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Full Research Article

Innovation in European food SMEs: determinants and links between types

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Abstract. The food sector has traditionally been considered one with the lowest research and development expenditure to value added ratio. In recent decades, however, the business environment has become more demanding in terms of technological inputs for reasons related to food safety, quality and also the globalisation of the food market. This provides a strong incentive to innovate, especially for small and medium-sized enterprises (SME) seeking to remain in business.
Most businesses operating in the food sector belong to the SME category which, based on the literature, tends to have a low level of research capacity.
This study seeks to identify determinants of the types of innovation adopted and associations between them by analysing a sample of European food SMEs. For this purpose a non-parametric analysis, namely the classification tree technique, is carried out. The main finding is that due to the technological factors inherent in the food industry, a tight linkage exists between product, process and market innovation. Moreover, the study shows that collaboration between competitors encourages SMEs to engage in market, process and business model innovation. Conversely, synergy with suppliers and customers supports product innovation.

Keywords. Food SMEs, innovation, SME network

JEL Codes. O31, O32

1. Background and objectives

The food sector has traditionally been considered to be a low-tech sector in comparison with other sectors (Christensen *et al.*, 1996; Garcia-Martinez *et al.*, 2000). There are numerous reasons for this. First, innovation in the food industry does not usually make use of scientific inputs as innovation in the sector tends to be more incremental than radical; this is also related to the observation that consumers are typically conservative and reject radically novel food products (Garcia-Martinez *et al.*, 2000). Second, the food industry is

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mostly characterised by small and medium-sized enterprises (SMEs) (Schiemann, 2008), a size typology that is often deemed to lack the internal resources necessary to undertake innovation. This occurs in spite of the fact that various studies have demonstrated the contribution of SMEs to the main innovations of the twentieth century (although this has been observed mostly in non-food related sectors) (Oakey, *et al.*, 1988; Rothwell and Zegveld, 1982; Rothwell, 1994). Recently, however, changes in food demand have introduced new requirements for the food industry, hence generating the need for new technological inputs and a growing interest in the promotion of innovation in the food sector as well (Traill *et al.*, 2002). The technological needs of the food sector are increasing as a result of the introduction of new technology as a means of increasing food safety and quality (Traill *et al.*, 2002). In particular, the food industry has increased the use of technological inputs to meet emergent economic social requirements (Baregheh *et al.*, 2012) and to keep pace with the globalisation of demand in the food market (Grunert *et al.*, 1997).

This scenario not only boosts the role of innovation in improving competiveness, but also explains the growing interest shown by scholars in analysing innovation behaviour in the food sector (Traill *et al.*, 2002). Hence in order to become competitive it is necessary for SMEs to develop the capacity to innovate, that must be maintained in the future, along the whole process of innovation (Gellynck *et al.*, 2007).

The literature reveals that several topics related to innovation have already been thoroughly explored, notably with regard to both large firms and SMEs, but mostly without focusing specifically on the food sector.

A review of the literature suggests that success in innovation lies in the understanding of the local contest (Ebbekink *et al.*, 2012; Van Der Borgh *et al.*, 2012) and is determined by factor combinations in connection with several firm characteristics, such as type of sector, country etc. In particular, in the food sector, the literature points to the importance of networking for food SMEs and how firm size influences innovation behaviour (Colurcio *et al.*, 2012; S O'Reilly *et al.*, 2003; Olsen *et al.*, 2012; Bhaskaran, 2013; Minarelli *et al.*, 2014).

Innovation is defined in the literature as the process of bringing new ideas to the market. It starts with the strategic goals, then develops through product development, process development, marketing development and organisational development, or combinations of them (Earle M.D., 1997).

Prior research has highlighted that in order to identify the determinants of innovation it is necessary to distinguish types of innovation (Knight, 1967; Rowe and Boise, 1974; Downs and Mohr, 1976). Joseph Schumpter is often recognised as the first economist to focus on the importance of innovation for industries (Rogers, 1997). He defined five types of innovation, namely: the introduction of a new good or a change in the quality of an existent product; the introduction of a new production process; the introduction of product into a new market; the acquisition of a new source of supply of raw materials; and the implementation of a new industrial organisation.

Thereafter, the OECD's Oslo Manual (OECD, 1997 2nd edition) concentrated on the first two types due to the greater ease in defining and measuring: technological product innovations and technological process innovations.

The connection between product and process innovation is also stressed in the literature in terms of existing relationships, due to the fact that a linkage exists between technical products and the processes implemented to generate these products. In fact, among

researchers, changes in the product systems have significant consequences for a firm´s manufacturing system and for technical and administrative processes and the dynamics involved in their adoption at the industrial, environmental and organisational level are different. (Abernathy and Utterback, 1978; Daft, 1978; Tornatzky and Fleischer, 1990; Jansen *et al.*, 2006; Kimberly and Evanisko, 1981; Light, 1998).

Moreover, as several academics suggest (Utterback and Abernathy, 1975; Hayes and Wheelwright 1979 a, 1979 b; Kim *et al.* 1992), changes in the product system also have significant impacts on a firm's business model. Once the firm introduces a new product, a change must be considered not only in the technical processes, but also in the administrative ones.

To the best knowledge of the authors, there is a lack of studies available addressing the topic of the determinants of different types of innovation pursued by food SMEs. In many cases the literature tends to focus both on process and product innovation (Triguero *et al.* 2013, Capitanio *et al.* 2010, Avermaete *et al.* 2004, De Jong and Vermeulen, 2006) without analysing them separately and without considering possible interactions/links between them. Moreover, other types of innovation, such as market and business organisation innovation, are often neglected.

Given these premises, the objective of this study is twofold:

- first, to investigate the link between different types of innovation (in product, process, market and business models) introduced by food SMEs; and
- secondly, to identify the specific determinants of each type of innovation (in product, process, market and business models) by food SMEs.

The analysis is carried out based on information collected through a survey of 381 food SMEs located in 6 European countries. Survey data are analysed through non-parametric techniques, (the classification tree analysis), to establish which firm characteristics affect the innovation realised (distinguishing product, process, market and business model innovation) over the years 2011-2013 and the existence of relationships between the different types of innovations.

In light of the limited amount of studies available related to the food sector and the increasing demand for research on this topic, this study provides mainly an empirical contribution to the description and understanding of innovation in food SMEs and similar low tech sectors. Moreover, to the best knowledge of the authors, the classification tree analysis has never been used before in this field. Hence, we also provide insights into the potential and limitations of this methodological approach.

The remainder of the study is organised as follows: chapter 2 describes the methodology, chapter 3 illustrates the results, and a discussion and conclusions are provided in chapters 4 and 5.

2. Methodology

2.1 Overview

The paper attempts to test for the existence of relationships between innovation types and explores the determinants of single types of innovations in a sample of European food SMEs. Accordingly, the analysis includes two separate steps. First, a classification tree

analysis was performed making use of the four innovation variables: product, process, market and business model innovation. Second, the classification tree analysis was computed individually for each innovation type, entering the following potential explanatory variables: innovation strategy, firm size, and collaboration typology.

Information was collected through a web survey carried out in 6 EU countries in 2012-2013. In the following we discuss the data collection process and the methodology used to identify significant determinants.

2.2 Data collection

The present work makes use of data collected through a web-survey developed for the European Commission-funded project NetGrow (www.netwgrow.eu).

The survey respondents represented food and drink SMEs in six EU countries (Belgium, France, Sweden, Ireland, Italy and Hungary). The SME definition adopted is the one provided by the European Commission (2009), namely 'firms with less than 250 employees'. In particular, the class Micro-enterprises identifies firms that have up to 10 employee, the class Small-enterprises those that have up to 50 employees and Medium-enterprises up to 250 employees.

The respondents were identified through national databases, where available. Generally, SME owners or managers were the target interviewees for each company. The contact details of the firms were not readily available from databases in all of the countries. Accordingly, in those countries where contact details were difficult to locate, some missing contacts were collected by way of internet searches or telephone calls. In addition, in several cases, telephone calls were needed to obtain the contact details of a suitable respondent within the firm.

Depending on the country, respondents were approached directly by e-mail or through an initial telephone call, followed by an e-mail. The e-mail provided the web-link to the survey and a personalised cover letter explaining the project. Additionally, reminders to some respondents were sent via e-mail. The data were collected between October 2012 and April 2013 using an online questionnaire.

Five hundred and sixty-two (562) SMEs completed the questionnaire during this period. Around 36% were from France, 18% from Belgium, 13% from Italy, 12% from Sweden, 10% from Hungary and 10% from Ireland. Not all of the SMEs that initiated the questionnaire process actually completed it. The percentages of SMEs having completed the survey in each country are as follows: 78% in Belgium, 76.5% in Hungary, 72% in Sweden, 70% in Ireland, 65% in Italy and 54% in France. Finally, 381 of the questionnaires were usable for data analysis. Table 1 provides the percentage distribution of SMEs participating in the survey in Europe.

In the questionnaire, each of the four variables capturing product, process, market and business model innovation was re-coded from a Likert scale, into a dummy variable for analysis purposes (0= no innovation, 1= 1, 2, 3 to 5, 6 or more innovations in the last two years, 999= missing values). The definition of innovation provided in the questionnaire was stated as follows:

- innovation in products: new products or services;
- innovation in processes: new processes;

Table 1. Distribution of SMEs in European countries.

Size	Country					
	Belgium	France	Hungary	Ireland	Italy	Sweden
Micro-sized	31%	31%	45%	25%	40%	58%
Small-sized	49%	40%	40%	30%	44%	38%
Medium-sized	20%	29%	15%	45%	17%	4%
Total per country	100%	100%	100%	100%	100%	100%

- innovation in new markets: new types of customers or new geographical markets;
- innovation in business models: new business model or management tools.

It should be noted that the concept of innovation in the web-survey is rather broad, and strongly related to what is perceived as 'new' by the firm. This approach is not suitable for some types of analyses. For example, it is not suitable for studies seeking to assess the spread of new ideas or evaluate the impact of innovation. However, the approach can be useful to analyse factors that influence a firm's propensity to innovate and hence was adopted for the aim of this study.

The variables entered in the classification tree analysis to identify the determinants of each innovation type are: innovation strategy, firm size and collaboration typology. This study distinguishes innovation strategy, according to Miles and Snow (1978), based on the type of innovation strategy adopted, namely: prospectors, analyzers and defenders. While a prospector type company seeks opportunities and responds rapidly to changes in the external environment, analysers focus on efficient and full analyses of directional strategies and how best to compete. Defenders, for their part, will focus on maintaining existing markets and competing on price and quality rather than being at the forefront of innovation (Laforet, 2008).

There are different outcomes in terms of innovativeness. In fact, prospectors seek to exploit new products and new markets, whereas defenders try to protect their existing market. For their part, analyzers combine the two behaviours by quickly following prospectors into new products and markets while at the same time protecting their niche market of products and customers.

The reason for the adoption of these categories as explanatory variables in this paper is their prominence in the literature with regard to explaining innovation behaviour. In the present analysis innovation strategy is entered as a multinomial variable consisting of three categories: prospector, analyzer or defender.

Many scholars have investigated the issue of innovation relating to firm size, without conclusive results (Cohen and Mowery, 1987; Amato *et al.*, 1981) or highlighted the variation of the effect of size depending on the sector (Acs and Audretsch,1987; Acs and Audretsch, 1991; Cohen and Klepper, 1996). For example, large firms in low-tech industries have an advantage over small firms, but no difference exists in high-tech industries (Acs and Audretsch, 1991). Recent findings have also reported that firm size has an impact on innovation type in low- tech industries (Wagner and Hansen, 2005; Karantininis, 2010). In many cases, the literature reports different results because the existence of a

relationship between size and innovation depends on a combination of factors or typologies of innovation. For example, Maietta (2014) found that very small size significantly influences innovation in products but not innovation in process. Moreover, different outcomes in the literature in terms of existing relations between size and innovation are due to the use of different definitions for firm categories in the sample or to the different target populations.

The inclusion of 'collaboration typology' as a determinant is motivated by several studies. Collaboration between chain network members is considered as an important factor for enhancing the innovation competence (Gellynck and Kühne, 2010). Also, the existence of a significant interaction between the type of innovation introduced and the type of actors present in the network in which the firm is involved is well recognised among scholars. In fact, Gemunden *et al.* (1996) demonstrate that horizontal collaboration, namely collaboration between SMEs and their suppliers and customers, prompts product innovation in the high-tech sector. They also show that collaboration with consultants and universities fosters process innovation.

A summary of dependent and explanatory variables, as well as their coding and frequency of answers in the sample is provided in Table 2.

In Table 3 frequency of collaboration, expressed as a percentage, with suppliers, customers, competitors, and public and private research institutions per country are reported. Due to the structure of the survey, in which information on collaboration between firms and actors are aggregated for resource type, it is not possible to express firms' engagement in collaboration as a percentage. Collaboration with suppliers is the highest percentage in all countries, followed by collaboration with customers. Differences in behaviour from different countries sampled are more evident for horizontal collaboration (competitors) and research.

2.3 Methodology

Various studies have investigated determinants of innovation through parametric models (Triguero *et al.*2013; Bhattachary and Bloch, 2002). Such approaches are suitable only if the relationships between explanatory and dependent variables follow the imposed functional form. However, data frequently do not match with underlying distributional hypotheses. In these cases, a non-parametric model can be more suitable than a parametric one for the identification of significant relationships and for explaining response variables.

In this paper, due to the features of the dataset, the understanding of determinants is carried out by means of a non-parametric technique. In particular, a classification tree analysis is applied, using the CHAID algorithm (Chi-squared Automatic Interaction Detector) (Kass 1980).

This technique has been used in different contexts, with only few examples related to the agri-food sector, either focusing on firm decisions (Viaggi *et al.*, 2011) or consumer behaviour (Bozkir and Sezer, 2012).

The aim of the classification tree procedure is to divide the population into subgroups based on the best predictor of the dependent variable. The best split is determined by checking whether there is any statistically significant difference, by computing

Table 2. List of variables used in the classification tree analysis.

Code	Coding	Frequency (%)	Variable description	Type of variable	Missing value (%)
Product innovation	1= 1 or more innovation 0= no innovation	80 20	Number of new products realised in the last 2 years	Dummy	7.6
Process innovation	1= 1 or more innovation 0= no innovation	56 44	Number of new processes realised in the last 2 years	Dummy	14.7
Market innovation	1= 1 or more innovation 0= no innovation	70 30	Number of new markets realised in the last 2 years	Dummy	13.6
Business model innovation	1= 1 or more innovation 0= no innovation	38 62	Number of new business models realised in the last 2 years	Dummy	22.6
Innovation strategy	Prospector Analyzer Defender	28 18 54	Prospector: first to market Analyser: seldom first to market but fast follower Defender: focus on niche market	Multi nomial	1
Firm's size	Micro Small Medium	37 41 22	Micro (less than 10 employees), Small (10 to 50 employees), Medium (50 to 250 employees)	Multi nomial	0
Vertical collaboration	1= at least one collaboration 0= no collaboration	85 15	Collaboration with suppliers and clients	Dummy	11.8
Horizontal collaboration	1= at least one collaboration 0= no collaboration	74 26	Collaboration with competitors and research institutions	Dummy	17.6

Table 3. Collaboration with different actors per country.

Country	Actor					
	Suppliers	Customers	Competitors	Universities & Research Institutions	Private research organisations	Total
Belgium (%)	36	25	12	20	7	100%
France (%)	36	26	7	18	13	100%
Hungary (%)	32	26	19	17	6	100%
Ireland (%)	29	23	8	23	17	100%
Italy (%)	31	28	12	16	13	100%
Sweden (%)	37	28	17	11	7	100%

the Chi-square test, between respondent variable categories and the independent variable. The first split cuts where the stronger association occurs i.e. on the variable that shows the lowest p-value. Once the first level of the tree is concluded, the procedure starts again

by attempting to split each of these groups into smaller sub-groups until associations are statistically significant.

The CHAID method tends to be more flexible than conventional statistical models and accordingly is more suitable for the analysis of the surveyed sample. This technique makes it possible to recognise the main characteristics explaining the variations with respect to the target variable, in this contest expressed by the four types of innovation implemented in the last two years by SMEs: product innovation, process innovation, market innovation and business model innovation.

First, the four innovation types were used as an input in the decision tree analysis to highlight the existence of some degree of interaction among them. Innovation in products was used as the dependent variable in this case. Innovation in process, markets and business models was used as independent variables. This choice is motivated by the prominent role of product innovation in the literature and also in the answers to the survey (it is the most frequent type of innovation in the sample). Moreover, the literature highlights a strong relationship between innovation in product and process; in addition, some studies suggest that when innovation in product occurs, changes in process and administrative organisation can also be expected (Utterback and Abernathy 1975; Hayes and Wheelwright 1979 a, 1979 b; Kim *et al.* 1992).

Classification trees were also computed using each innovation as a dependent variable in order to investigate innovation determinants. The variables considered as determinants are all derived from the questionnaire and are described in Table 1.

The analysis was performed by means of IBM SPSS Statistics 21.

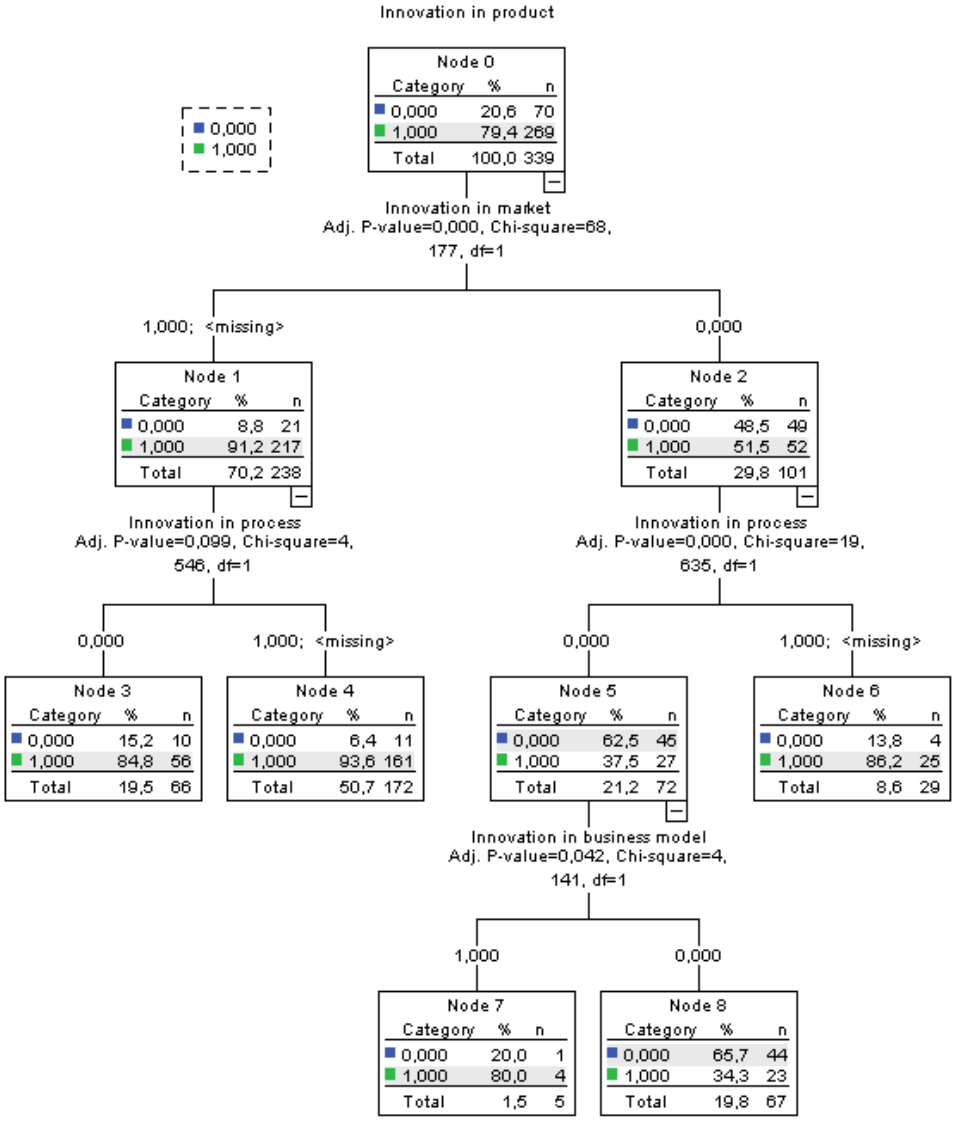
3. Results

The first aim of this study is to investigate the link between different types of innovation. In this regard, of the 381 European SMEs surveyed, 282 declared to have innovated in products, 70 declared not to have innovated in products and 29 SMEs have not provided any answers. 228 SMEs have innovated in markets, 184 in processes and 110 in business models in the last two years. Conversely, 101 SMEs have not produced any innovation in market, 141 SMEs have not produced any innovation in process and 185 SMEs have declared no innovation in business models. These data are expressed also in percentage in Table 4. As it can be notice in Table 4, the majority of SMEs innovate in products,

Table 4. Frequency of SME innovation.

	Number of respondents	Frequency SMEs with innovation	Frequency SMEs with no innovation	% SMEs with innovation	% SMEs with no innovation
In product	352	282	70	80	20
In process	325	184	141	56	44
In markets	329	228	101	70	30
In business models	295	110	185	37	63

Figure 1. Relationship between the four types of innovation.



then market and process, conversely, only 37% reported to have introduced innovations in business models.

The classification tree in Figure 1 reports the association identified between the four types of innovations determined by computing the Chi-square test. The results highlight a relationship between the four types of innovation.

The main association identified is the one represented by the linkage between innovation in product and innovation in market. In fact, the latter variable represents the first

category where the split is made. Two groups are created: SMEs that introduced innovations in markets and SMEs that did not introduce innovations in markets. As can be seen in the first group, 91% of firms also introduced a product innovation. This group is further split into two groups based on innovation in process, where there is a higher percentage of SMEs innovating in products among those innovating in processes (93%), with respect to SMEs that do not innovate in processes, among which innovation in products falls to around 84%.

At the level of the second group originated from the first split second branch, SMEs that do not introduce any market innovations are also split based on innovations in processes. Two groups are identified: SMEs that innovate in processes and those that do not. It should be noted that 86% of the SMEs that innovate in processes (without have innovations in markets) introduced an innovation in products. On the contrary, only 37% of those SMEs that do not innovate in either processes or markets had introduced a new product into the market. The final split occurs only for this last group and it is characterised by innovation in business models. The division is once again between SMEs that innovate and those that do not innovate in business models. Eighty per cent (80%) of SMEs introducing an innovation in their business models also introduced new products, while this figure is only 34% for the SMEs that did not innovate in business models.

The main outcome from this analysis is that the introduction of the different types of innovation occurs simultaneously in the majority of the cases, the introduction of a new product type implies the adoption of new business models or new markets or new processes.

The second objective of this study is to identify determinants of each type of innovation. The analysis through CHAID demonstrates that innovation in products is primarily explained by the innovation strategy (Figure 2).

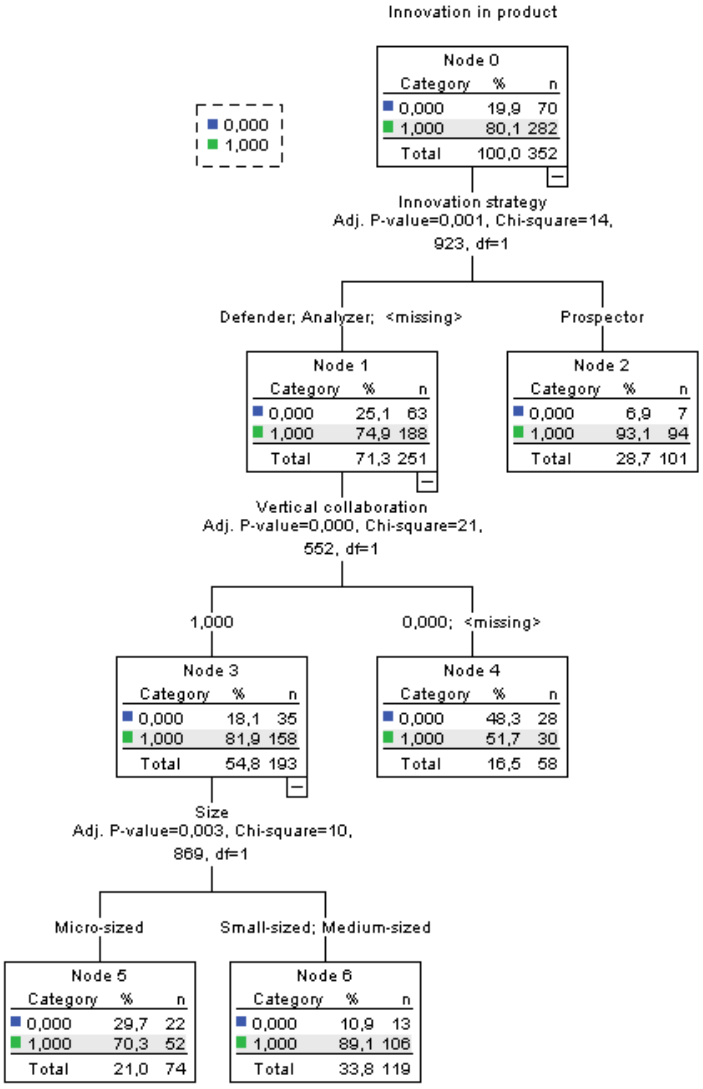
SMEs that innovate in products are highly differentiated between two groups based on the innovation strategy in place: prospectors and defenders/analyzers. The first branch (full sample) of the tree reports that 80% of SMEs introduced innovations in products. The percentage is higher (94%) for prospectors, but falls to less than 75% for the other innovation strategies.

The second significant variable is the vertical collaboration that splits the analyzer and defender into two groups based on the fact that SMEs either engage or not in vertical collaboration. It can be noted that 81% of SMEs involved in collaboration with suppliers and customers introduced innovation in products in the last two years (2011-2013). This amount is considerably higher with respect to SMEs that did not have any collaboration, i.e., 51% of whom innovate in products. The group of SMEs engaged in collaboration is then split further based on a third significant variable, namely firm size. Small and medium-sized firms introduced more innovations in products compared with the micro-sized firms.

In the classification tree analysis computed for innovations in processes, the main determinant of innovation is once again the innovation strategy (Figure 3.).

This distinguishes two groups: one with a lower percentage of innovation in processes (48%) and another with a higher percentage of innovation in processes (79%). The first group is characterised by analyzers and defenders and the second group by prospectors. The first of these two groups is further split into two groups based on horizontal collaboration. Around 61% of SMEs having horizontal collaboration with competitors and

Figure 2. Determinants of innovation in products.

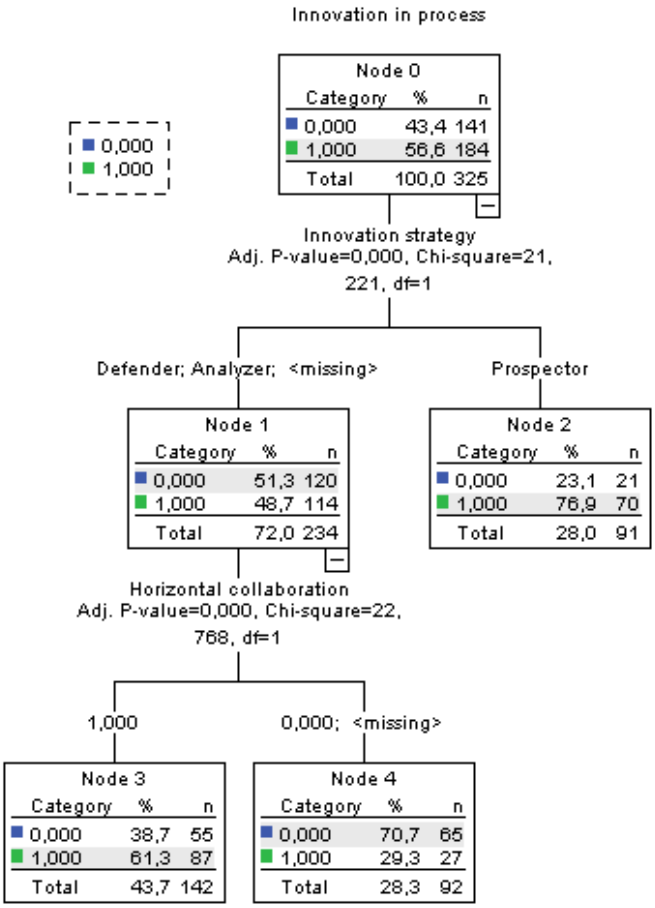


research institutions innovate in processes, while this figure falls to less than 30% for those not involved in horizontal collaboration.

In the classification tree analysis computed for innovation in markets, the main determinant of innovation is once again the innovation strategy (Figure 4).

Once again, two groups are identified, but with a different combination compared with the types of innovations discussed previously: prospectors/analyzers are merged together and, in this group, almost 80% of SMEs introduce innovation in markets. On the contrary, only 62% of defenders introduced innovation in markets and this group is fur-

Figure 3. Determinants of innovation in processes.

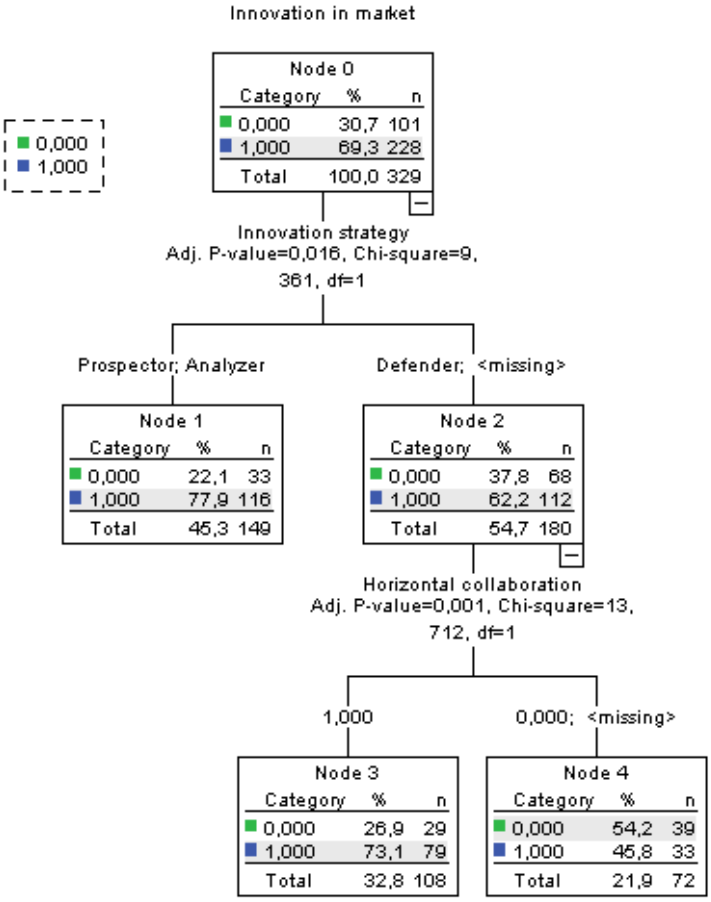


ther split into two groups based on the existence of collaboration. The first group collects SMEs with horizontal collaboration; among these, 73% introduce market innovations. The second group includes SMEs that do not collaborate and a minority of SMEs that innovate in markets (only 46%).

Distinctive behaviour is observed for the innovation in business models. This is the only respondent variable that is not affected by innovation strategy. On the contrary, the classification tree analysis of innovation in business models (Figure 5) shows horizontal collaboration as the main significant determinant.

The percentage of SMEs in the sample that introduced innovation in business models is about 37%, in contrast to the much higher share of SMEs innovating in the previous innovation types. Here, the first split divides SMEs into two groups: those that engaged in collaboration with competitors and suppliers and those that did not. Within the first group, 42% of SMEs introduced innovations in business models, whereas only 20% of those not having any collaboration have introduced innovation in business models. The

Figure 4. Determinants of innovation in markets.

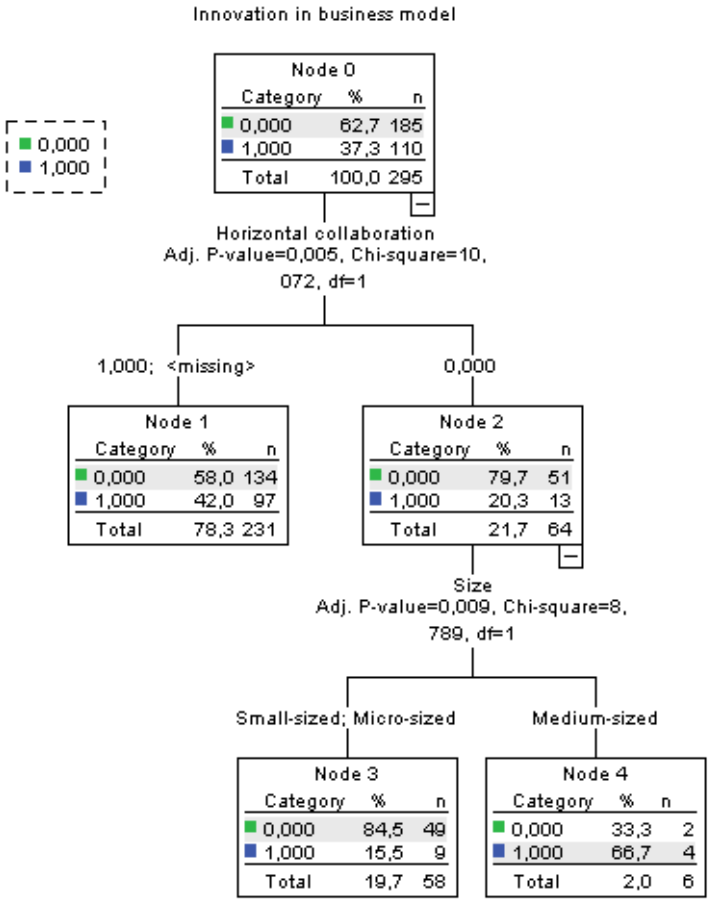


last split is made within this last category, introducing firm size as a second determinant of innovation in business models. Firm size can influence the introduction of new business models in firms that do not engage in horizontal collaboration. Specifically, two groups are created from the size category, micro/small firms and medium firms. By comparing these two groups it is noted that around 66% of medium-sized firms introduced innovations in business models, versus 15% of micro and small firms.

A summary of the findings illustrated above is provided in Table 5.

We found that there are important differences and similarities in the characteristics of the firms that adopt the four types of innovation. First, the connection between SMEs that seek to enhance innovativeness and firm innovation strategy is emphasised. Basically, the results highlight that the group with the greatest number amount of firms willing to improve their innovativeness are those adopting the prospector strategy (Figures 2, 3 and 4). Prospector SMEs seek to enhance their innovativeness in all innovation types, with the exception of the adoption of new business models.

Figure 5. Determinants of innovation in business models.



Second, the collaboration with other actors in the food chain, such as competitors, suppliers and customers represents a common determinant of all SMEs that innovate. In particular, as also noted in the literature, it is not only the existence of relationships between firms that fosters their innovativeness, but also the type of actor participating in the collaboration that influences the firm's innovation objective. In fact, horizontal collaboration seems to have a significant influence on the achievement of innovation in processes, markets and business models. Conversely, SMEs that seek to achieve innovation in products are mostly focused on vertical collaboration.

SMEs not at all engaged in collaboration tend to pursue innovation to a lesser extent. This feature is common to all types of innovation, but mostly stressed in process and market innovation. In fact, the lack of horizontal collaboration significantly reduces innovation output.

Finally, size only impacts those SMEs that innovate in products and business models (Figures 2 and 5).

Table 5. Determinant comparison for types of innovation

Determinants		Innovation in products	Innovation in processes	Innovation in markets	Innovation in business model
Size	Micro	+	no sign.	no sign.	-
	Small	++	no sign.	no sign.	-
	Medium	++	no sign.	no sign.	++
Innovation strategy	Prospector	++	++	++	no sign.
	Analyzer	+	-	++	no sign.
	Defender	+	-	+	no sign.
Collaboration: horizontal	0	no sign.	-	-	-
	1	no sign.	++	++	+ (-)
Collaboration: vertical	0	+	no sign.	no sign.	no sign.
	1	++	no sign.	no sign.	no sign.

Source: own elaboration
++ positive strong association: the percentage of independent variables is above the percentage of the respondent variable which is above 50%.
+ positive association: the percentage of independent variables is above 50% but below the percentage of the respondent variable.
- negative association: the percentage of independent variables is below 50% and below the percentage of the respondent variable.
+ (-) the percentage of independent variables is above the percentage of the respondent variable, but below 50%.

4. Discussion

Of the 381 European SMEs surveyed, 285 indicated having undertaken innovation in products, 228 in markets, 184 in processes and 110 in business models in the last two years. This result is in contrast with findings from the literature in which the most common type of innovation pursued in the food sector is innovation in processes (Triguero *et al.*, 2013; Alfranca *et al.*, 2002; Capitanio *et al.*, 2010; Galizzi *et al.*, 1996; Grunter *et al.*, 1997). A result of this kind can usually be explained by the tendency for firms in the food sector to engage in incremental rather than radical innovation, notably due to conservative consumer preferences with regard to food. The difference between the literature and the results from our sample, in which the majority of SMEs declared to have introduced new products in the years 2011-2013, may be due to a degree of bias in the sample because of the self-selection process in the sampling modalities (no stratification was imposed and available databases may under-represent micro-firms) and the questionnaire approach , in particular the request for respondents to access a web-survey. The result may be a sample biased towards more marketing and communication-oriented firms, most likely also focusing on product and market innovations. This represents a difficulty often observed in studies involving surveys.

Another underlying issue, highlighted in the extensive work of the Oslo manual, is that types of innovation are difficult to define (Rogers, 1998). There may well be different interpretations of what qualifies as an innovation and indeed there is a high degree of subjectivity in distinguishing types. Findings from academic studies (Simonetti *et al.*

1994) have shown that a large majority, around 96%, of innovations can be classified as product or process innovations, hence falling into a so-called "grey zone", depending on the type of definition adopted. Only 4% of innovations can be unequivocally classified as product or process. This result implies that the distinction between types of innovations is not straightforward and that it depends on the perception of innovation. This may have affected the answers of the participants in this study, and, in particular, the multiplicity of innovations declared by several firms. We did not, however, find any clear and explicit distortion or difficulty due to definition issues, likely in part because the distinction between innovation types, though difficult to define, is now well established among practitioners. Yet it should be noted that differing perceptions, or indeed definitions, of innovation among innovating actors can lead to a degree of confusion or misunderstanding among academics and operators.

The main finding of this study is that, in the majority of firms, there exists a coexistence between types of innovations. The decision tree (Figure 1) illustrates this concept by reporting which type of innovations are associated and the level of importance.

The decision tree makes it possible to recognise the degree of intensity of this association, which can be identified through the level of the tree branch. The level of importance of associations between innovations in products and markets is stronger than the innovations in processes, which is displayed at the third level of the decision tree, and business models which are found at the fourth level of the tree. This is not in line with findings from the literature in other industrial sectors where the linkage between product and process innovation is more important (Utterback and Abernathy 1975; Hayes and Wheelwright 1979 a, 1979 b; Kim *et al.* 1992).

At the same time, however, by focusing on individual analyses carried out on determinants of innovation type, our findings show that each type of innovation has different determinants. This is consistent with the literature, whereby scholars distinguish innovation types on the basis of differing processing generations (Utterback and Abernathy, 1978; Daft, 1978; Tornatzky and Fleischer, 1990).

Prospectors are those that mostly innovate with respect to all of the three types of innovations: product, process and market innovations. Defender strategies are mainly adopted by SMEs that pursue innovation in markets in order to increase their competitiveness by placing their products in new geographical areas or by addressing new potential customers.

The literature stresses that the likelihood of a firm engaging in collaboration is influenced by the innovation objective (e.g. product, process, and market innovations) (Goorochurn *et al.*, 2007).

Findings from this study demonstrate that through their collaboration with competitors and research institutions SMEs are encouraged to undertake market, process and business model innovations. Conversely, synergy with suppliers and customers tends to support product innovation. These results are in line with findings in the literature that underscore that collaboration between customers and suppliers increases product innovation, not only in the food sector, but also in the high-tech industry (Gemunden *et al.*,1996).

Finally, innovation in business models shows a distinctive behaviour compared with other innovation types. Different dynamics are involved in the innovation process with

respect to business models that are not dependent on the type of innovation strategy adopted by the company, but have more to do with horizontal collaboration, size of the firm and business models adopted by other firms within their networks. In fact, innovation in business models is a type of innovation that more likely can be shared with competitors and is influenced by the size of the company in the majority of medium-sized firms that introduce innovations of this type.

Finally, some weaknesses can be identified in the use of high aggregated categories in the questionnaire; in particular, the questionnaire considered collaboration between firms and competitors, and research institutions as a whole. Yet, other sector findings show that innovation in processes requires intensive collaboration between universities and consultants (Swann, 2002). In the same line, a more detailed specification of different types of collaboration would be needed for a better explanation of these connection with innovation.

The methodology used in this paper proved to be very practical for explorative purposes, thanks to the fact that it can be applied without pre-defined assumptions about the functional form of relationships among variables. However, this also has limitations in terms of consistency with theory and understanding/interpretation of the direction of causality. For example, the association between different types of innovation may derive from very different stories, and possibly with a different sequence of innovations. Likewise, a firm's collaboration can be either a determinant of, or an action purposely oriented to support, an innovation the determinants of which are to be found elsewhere.

5. Conclusion

The analysis carried out suggests, as a main finding, the existence of a tight relationship between different types of innovation in the food sector. The study also highlights a relationship between types of collaboration and types of innovation.

The practical contribution of this study is to provide information on which type of factors are more likely to affect innovation with regard to the innovation objective, and in particular which factors should be fostered in relation to the type of innovation that SMEs want to pursue. First, even if a linkage exists between innovation types, different factors must be targeted in relation to the type of innovation that the firm or the policy-maker seeks to enhance. Second, policies should explicitly take into account the interconnection between different types of innovation. Third, different types of collaboration and network types would need to be tailored to the type of innovation sought. The latter point also highlights the relevance of further connecting SMEs with research institutions and activities specifically aimed at supporting SME involvement in the innovation process, which represents the core of European policies for the enhancement of competitiveness.

Given the limitations of the methodology, further research could be carried out by using other statistical techniques on the same sample to better connect empirical findings with theoretical insights.

In addition, potential for further studies is highlighted by the weaknesses discussed in the previous section as well as by its empirical insights, including the limited number of observations. The distinction between different types of innovation may be an important issue, yet greater priority should perhaps be placed on clarifying their connections. Furthermore, the issue of collaboration as a determinant of innovation has been treated in a

simplified manner here, but has proved to be very important. Consequently, further studies focused on disentangling in greater detail the effect of different forms of collaboration should be considered, in particular SME collaboration with universities and other similar stakeholders. This work also suggests that further studies should seek to better understand innovation-related interactions where innovation types prioritised by firms can also change in relation to either different stages of a firm's life cycle and/or the product life cycle in food companies.

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