Should I make or should I buy?

Innovation strategies and governance structures in the Italian food sector

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Abstract

This paper analyses the "make or buy" decision of food firms applied to innovation strategy using 389 Italian food firms data from the Unicredit 2007 database. We develop a set of hypothesis from three theoretical perspectives such as transaction cost economics, strategic management and resource-based view. Our paper aims at highlight whether or not different firm's features can be linked to the decision to make or buy. We found out that these two decisions are positively interlinked. Moreover we also found out that it is difficult to indicate a clear-cut behaviour for the Italian food firms if we refer to making or buying decisions. We discuss these results and use them to bring some interesting outcomes to discuss managerial implications and/or policy interventions in this highly strategic domain.

Keywords: Innovation determinants, technology sourcing, innovation.

1. Introduction

In recent years, both the evolution of food demand, which brought more attention to quality and safety issues, and the increasing international competition that pushes the pace of technological change, have led to a higher rate of innovation in the food industry (Capitanio et al., 2010). Diversification and quality innovation (Traill and Meulenberg, 2002), as well as process innovations are becoming major factors of competitiveness. As a European commission online magazine on enterprise policy indicates: "*Innovative food production systems, higher quality standards, and an evolution towards value-added products are important ingredients in meeting the challenges posed by more competitive food markets*".[1]Next to the decisions on whether to innovate or not and what innovation, is the decision of how to innovate. As Veugelers and Cassiman (1999) pointed out, given their uncertain returns and short life cycles, investments in risky sunk R&D expenditures have taken an overriding importance in the survival of firms. The decision to innovate "in-house" or to outsource the process of innovation is thus becoming an important aspect of firms' strategic management.
The empirical literature is replete with studies investigating the make or buy decision and most of these works are supportive of both the Williamsonian transaction costs theory and the property rights approach developed by Grossman, Hart and Moore (Klein 2005). Besides the transaction cost reduction arguments, firms may have other reasons to choose between making and buying, especially when it comes to innovation

[1]http://ec.europa.eu/enterprise/e_i/news/article_8571_en.htm

outsourcing. These reasons may relate to strategic management (e.g. market power, appropriability concerns, size of the firm),competence and resource-based elements (e.g. availability of in-house resources and capabilities) and the institutional environment (e.g. legal restrictions).
The make or buy decision applied to a firm's innovation sourcing strategy is receiving increasing attention in both the theoretical and empirical literature. Many works have been performed in the last ten years: Ulset (1996) on Norwegian information technology industry; Veugelers and Cassiman (1999) on the Belgium manufacturing industry; Love and Roper (2001); Love and Roper (2002) on UK manufacturing plants; Love and Roper (2005); Howells et al. (2008) on UK pharmaceuticals; Gooroochurn and Hanley (2007) on UK firms. Though growing fast, the literature has not yet investigated the case of the food sector. The innovation sourcing strategy of this unexplored sector might however differ from other economic sector since it has to deal with bio-based products. This peculiarity introduces many uncertainties at various levels of the processing process due to the fluctuating quality of inputs (e.g. unpredictable weather conditions and perishable nature of agricultural products) and the reliance on a multitude of more or less homogeneous farmers/suppliers. Moreover, new food products have generally a relatively low success rates (Søgaard 1994).
This paper aims at filling this literature gaps by investigating the determinants of the make or buy decision applied to innovation strategies in the food industry using a database collected by Unicredit in 2007 on 389 firms operating in the Italian food industry (fruits, vegetables, vegetal oil, wine and dairy). In order to have the most complete picture of the relevant determinants of make or buy in innovation, we make use of three theoretical approach to develop our hypothesis: transaction costs economics, strategic management and resource-based view. Our empirical analysis is presented in two steps. In the first one, we describe the relationship between food firms and their innovativeness. In the second step, we use a bivariate probit model to test the correlation between "making" and "buying" decisions and to highlight the main driving factors of innovation strategies in the Italian food sector.
Our main results show that making and buying innovation are correlated and interlinked decisions while a clear-cut behaviour which can distinguish food companies oriented to make to the ones oriented to buy innovations cannot be draw based on our empirical evidences.
This paper proceeds as follows. In section 2, we introduce the concept of innovation as used in this paper and we elaborate on the theoretical elements used to develop our hypothesis. In section 3, we present our empirical analysis with a first glance at some descriptive statistics before introducing our empirical model. Section 4 shows the results while in section 5 we discuss and conclude with policy and managerial implications.

2. Theoretical framework

2.1.Innovation in the Food Sector

The theme of innovation was approached from very different theoretical points of view. We can recognized two main economic fields of research: on one side the political economics approaches, which treated innovation at a sectorial/country level to analyze how innovation influence the development processes of an industry or a region (Dosi et

al., 1988; Nelson, 1993; Omta, Folstar, 2005). In this perspective innovation is mainly seen as an inter-temporal technological change. On the other side innovation is studied jointly with the analysis of private firm strategical/managerial decisions. In this case innovation is seen as the creation, development and introduction on the market of a new product (Omta, 2002; Omta, 2004; Omta, Folstar, 2005). The studies following this perspective are differentiated on the base of the economic sector, firm types, location and nature of innovations (product, process and/or organization) analyzed. It is easy to understand that on the base of the different approaches several definitions of innovations were adopted.

Innovation could be seen as a complex process in which each firm can be involved at different stages, from basic research up to the penetration of the market with new product, to reach a competitive advantage with respect to the other firms (Hollenstein, 1996; Omta, 2004). At firm level two ways to look at innovation can be distinguished. Firstly innovation can be studied as a development and change process (Teece, 1996; Grunert et. al., 1997). In this sense the innovative process is directly influenced by the level of expenditure, by the way R&D activities are carried out, for example by means of internal or external structures (Pavitt, 1984; Molero and Buesa, 1996; Acs and Audretsch, 1998), as well as by the "technological" characteristics of the innovation process, such as the degree of uncertainty related to the effectiveness and market success of innovations, the level of taciteness of knowledge, the degree of appropriability of innovation, and by the capacity of cumulate know-how inside the organisation (Teece, 1996). Secondly, innovation can be the analysed as the firm attitude to find and satisfy the needs and the preferences of its potential customers, using the own resources, skills and capacities (Grunert et al., 1996). In this case innovation is a process correlated to the market orientation of the firm and to the marketing activities. In the former case innovation might be seen as a technological process, while in the latter as a managerial and organisational process.

In fact, the two processes are strictly linked to each other. In a private enterprise, the research and development of new products, technologies and process (organisation of the innovation) have to be oriented by a strategy based on the commercialisation of the results obtained (Grunert et al., 1997; Traill and Meulenberg, 2002; Omta, 2004). Therefore, it is more appropriate to speak of innovativeness instead of innovation, considering the type of R&D activities, the market-oriented activities, and the way they are coordinate in the firm organisational model (Traill and Meulenberg, 2002). In this perspective the concept of innovativeness becomes by itself a key element to cluster and identify the nature of the firm in which the process is taking place. Innovativeness is a consistent part of the strategies of the firm and it influences both the organisational structure and the external linkages. Among them, the dimension of the market and the growth of the demand play a very relevant role as they have an influence on the incentive to innovate (Earle, 1997).

The definition of innovation that we used in this paper refers to the firm/management "study area" and can be synthesized in three key-concepts (Zaltman et al., 1973; Omta, 2004): (i) a creation of a new product/service (in this case innovation derives from a creative process in which an idea is transformed through the activities of R&D, management and production, into a new product and/or service); (ii) a process of development of new products/services (in this case innovation derives from R&D and market demand analysis activities to change/modify/adapt an existent product/service);

(iii) a process of diffusion of new products/services (in this case innovations derives from the adoption of a new process/products originated in a different sector/firm).
The decision to outsource innovative activities or R&D has to take into account a number of peculiarities that lie in the distinctive nature of innovation compared to other goods or activities (Howells 2006). Howells et al. (2008: 206) have made an exhaustive inventory of these peculiarities. First, the outcome of the outsourced innovation is highly uncertain and risky compared to other activities (Doctor et al. 2001). Second, the firm outsourcing cannot evaluate the quality of the knowledge that is transferred to them by the supplier (Arrow 1962). Third, the fact that the supplier of an innovation often does not know the quality of the knowledge it sells, because it does not know the future outcomes of its innovation, may lead to contractual incompleteness problem related to intellectual property exchange. Fourth, both partners, the firm and the customer, are involved in a co-joint production of new knowledge which may lead to intellectual property rights rent-sharing issues (Alchian and Demsetz 1972). Fifth, innovation outsourcing may lead to a whole set of moral hazard problems such as the use of the knowledge transferred to the supplier for other customers. Sixth, if outsourcing goes wrong, the future of the firm can be threatened given the importance of R&D and innovation as core competences and capabilities of firms. Seventh, outsourcing decisions have an irreversible effect on R&D or technical capacity of the firm. Eighth, the exchange of information during the outsourcing process is a unique event which limits the capacity of firms to learn from experience (Carter 1989). Ninth, tacit nature of the know-how exchanged when outsourcing makes it difficult to monitor contracts.These characteristics are not unique to innovation *per se*, other outsourced activities also show these features, but their combination surely is.
The list presented by Howells et al. (2008) could be extended when applied to the food sector.This economic sector handles bio-based products which show features that may lead to more uncertainty in the innovation process. Bio-based products have a greater fluctuating quality than manufactured products due to the perishable nature of agricultural products and the unpredictable weather conditions affecting the quantity and quality of products. Food firms also have to rely on a multitude of more or less homogeneous farmer/suppliers. These features of the food sector add to the existing uncertainty of the innovative activities. Moreover, new food products have generally a relatively low success rates as noticed by Søgaard (1994). Finally, innovation outsourcing has a greater importance within the food industry, where R&D intensity could be a non-exhaustive indicator to catch the innovativeness, because of some specific features of its innovation pattern: (i) food firms are mainly process-innovation oriented (Archibugi et al., 1991) and use new technologies developed by upstream industries. Then, innovation mainly occurs through equipment and capital goods investments; (ii) innovations in the food industry are mainly incremental rather than radical ones (Galizzi and Venturini, 2008).

2.2.Determinants of the make or buy decision

The transaction cost theory has proved to be quite successful in explaining the decision of firms to make in-house or to outsource activities.When it comes to innovation sourcing, the relevance of this theoretical framework seems however to be limited. A number of authors have argued that firms faced with the decision to innovate in-house or to outsource are more motivated by strategic (Gooroochurn and Hanley 2007;

Howells 2006; Howells et al. 2008) or resources (Conner and Prahalad 1996; Love and Roper 2005; Nooteboom 2004) rather than transaction costs considerations. When investigating the determinants of the make or buy decision applied to innovation outsourcing, transaction costs but also competence/resource-based approaches and strategic reasons must be taken into account. In this section, we present the make or buy innovation determinants according to the three theoretical background aforementioned (transaction cost economics, strategic management and resource-based view) and develop hypothesis to be tested.

2.2.1 Transaction cost economics

Outsourcing innovation allows firms to tap into advanced knowledge and technology, as well as to obtain a cost advantage (Gooroochurn and Hanley 2007; Ulset 1996). The downside of these advantages, especially when outsourcing innovation, is that transaction costs of control losses, maladaptations and technology leakages may be incurred. The sources of transaction costs in outsourcing innovation activities lie in the uncertainty and non-redeployability of efforts or assets (such as R&D sunk costs and customized R&D output). Contractual partners will thus seek to develop safeguards such as stronger administrative control rights and more exclusive property rights. Transaction costs economics argues that firms that incur heavy sunk costs in capital or R&D expenditures may want to amortize these costs by innovating in-house (Gooroochurn and Hanley2007). On the other hand, we can think that for strategic reasons, firms may want to invest in R&D to raise their absorptive capacity. These firms would then favour outsourcing in order to benefit from outside collaboration.

Hypothesis 1. Firms having high sunk costs of capital and R&D will be more incline to favour in-house innovation sourcing, except in the case of strategic outsourcing.

Another factor which can influence firm "off-house" innovation activities is related to the nature of the other contracting activities of the firm such as the chain and network relations. These include the linkages between the food firm and other agents of the food chains (agriculture, distribution operators, etc.) and deal with the attitude to enter in formal and/or relational networks (consortia, production-based association, manufacturing joint-ventures, informal contracts, etc.). The positive influence of such "contracting" strategies on the innovation capacities is given by the possibilities of sharing information and "know-how", the reduction of uncertainty and the increasing economies of scale for the firms involved (Teece, 1996).

Hypothesis 2. Firms that are part of a larger group of companies or of a relational network are more likely to innovate in-house to benefit reduction costs in reducing contractual uncertainty and accessing group resources.

2.2.2. Strategic management

The different capacity to innovate between investor owned firms (IOs) and cooperatives is gaining attention among social scientists as a consequence of the growing attitude of the cooperative model to innovate (Nilsson, 1997; Drivas, Giannakas, 2006). In particular, the "social environment" inside the cooperative is seen as a decisive factor of

innovation when management, workers and members behave as a coalition, coordinating their objectives (reducing the monitoring and agency costs). The presence of such organisational culture could help to surmount the problem of under-financial capacity, which remains one of the most relevant constrain for a cooperative to develop "in house" new projects and technologies. In fact, in many cooperatives the need to respect the member welfare-maximising objective through the distribution of the returns on sales still remains a factor of weakness that limits innovative activities (Nilsson, 1997).

Hypothesis 3. The organisation culture of cooperatives makes in-house innovation less costly than outsourcing. Cooperatives should then be more incline to innovate in-house.

The degree of appropriability of innovation is also a main feature in determining making or buying decision (Love and Roper 2001; Gooroochurn and Hanley 2007).
The ability of firms to appropriate post-innovation returns depends on the market structure, the nature of technology and the intellectual property rights regime (Teece 1986). In situations where such conditions are tight, that is leakage is limited and imitation is difficult, firms will be more incline to outsource innovation. On the other hand, in situations where these conditions are weak, that is leakage is frequent and imitation easy, firms will prefer to innovate in-house (Love and Roper 2001). Because of the complexity related to the measurement of data availability of appropriability often used proxies are the type of regulatory barriers and market concentration/competition.

Hypothesis 4. Firms evolving in tight appropriability conditions will be more incline to outsource innovation than firms evolving in a weak appropriability setting.

The relation between firm complexity (size) and innovativeness was originally analysed by Schumpeter (Schumpeter, 1934 and 1942). The studies following this theoretical perspective emphasised the role of size and the capacity to allocate financial resources to research activities and to new technologies and products development ("in house" innovations) trough hierarchies (vertical integration of R&D activities). In this sense, large firms operating in a context of a strong market power should show higher investments in innovation activities than the small ones, due to larger cash flow generated by monopolistic power and to a better access to capital market (Teece, 1996; Arundel and Kabla, 1998). Other authors deeply contested this point of view, according to the idea that small and medium firms (SMEs) are more adaptable to the market conditions, more opened to "innovation joint-venture" and "contracting strategies" ("buying" innovation activities) (Omta, 2002; 2004) and less constrained by the transaction costs of "bureaucratical" and managerial structures (Williamson, 1975; Mansfield 1981; Teece, 1996). Moreover, SMEs show a higher internal flexibility (related to the organization of the production and to decision making processes), a better flow of internal communication, greater specialisation possibilities, as well as a higher informal and strategic control (Galende and de la Fuente, 2003). Since the relationship between size and sourcing strategy is ambiguous, we derived a general hypothesis.

Hypothesis 5. The size of the firm has an effect on innovation sourcing strategy.
Veugelers and Cassiman (1999) have noticed that process and generic products innovation are more likely to be outsourced than product and specialized innovations.

Since product innovation is considered as a firm-specific input, leakage through outsourcing has more important strategic implications than for generic process innovations. Leakage over generic R&D innovations cannot be used opportunistically by the supplier firm since most firms are contracting these innovations. Therefore, similar to Gooroochurn and Hanley (2007), we make the following hypothesis.
Hypothesis 6. Process innovation is more likely to be outsourced than product innovation.

2.2.3. Resource-based view
Mason and Wagner (1994) have stressed the importance of highly skilled employees for innovation. Aurora and Gambardella (1994) have argued that internal knowledge resources allow to use foreign know-how more effectively in the firm, which would stimulate external innovation sourcing. On the other hand, high internal competences may be an incentive for firms to innovate in-house with available resources (Veugelers and Cassiman 1999).

Hypothesis 7. Firms with constrained human resources are more likely to engage in outsourcing during the innovation process.

The age of the firm can be used as another possible measure of its organisational complexity, potentially representing the experience and the knowledge accumulated throughout its history and the "learning" process of the firm (Galende and de la Fuente, 2003). Some articles showed the higher inclination to innovate by "old" firms (Kuemmerle, 1998), while some other considered "young" enterprises as more active in the direction of innovation (Molero and Buesa, 1996). In this sense the age remains a controversial factor of innovation. The knowledge transfer is influenced by the level of human quality, too. The way the firm acts in order to facilitate the cumulative learning can be assessed by the rate of economic and financial resources dedicated and oriented to the professional formation and its organisation inside the firm (Freeman, 1973; Rothwell, 1986).

Hypothesis 8. 'Old' firms are more innovative than young ones.

Some scholars have argued that better internal and external communication networks is an important features of innovative firms. Since better communication network is strongly linked to a better communication system, the presence of information and communication technology (ICT) in the firm should influence their willingness to outsource innovation.

Hypothesis 9. Firms with a highly sophisticated information and communication technology system are more likely to outsource their innovation activities.

2.2.4. Control variables

Contracting activities can be analysed in an indirect way, looking at the results of their influence on the firm strategies on the markets, such as the internationalisation, the export-orientation and the product-diversification/specialization (Hoskisson and Hitt 1988). The empirical literature shows a positive relationships between export

orientation and innovations (Lunn and Martin, 1986; Kumar and Saqib, 1996; Roper and Love, 2002), while the way product-diversification or specialisation affect firm innovation is not clearly recognised and remain still controversial (Hitt and Hoskisson, 1991; Hoskisson and Johnson, 1992; Link, 1982; Chen, 1996). Since export activities might have an important effect on the decision to innovate, we use it as a control variable in our model.
Moreover sourcing decisions are influenced by the context in which the firm operates. In other words, the geographical location and local networking of food firms are key factors behind different attitudes to innovativeness (Omta et al., 2001; Nielsen, 2008). The specific location of a firm is important to understand the opportunities to use local social capital and the institutional environment as a source of knowledge and innovativeness (Capitanio et al., 2009; 2010).

3. The empirical analysis: testing the hypotheses for "making-buying" decisions

3.1. Data and descriptive analysis

In this paper we use part of a database from the 10th survey on Italian manufacturing companies carried out by *Unicredit Group*. The database refers to a sample of 389 food companies with information related to the period 2004-2006. Data refer to financial and economic characteristics, organization, investments, internationalization and innovation processes. More specifically the dataset allow us to distinguish between internal and external sourcing of innovation activities. Therefore we defined the two dependent variables of our analysis as follow:

(1) "*making innovation*" relates to R&D activities carried out by external entities and not by any division or department of the company. Moreover we consider as "making innovation condition" the presence of training activities for the employees of the company with the specific purpose of increasing the firm innovation capacities.
(2) "*buying innovation*" relates to the presence of Research and Development (R&D) activities carried out within the company, due to the presence of a specific department or division. We also consider as a "buying condition" whenever the company indicates to have acquired technologies, industrial equipment, machineries, patents and/or know-how from other companies with the specific purpose of introducing new processes and/or products.

About 1 out of 4 of the sample companies indicates that at least an activity of making or buying has been carried out in the 2004-2006 period. Moreover the 20% of the sample shows a simultaneous presence of buying and making decisions while 5% of the sample only buys or only makes innovations (table 1).

Table 1 – Making and buying innovation in the Italian food companies

Buy	Make		
	No	Yes	Total
No	268	18	286
Yes	20	83	103
Total	288	101	389

Source: own elaboration on Unicredit 2007

To empirically test our theoretical hypotheses we use a set of variables which are presented in table 2:

Table 2 - Descriptive of the explanatory variables used in the empirical approach

Theoretical background	Hypothesis	Variable		Statistics	
				Mean	S.D.
Transaction Cost Economics	H1	Total amount of investment 2004-2006	inv_tot	127.79	227.73
		Total amount of R&D expenses 2004-2006	rd_tot	98.24	197.89
	H2	Being part of a holding/group	holding	0.19	0.46
		Participating in a consortium	consort	0.07	0.25
Strategic management	H3	Being a cooperative	coop	0.09	0.29
	H4	Index of market concentration (% Turn-over first 4 companies in the same sector of specialization)	c4	34.00	24.40
	H5	Size (number of employees)	tot_employ	54.17	92.30
	H6	Presence of product innovation	in_prod	0.43	0.50
		Presence of process innovation	in_proc	0.19	0.39
Resource-based view	H7	Number of skilled workers	skilled_work	29.77	69.67
		Percentage of employees attending training activities	per_training	6.41	20.16
		Percentage of employees dedicated to R&D activities	per_empl_rd	5.53	17.35
	H8	Age of the firm	age	31.47	25.86
	H9	Amount of investment in ICT (2006)	inv_ict	0.54	0.58
Control		Percentage of R&D outsourced to Universities in the same region	rd_reg_univ	2.13	13.82
		Percentage of R&D outsourced to other companies	other_firms	1.47	11.80
		Presence of export activities	export	0.63	0.61
		Capacity of capital accumulation in the region of location	cap_stock	21.72	2.27
		Innovation capacity in the region of location	in_capac	1.10	0.34
		Percentage of public R&D expenses in the region of location	pub_r_d	0.52	0.22
		Percentage of private R&D expenses in the region of location	priv_r_d	0.54	0.31

Source: own elaboration on a. Unicredit, 2007; b. ISMEA, 2009; c. ISTAT, 2010

3.2. The empirical model

A widely used approach to estimate the probabilities of choosing between alternative strategies is to implement a discrete-choice model (Masten and Saussier, 2002). In this case the observed innovation strategy (i.e. making or buying) is considered as an expression of a continuous latent variable reflecting the propensity to choose a specific option among different alternatives.
The generic empirical model related to the firm *j* to choose an innovation strategy *s* can be written as follow:

$$Y_{sj}^{*} = X_{j}^{'}\beta_s + \varepsilon_{sj} \qquad \forall s \in S \qquad (1)$$

$$Y_{sj} = 1 \quad if \quad Y_{sj}^{*} > 0$$
$$Y_{sj} = 0 \quad otherwise \qquad \forall s \in S \qquad (2)$$

where Y_{sj}^{*} is the unobservable value of the strategy *s* for firm *j* (latent variable), Y_{sj} is the observable strategy choice, for s = 1 in case of buying strategy and s = 2 in case of making strategy. As defined in section 2 $X_{j}^{'}$ is the vector of explanatory variables for firm *j*, β_s a vector of coefficients for strategy *s* and ε_{sj} a vector of unobservable characteristics related to firm *j* and strategy *s*. We can derive the probability that strategy *s* is chosen by firm *j* (γ_{sj}) as a function of the potential explanatory variables:

$$\gamma_{sj} = P(Y_{sj} = 1) = P(Y_{sj}^{*} > 0) = P(X_{j}^{'}\beta_s + \varepsilon_{sj} > 0) = P(\varepsilon_{sj} > -X_{j}^{'}\beta_s) = F(X_{j}^{'}\beta_s) \qquad (3)$$

where *F* denotes the distribution function of the unobservable characteristics ε_{sj}. Different econometric strategies can be implemented accordingly to the nature of the strategical choice analysed and the distributional form it is assumed for *F* (Verbeek, 2004). For example a relatively common approach is to use separate logit/probit models to depict the basic binary choice of for example innovate trough outsourcing or in house strategies. In this case the decision setting is about (1) innovate in house (making) and (2) outsourcing (buying). This would lead to a system of (two) equations. The implicit assumption is that the probability of making is independent from the probability of buying. But there is a good chance that the firm likelihood to make is conditional to the decision whether or not to buy innovation. In other word these decisions are likely to be interrelated. The usual alternative would be to estimate a bivariate probit model. For each choice (making or buying) a probit model is estimated and it is assumed that the error terms for the two equations are correlated.

The bivariate probit model enables us to model firm's decisions to choose more than one contract simultaneously (Greene, 2008). Since the outcomes are treated as binary variables any combination of strategies is possible. The strategies can be complements rather that substitutes only. The two equation model (one for s = 1 and the other for s = 2) is featured by correlated disturbances, which (due to identification reasons) are assumed to follow a normal distribution (variance is normalized to unity). That is for each j^{th} firm:

$$E\lfloor \varepsilon_{1j} \rfloor = E\lfloor \varepsilon_{2j} \rfloor = 0$$

$$\text{cov}\lfloor \varepsilon_{1j}, \varepsilon_{2j} \rfloor = \rho = \{\rho_{12}\} \quad (4)$$

$$\text{var}[\varepsilon_{1j}] = \text{var}[\varepsilon_{2j}] = 1$$

where ρ is a vector of correlation parameters denoting the extent to which the error terms co-vary. Should this be the case, we would need to estimate the two equations jointly, following a bivariate normal distribution: $\{\varepsilon_1, \varepsilon_2\} = \phi_2(0,0,1,1,\rho)$. Because in this model we are interested in simultaneous strategical decisions we have to define the joint probability. For example, the probability of firm *j* of choosing making and buying strategies at the same time $(Y_{1j} = Y_{2j} = 1)$ would be:

$$\gamma_{sj} = P(Y_{1j} = 1, Y_{2j} = 1) = \int_{-\infty}^{\varepsilon_{1j}} \int_{-\infty}^{\varepsilon_{2j}} \phi_2(X'_{1j}\beta_1, X'_{2j}\beta_2, \rho) d\varepsilon_{1j} d\varepsilon_{2j} \quad (5)$$
$$= \Phi_2(X_{1j}'\beta_1, X_{2j}'\beta_2)$$

In this model the log-likelihood is then a sum across the four possible stretagies variables (that is, four possible combinations of innovate $(Y_{1j} = Y_{2j} = 1)$ and non-innovate $(Y_{1j} = Y_{2j} = 0)$ times their associated probabilities (Greene, 2003). These probabilities may be drawn from (5) as well. The most relevant coefficients estimated in the model are β_1, β_2 and $\rho(\rho_{12})$. The latter, if significantly different from zero, will evaluate to which extent each pair of decisions are interrelated.

4. Results

Results from the bivariate probit model give indications on the correspondence between our theoretical hypotheses and the empirical evidences (table 3).
The correlation between making and buying decisions (*make*) has been confirmed by the model results which indicate that the likelihood that a firm jointly consider strategy of out-sourcing and in-house realization of innovative projects is relatively high. This result is indeed intriguing from a theoretical perspective where often making-buying decisions are seen as alternatives rather than complements. Of course results refer to join decisions on innovation strategies which involve different type of innovative projects with different features. Therefore it would be necessary to analyse in further details the type of innovative projects implemented via in house strategies vis-à-vis the innovative projects implemented via out-sourcing strategies.
If we look at the results related to the explanatory variables we can discuss the validity of our theoretical hypotheses in more detail. We stated in hypothesis 1 the "*firms having high sunk costs of capital and R&D will be more incline to favour in-house innovation sourcing, except in the case of strategic outsourcing*". Results indicate a positive effect of R&D costs on both buying and making decisions while overall sunk costs (*invest_tot*) negatively affect the likelihood of the firm to buy innovation. Therefore we can state that the empirical results confirm the hypothesis indicating the presence of strategic outsourcing in case of high R&D investments.

Table 3 - Results of the bivariate probit model

Variable		Buy				Make			
		Coef.	S.E.			Coef.	S.E.		
Total amount of investment 2004-2006	inv_tot	-0.001	(0.001)	**		-0.001	(0.001)		
Total amount of R&D expenses 2004-2006	rd_tot	0.007	(0.001)	***		0.006	(0.001)		***
Being part of a holding	holding	0.605	(0.323)	*		0.201	(0.306)		
Participating in a consortium	consort	-0.134	(0.475)			-0.353	(0.438)		
Cooperative	coop	0.089	(0.486)			0.568	(0.407)		
Index of market concentration	c4	-0.005	(0.005)			-0.011	(0.005)		**
Size (number of employees)	tot_employ	-0.005	(0.008)			-0.006	(0.004)		
Presence of product innovation	in_prod	0.610	(0.246)	**		0.794	(0.222)		***
Presence of process innovation	in_proc	0.736	(0.321)	**		0.497	(0.286)		*
Number of skilled workers	skilled_work	-0.004	(0.010)			-0.004	(0.006)		
Percentage of employees attending training activities	per_training	-0.007	(0.008)			0.005	(0.005)		
Percentage of employees dedicated to R&D activities	per_empl_rd	-0.037	(0.011)	***		-0.012	(0.007)		
Age of the firm	age	0.011	(0.004)	**		0.001	(0.005)		
Amount of investment in ICT (2006)	inv_ict	0.285	(0.224)			0.726	(0.206)		***
Percentage of R&D outsourced to Universities in the same region	rd_reg_univ	-0.030	(0.026)			-0.026	(0.028)		
Percentage of R&D outsourced to other companies	other_firms	-0.008	(0.012)			-0.012	(0.008)		
Presence of export activities	export	0.190	(0.209)			0.235	(0.165)		
Capacity of capital accumulation in the region of location	cap_stock	-0.054	(0.069)			-0.219	(0.067)		***
Innovation capacity in the region of location	in_capac	-2.069	(2.413)			-3.512	(2.260)		
Percentage of public R&D expenses in the region of location	pub_r_d	2.317	(2.298)			2.988	(2.135)		
Percentage of private R&D expenses in the region of location	priv_r_d	1.512	(2.549)			3.109	(2.391)		
Constant	cons	-0.778	(1.763)			3.298	(1.729)		*
Correlation between making and buying decision	make	0.726	(0.093)	***					
Number of obs. = 309		McFadden R2 = 0.60				Likelihood ratio test of make = 0: chi2(1) = 28.0646 Prob > chi2 = 0.0000			
Wald chi2(42) = 128.28 Log likelihood = -139.4126 Prob > chi2 = 0.0000									

*** significant at 1%; ** significant at 5%; * significant at 10% level; Standard errors in parentheses

In the hypothesis 2 we indicate that "*firms that are part of a larger group of companies or of a relational network are more likely to innovate in-house to benefit reduction costs in reducing contractual uncertainty and accessing group resources*". Being part of a holding (*holding*) increases the likelihood of outsourcing instead of implementing in-

house projects. Moreover it doesn't affect the likelihood to make innovations such as the firm participation in networks (*consort*). Therefore *H2* doesn't hold according to our empirical results.
In hypothesis 3 we focalize on theoretical arguments related to strategic management such as the role of organization and more specifically we state that "*the organisation culture of cooperatives makes in-house innovation less costly than outsourcing. Cooperatives should then be more incline to innovate in-house*". Results indicate that ceteris paribus the organizational formal status (such as being a cooperative) doesn't matter that much in the decision process of making-buying innovations.
If we look at hypothesis 4 we indicate that "*firms evolving in tight appropriability conditions will be more incline to outsource innovation than firms evolving in a weak appropriability setting*". This is substantially confirmed by empirical results which don't indicate any impacts on buying decision while a strong negative effect on the likelihood of the firm to implement in-house projects.
In our empirical results size doesn't matter therefore hypothesis 5 which states that "the size of the firm has an effect on innovation sourcing strategy" doesn't apply to food firms.
In hypothesis 6 we indicate that "*process innovation is more likely to be outsourced than product innovation*". Also in this case results partially confirm the hypothesis because while we can highlight that more process related innovations are more likely to be outsourced it also applies to product innovations. Moreover it seems that also making decisions are considered therefore indicating that a clear-cut relationship doesn't exist.
Hypothesis 7 states that "*firms with constrained human resources are more likely to engage in outsourcing during the innovation process"*. Results indicate (*per_empl_rd*) that this hypothesis holds and that food firms with higher application of human capital in R&D activities are less likely to implement out-sourcing innovative projects. The same applies for hypothesis 8 confirming that "'*Old firms are more innovative than young ones*" when we consider buying decisions (*age*).
Finally looking at hypothesis 9 which states that "*firms with a highly sophisticated information and communication technology system are more likely to outsource their innovation activities"*. Results don't confirm this statement while indicating a strong positive correlation between investment in ICT and making innovation decisions.
Among the control variables we use to test the role of location and local interactions only the index of the capacity of capital accumulation in the region of location has showed a significant correlation. Food firms located in area with higher intensity of investments are less likely to make innovation in-house but not necessary this is transferred in outsourcing strategies. It means that food firms do not fully benefit of a better environment of implement innovative strategies. It also indicates that internal factors seem to be more relevant than external ones.

5. Discussion and conclusions

This paper investigates the likelihood of Italian food companies in sourcing their innovation activities in and/or outside the boundaries of their organization structure. Despites the large amount of empirical and theoretical literature on the issue of innovation in manufacturing sector less papers have focalized on the specific trade-off of making and buying innovation in the food sectors. We pose a certain number of research hypotheses and use the empirical data to test them. Results highlight that only

some of the theoretical statements can effectively be confirmed empirically. For example making and buying decisions have to be consider as a synergic rather than alternative actions, indicating that it is the overall propensity of the food firm to innovate that matters instead of the process of innovation in itself In other words it matters whether or not the food firm is open to innovation. When this propensity is higher enough then the implementation of such attitude is done mainly through a multiple-strategy approach.

Focalising more on the specific factors affecting the making or buying decisions we have found a more puzzling behaviour than we would expect on the base of merely theoretical argumentations. We figure it out that sunk costs and specificity of investments matter as indicated by the more transactional cost economics approach while little significance should be given to other features such as belonging to a larger group or the legal status of the company. This is indicating that other factors matter slightly more in the food sector in comparison to the overall manufacturing one. Interesting indications arrive from the role of features such as market competition, size and type of innovation. We found out that size doesn't matter that much if we are analysing the likelihood to buy or make innovation while the degree of concentration in the specific sub-sector in which the company operates matters and the same applies for the type of innovation. A higher concentration reduces the likelihood to implement in-house projects while not affecting the likelihood to out-source them. Therefore in a highly concentrated market we should expect that internal initiatives related to innovation are substantially depressed. An argument often used in this case relates to impossibility of the company to cope with low market-power and higher risk of internal innovation projects. In this case innovation are difficult, mainly incremental while other strategies (i.e. advertising, restyling or repositioning the products) are often implemented. The likelihood of a company to make and buy innovation increases both in case of process and product innovation, again indicating that what really matters is the decision on whether or not to innovate.

A final set of hypotheses was made following the resource-based view approach. In this theoretical framework human resources, firm dynamicity and internal vs. external communications and ties matter more than in other approaches. Empirical results indicate that these factors can have a role in determining making and buying decision but less than we expected *a priori*. For example the more the company invests in human resources applied to R&D activities the less it is likely to buy innovation, but this factor is not significant in term of likelihood to make innovation. While older firms are more likely to internally innovate , developing higher communication capacities do not lead to external ties but increase the likelihood to implement internal innovative projects.

The overall picture we can draw by using the empirical results shows the absence of a clear-cut dynamics in making and buying decisions in the Italian food companies. It seems that the main concern of Italian food companies is whether or not to innovate instead of which type of strategy to implement. The substantial absence of evidences indicating positive effects of the external environment on the companies` strategy is also an element for thinking about policy and managerial strategies in this domain. More synergies should be developed and also more capacity to select differential path of innovation should be stimulated in food companies. In a context where the prevalence of food firms is based on SMEs the capacity to innovate via outsourcing is fundamental. The capacity to both public and private collaborations to induce this mechanism is very limited according to our empirical results.

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