objectives of innovation activities

Firms undertake innovation activities to improve production processes, and thereby to reduce production costs through process innovation, or/and to develop new products, or enhance existing products, through product innovation. The innovation questionnaire provides subjective information on the firms' objectives for engaging in process and product innovation through a four-point Likert scale ranging from 0, '*insignificant*' to 3, '*very significant*'.

Figs. 3 and 4 compare the mean scores for product and process innovation objectives respectively. Overall, product innovation objectives are the primary goal for most of the respondents. Similar results were reported by the PACE study (Arundel et al., 1995) where for the food industry, product innovation was also considered more important than process innovation. These findings, however, do not support the argument that low R&D intensity sectors, such as the food industry, should find reducing production costs to be the most important objective while high R&D intensity sectors should find the creation of new products to be the most relevant (OECD, 1986). The SAST report (Tsipouri et al., 1994) on technological change in the food industry in Less Favorable Regions (LFRs), argues that since the bulk of food processing companies are SMEs, and thereby unable to profit directly from major technological change, the role of technology concentrates more on the product



Obs. 118

[1]0 = *'insignificant'*; 3 = *'very significant'*

Fig. 4. Economic objectives of process innovation.

differentiation than on the scale of production. Investments in equipment and marketing are seen to play a more important role than technology generation.

'*Improve customers' satisfaction*' and '*maintain/extend current market share*' were suggested as the key objectives for innovative effort in the Spanish F&DI (Fig. 3). These objectives relate to the importance attached by F&D manufacturers to market environment and changes in consumer behavior as sources of technological development (Garcia Martinez & Burns, 1999). It is worth noting, however, that F&D firms try to meet consumer demands through nonradical innovations (i.e., '*extend product range*') as opposed to 'truly' innovative actions ('*replacing phased-out products*'). These findings are in line with those reported in Fig. 2 where product differentiation obtained the highest score, and denote a '*defensive/imitative*' innovative behavior by Spanish F&D firms.

Market penetration is mostly confined to '*new domestic target groups*' rather than investing abroad which relates to the obvious innovation objective of strengthening firms' market position, particularly given the current retailer-manufacturer relationship. The low internationalization of the Spanish F&D companies has been highlighted as one of the main weaknesses of the industry (MAPA, 1992). The end-result has been a continuous deterioration of the trade deficit with increasing imports and slow export growth.

Process innovation objectives are associated to the achievement of efficient production systems with the ultimate goal of implementing a Total Quality Management (TQM) system that will allow the improvement of production flexibility and working conditions (Fig. 4). Pressures to launch new products and reduce time to market have made flexibility the key factor for growth and development in the food industry (Food Manufacture, 1996a).

Answers related to cost cutting were quite heterogeneous. The most important variables relate to cuts in rejection and labor costs while cost variables related to product innovation

Table 5
The structure of objectives of innovation

Objectives	Production Efficiency	Cost Cutting
Process Innovation		
Improve production flexibility	0.60714	
Lower production cost by		
* Reducing the share of wage costs		0.75191
* Cutting the consumption of materials		0.82757
* Cutting energy consumption		0.72608
* Reducing the reject rate	0.70729	
* Reducing product design costs	0.61314	
Improve working conditions	0.66406	
Reduce environmental damage	0.67755	
Achieve a Total Quality Management System	0.64573	
	Market Orientation	**Product & Market Diversification**
Product Innovation		
Improve customers' satisfaction	0.69314	
Replace products being phased out		0.53334
Extent product range		0.62171
Maintain/Extent current market share	0.82659	
Compete with distribution's brand products	0.75185	
Open up new markets		
* Abroad		0.71325
* New domestic target groups		0.74639

(i.e., cuts in design cost) scored far less. Developments in machinery and production processes (i.e., automation and computerization) would help F&D companies to optimize the use of resources and reduce wastage. The precise impact of process innovation on labor cost, however, is not clear from the survey. It has been argued that not all workers are affected in the same way by innovation. While complex, high-tech production processes would reduce the need for unskilled workers, F&D firms would demand more skilled and technical personnel (Garcia Martinez, 1999). The Skill Needs in Britain Survey 1996 (Walsh, 1997) reported that three-quarters of the employers believed that average employment's skill requirements were increasing, and pointed out changes in processes/technology as the main factors for this increase, followed by changes in work practices/multiskilling. Similarly, the Food and Drink Manufacturing Sector Group (NEDC, 1990) reported that more semiskilled and skilled employees were required to operate high technology equipment, and undertake more routine quality control tasks.

Factor analysis[7] has been applied to measure the underlying structure of the importance of the different objectives of innovation. Table 5 shows the factor loadings[8] based on principal component analysis with varimax rotation after excluding missing values. For process innovation, two factors have been extracted[9] and collectively account for 52.4% of the variance. On the basis of the factor loadings, these two factors can be interpreted as follows:

- **Factor 1**: The issues which load most heavily on this factor are the reduction of production costs by reducing the reject rate and product design costs, reduce environmental damage, improve working conditions, achieve a TQM system, and improve production flexibility. This suggests that this factor is related to **Production Efficiency**.
- **Factor 2**: The issues which load most heavily on this factor include objectives related to production cost reduction in terms of waste costs, consumption of materials and energy. This suggests that this factor is clearly associated with those elements related to **Cost Cutting** activities.

Two factors have also been extracted in the case of product innovation and collectively account for 53.8% of the variance. On the basis of the factor loadings, these two factors can be interpreted as follows:

- **Factor 1**: The issues that impact most heavily on this factor are maintain/extend current market share, compete with distributors' own labels and improve customers' satisfaction. This suggests that this factor is related to the **Market Orientation** of the company.
- **Factor 2**: The issues which impact most heavily on this factor include opening new markets (both abroad and at home), extend product range and replace products being phased out. This suggests that this factor is clearly associated with elements related to **Product and Market Diversification**.

4.3. Barriers to innovation

This section aims to identify the main factors impeding innovation activities at firm level. Noninnovators were asked to rate the significance of 12 specific obstacles on a four-point Likert scale ranging from 0, '*insignificant*' to 3, '*very significant*'. The barriers to innovation were grouped under two headings: economic factors and variables related to the firm's innovation potential.

Mean scores[10] have been computed based on replies to each of the obstacles presented to surveyed firms. Table 6 shows how economic factors appear as the most relevant barrier to innovation in the Spanish F&DI, in particular the '*lack/scarcity of appropriate sources of finance*' and '*innovation expenditure too high*'. These cost factors have, in turn, an impact on the firm's innovation potential in terms of R&D efforts and skilled personnel, which add to the innovation process '*excessive perceived risks*' regardless of the prospective increase in profitability to innovating firms. It is worth noting that structural factors (i.e., '*small size of the company*') or corporate level obstacles (i.e., '*resistance to change in the company*') scored far less.

Similar results have been reported by other innovation surveys. The ISME (1994) report involving Irish SMEs, covered obstacles as well as incentives to innovation. From the study it emerged that both operational and attitudinal measures were necessary to overcome these barriers. This will require government intervention through industrial policies to encourage innovation activities as well as education and training program to improve firms' attitudes towards innovation.

Comparing the results from this paper with those obtained by the Spanish Business

Table 6
The structure of factors hampering innovation

Factors hampering innovation activities	Mean Scores[a]	Std. Deviation
Economic factors		
No need for innovation	0.923	0.954
Small size of the company	1.538	1.127
Lack/scarcity of appropriate source of finance	2.077	1.188
Innovation expenditure too high	2.083	1.240
Excessive perceived risks	1.750	1.288
Innovation Potential		
Company's innovation potential too small	1.615	1.261
Lack of skilled personnel	1.769	1.013
Lack of information on technology	1.308	0.947
Innovation cost hard to control	1.385	1.044
Resistance to change in the company	1.000	1.291
Deficiencies in the availability of external sources	1.846	1.144
Lack of opportunities for co-operation with other firms	1.308	1.109

[a] 0 = 'insignificant'; 3 = 'very significant'

Association's survey (Circulo de Empresarios, 1995), including the top 500 firms in Spain manufacturing and services industries, significant similarities emerge. Results for the F&D subset pointed out '*small R&D budget* ' as the main economic factor hampering innovation (51.2% of respondents). Regarding factors related to the innovation potential, '*uncertainty over the length of the innovation process*' (53.7% of respondents), and '*customers not reacting to new products and processes*' (39% of respondents) were regarded as the main barriers.

5. Innovative performance of the Spanish Food & Drink Industry

This section focuses on the impact of respondents' innovation activities through the analysis of their innovation output.[11] To that end, firms were asked to indicate the percentage shares of total sales and exports due to new products or new production processes. Table 7 shows significantly low levels of innovation among surveyed F&D firms both in terms of new products and production processes as part of total sales. 70.4% of F&D firms reported sales generated by new products introduced between 1993/95 accounting for less than 25% of total turnover while for new production processes, 31.5% of respondents reported no impact at all.

Regarding innovation performance in international markets, results again show disappointingly low levels, in particular exports from new production processes where only 5.6% of F&D firms reported more than half of their exports due to process innovation. As for the second indicator, innovation intensity, F&D firms equally exhibit very low ratios. However, there are differences depending on whether it is product or process innovation. Despite the Spanish F&DI's product-oriented innovative behavior, the percentage of highly innovative firms (i.e., firms whose innovations accounted for more than 50% of their sales) in terms of process innovation is twice that for product innovation.

Table 7
Innovation performance[a] (%)

% total sales	Product Innovation		Process Innovation	
	Sales	Exports	Sales	Exports
0%	13.0	40.7	31.5	44.4
<25%	57.4	33.3	25.9	25.9
25%–50%	14.8	13.0	16.7	5.6
51%–75%	3.7	1.9	3.7	1.9
>75%	1.9	5.6	7.4	3.7
na	9.3	5.6	14.8	18.5
Innovation Intensity[b]	6.1	7.8	13.0	6.0

Obs. 54

[a] Firms who have introduced new products or processes during the last 3 years as a % of the total of firms.

[b] Firms for which new products or processes have an effect on more than 50% of their sales or exports as a % of the total of firms.

In addition, F&D firms were asked to estimate the distribution of their 1995 sales and exports in terms of new, slightly change, and unchanged products with changes taken place during the period 1993/95. This breakdown enables the classification of firms according to their innovative performance, and allows an analysis of the characteristics that identify each group. To that end, Cluster Analysis has been applied to obtain a three-cluster solution, through the average linkages between groups method (UPGMA) using the squared Euclidean distances as proximity measures.

Table 8 shows the results of cluster analysis after missing data were excluded. Though clusters are not well balanced, they still provide a useful insight into the different innovation strategies pursued by innovative Spanish F&D companies. *Cluster 1* includes those F&D firms whose sales are largely coming from product differentiation activities (i.e., 73% on average). *Cluster 2* presents a clear orientation to real innovative activities, in particular major innovation where 50% of 1995 total sales came from radically changed products. Finally, *Cluster 3* largely represents firms owing their sales to incrementally changed products (i.e., 80% on average).

Table 9 shows the Pearson correlation matrix between the distribution of sales across different degrees of product innovativeness and additional variables. Firm size in terms of employment is negatively linked to product innovation activities per se (i.e., major and

Table 8
Cluster of firms by sales of different types of product innovation

	CLUSTER 1	CLUSTER 2	CLUSTER 3
Number of firms:	38	3	2
Mean % of sales due to products at:			
—Major product innovation	7.72	50.00	5.00
—Incremental product innovation	19.05	36.67	80.00
—Product differentiation	73.23	13.33	15.00

Obs. 43

Table 9
Pearson correlation coefficients between share of innovative products and firm characteristics

	Employment[a]	Export Intensity[b]	Sector[c]	Process Technology[d]	Product Technology[e]
% of sales due to:					
Major product innovation	−0.3131*	0.0707	0.2681	0.0958	0.3131*
Incremental product innovation	−0.2639	−0.0590	0.1523	0.0504	0.0680
Product differentiation	0.4423**	0.0778	−0.1872	−0.0573	−0.2968

* = Signif. LE .05 ** = Signif. LE .01

[a] Number of employees: small (1–49 employees), medium (50–499 employees) and large (>500).

[b] Export intensity is used as a 3-category variable: 1) up to 10% of output exported for the low export group, 2) between 11% and 50% for the medium group, and 3) over 50% for the high export group.

[c] Economic sector codes were collapsed into a dichotomous variable, coded as '1' if first transformation sector and '0' if second transformation.

[d] Process technology autonomy used a 3-category variable: 1) absolute dependency; 2) medium product technology autonomy; and 3) total autonomy.

[e] Product technology autonomy used a 3-category variable: 1) absolute dependency; 2) medium product technology autonomy; and 3) total autonomy.

incremental innovation) while positively related to product differentiation. The higher the degree of technological autonomy[12] both for product and process, the higher the probability for F&D firms to perform 'real' product innovation, while low technological autonomy leads to product differentiation activities. Empirical results from our previous study also underlined the importance of in-house technological capabilities in innovation behavior (Garcia Martinez & Burns, 1999). Firms' internal stock of basic technological know-how increased the probability of being product/process innovator, and thereby the problems the F&DI faces if it largely relies on external sources as opposed to internal developments. The long term and cumulative nature of technological knowledge demands firms to set up strategies both to develop existing core technologies and to access new technology. F&D firms, therefore, need to acquire related knowledge in order to maximize the benefits from externally generated technological advances.

6. Conclusions and managerial implications

This paper has presented the results of an innovation survey designed to analyze the innovative performance of the Spanish F&DI, using postal innovation questionnaires as an alternative to traditional measures of technological activity.

While process innovation is clearly the most common type of innovative activity within manufacturing industries, in the case of the F&DI its impact is probably less relevant than product innovation. Empirical results indicate that product innovation objectives are the primary goal for most Spanish innovating F&D firms. The oligopolistic structure of the F&DI and the increasing buying power of food retailers have put pressure on NPD as a means of differentiation. For major manufacturers of branded products, innovation strategies should be an integral component of any action to keep ahead of the retailers' own label developments.

However, the study highlights the 'evolutionary' rather than 'revolutionary' nature of innovation in the Spanish F&DI. Innovating F&D companies largely concentrate their product-oriented activities towards product differentiation or incremental innovation. Current NPD activities are largely about minor line extensions, clever revivals or stretching the brand into new categories. As a result, many new food product introductions fail as they do not offer any apparent consumer-relevant advantage. F&D companies tend to see consumers as a 'target audience,' instead of listening to what they want and then trying to meet that demand. Estimates for the number of new product failures are as wide-ranging as those for new product introductions. For the US F&DI, Fuller (1994) reports that for each product going into test market, another 13 have been developed at lab level or gone through preliminary production viability assessment before being rejected. He suggests that more than 90% of new food products fail within one year of introduction. According to research by Information Resources, which followed the fortunes of 2,250 launches between 1997 and 1998, only one in six new products succeed[13] (The Grocer, 3rd April, 1999). Overall, 11.5% of all new launches achieved annualized sales of over £1m per annum. Only 1.7% of new grocery launches 'hit the big time' with annual sales of more than £5m, while for health and beauty and impulse this figure increases to 3.1%.

The study indicates a relationship between the degree of technological autonomy and the nature of innovation with a higher probability for Spanish innovating F&D firms to be involved in 'true' product innovation (i.e., major or incremental) the higher their level of technological autonomy. This relationship stresses the need for in-house technological capabilities in order to maximize the benefits from externally generated technological knowledge. According to Durand (1991), a firm's capacity to maintain a leading position on a given current or future technology rests on the relevance of its technological competence related to that technology. Underlining the importance of firms' "*absorptive capacity*,"[14] the SAST project on technology management in European enterprises states that ". . . *there is no longer an obvious deficit in the overall level of supply of technology transfer infrastructure. The principal bottlenecks are now in the supply of highly specialized services and support for organizational innovation, and in the demand for infrastructure (the "absorptive capacity" of firms)*" (Dankbaar et al., 1994; p. v).

In this regard, it is worth noting that, overall, economic considerations rather than factors related to the firm's innovation potential emerged as the main obstacles to innovation in the Spanish F&DI. These findings clearly reveal the need for government intervention through industrial policies aiming to encourage innovation activities and improve firms' attitudes towards innovation. The need to foster an environment where innovation is encouraged and nurtured has been recognized by European Union (EU) policy-makers as a means to ensure sustainable economic and employment growth. The Commission first with the White Paper on Growth, Competitiveness and Employment (EC, 1993), and then in its 1994 communication on An Industrial Competitiveness Policy for the European Union, recognized that firms' capacity to innovate and support from authorities, were essential for maintaining and strengthening competitiveness and employment. On 20 December 1995, the Commission adopted a Green Paper on Innovation aiming: "*to identify the factors—positive or negative—on which innovation in Europe depends, and to formulate proposals for measures*

which will allow the innovation capacity of the Union to be increased" (EC, 1995, p. 2). In addition, the Commission established the First Action Plan for Innovation in Europe and defined three major objectives: promoting a true innovation culture, establishing a favorable environment and creating better links between research and innovation. The major results have been changes in competition law, simplifying the legal requirements for state aid to research and cooperative research between companies.

Notes

1. Line extensions (1.8%), seasonal/temporary (promotional) products (1.4%) and conversion/substitution products (0.5%).
2. Assuming the response distribution to the survey follows a random behavior among respondents to whether answer or not, the error for the sample as a whole is ±6.87%, with a confidence level of 95.5%. While the error is not too high, it is above the level 5% considered desirable in research studies seeking a high quantitative accuracy. Obviously, the sample error increases for each of the individual sectors.
3. Innovation was defined according to the definition given by the Oslo Manual (OECD, 1992), Chapter IV.2., p. 28.
   *The concept **innovation** consists of all those scientific, technical, commercial and financial steps necessary for the successful development and marketing of new or improved manufactured products (**Product innovation**), the commercial use of new or improved processes or equipment (**Process Innovation**) or the introduction of a new approach to work organization (**Innovation in organization and management**).*
4. See Bredahl et al. (1998) for a review of existing studies regarding consumer attitudes towards genetic engineering in food products.
5. The criteria followed to classify firms according to their innovative activities (i.e., product innovation or/and process innovator) based on the definition of innovation given by the Oslo Manual (OECD, 1992) Chapter IV.2., p. 29 et seq.
   ***Product Innovation** is the commercialization of a technologically changed product. Technological change occurs when the design characteristics of a product change in ways which deliver new or improved services to consumers of the product.*
   ***Process Innovation** is the adoption of new or significantly improved production methods. These methods may involve changes in equipment of production organization or both. The methods may be intended to produce new or improved products, which cannot be produced using conventional plants or production methods, or essentially to increase the production efficiency of existing products.*
6. ***Major product innovation** is a product whose intended use, performance, characteristics, attributes, design properties or use of materials and components differs significantly compared with previously manufactured products. Such innovations can involve radically new technologies, or can be based on combining existing technologies in new uses. **Incremental product innovation** is an existing product whose performance has been significantly enhanced or upgraded. Minor technical or es-*

*thetic modifications of products (**product differentiation**) are not incremental product innovation. The changes do not significantly affect the performance, properties, cost or use of material and components in a product.*
Food products with a new or significantly change composition of raw materials, or new methods of preservation, might be considered incremental product innovation. Introduction of a new flavor to an existing range- such as a new fruit flavor within a range of yogurt, is product differentiation.

7. Two independent factor analyses have been carried out since respondents were asked to respond according to the nature of their innovation activities (i.e., process or/and process), and thereby the total number of observations is different in each analysis. The former contains 118 observations while the latter includes 116 data points.
8. Factor loadings are the correlation coefficients between the variables and the factors (i.e., the higher the absolute value of the loading [it can never be greater than 1], the more the factor contributes to the variable). For better understanding, the table only shows factor loadings with values greater than 0.5.
9. Factors have been extracted according to the Kaiser criterion (i.e., only factors that account for variances greater than 1 [eigenvalue greater than 1] should be included, since factors with an eigenvalue less than 1 are not better than a single variable, and can therefore be ignored).
10. The low number of observations made it impossible to apply factor analysis on barriers to innovation data.
11. Responses come from the second innovation questionnaire which was exclusively sent to F&D firms classified as innovative by the first survey. Hereafter, the analysis will be based on responses from 54 respondents. While this is not a statistically representative sample of Spanish innovative F&D firms, the analysis would improve our knowledge on innovation strategies by Spanish F&D firms.
12. The Index of Technological Autonomy is computed taking into account all possible sources of technological resources (i.e., in-house development and/or external acquisitions). The value of the index varies from 100 (total autonomy) to 0 (total dependency). Refer to Garcia Martinez and Burns (1999) for further details.
13. Success was defined as achieving sales above £1m or a market share of more than 2% in the first year.
14. Cohen and Levinthal (1989; 1990) argue that the ability to identify, assimilate, and exploit outside knowledge is a function of the firm's level of prior related knowledge. They call these abilities a firm's '*absorptive capacity*', which includes both basic skills as well as knowledge of newly emerging technologies.

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