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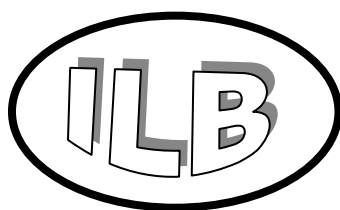
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Network Competence and Open Innovation Behaviour in the Food Sector: An Empirical Investigation

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Abstract

In today business world where knowledge and resources are increasingly spread among organizations, enterprises often develop a wide variety of relationships with other organizations in order to access new technologies, know-how and resources. Increasingly, the use of external resources for innovation – also referred as inbound open innovation in literature – is seen as a key factor to remain innovative and hence competitive. While the impact of open innovation on the firm's innovativeness and performance has received quite some attention by scholars, the mechanisms that push firm to open up their innovation process remain under investigated. The aim of this paper is to contribute to fill in this gap by developing and testing empirically a research framework on the firm specific factors impacting the firm's degree of openness. In order to reach the research objective, an extensive literature review was performed based on which several research hypotheses were developed. A web-questionnaire was then designed and distributed to the CEOs of food SMEs in Europe. A major result of this study is that network competence – defined as the firm's ability to establish and use relationships with other organization – drives the firm's openness in terms of ambidexterity (i.e. new versus existing relationships) and breadth (number of external sources or search channels that the firm relies upon in its innovative activities).

Key-words: *Open innovation, network competence, low-tech sector*

1 Introduction

In today's economy, firms have moved from the traditional 'closed innovation' processes to 'open' ones where they rely on a wide range of external actors and sources in order to innovate [1, 2]. As in today's world knowledge is increasingly getting specialized and distributed across organizations, firms that follow an open innovation strategy can tap into the disconnected pools of knowledge and capabilities which may lead to successful innovations if properly combined [3, 4]. However, openness does not always assure benefits for the firm's innovation performance. Some studies have shown that exhibiting a too open behavior can actually diminish returns to performance [2, 5, 6]. In such a context, some researchers have started to look at the antecedents of a firm's degree of openness in order to understand the reasons of its origin [5, 6]. Although they have uncovered some of these antecedents and have demonstrated for some their relation to openness empirically, they encourage further studies on the topic as these are still scarce. With this paper, we answer that call by developing and testing empirically a research framework on the firm specific factors impacting the firm's degree of openness.

Similarly to previous studies [5, 6], we adopt contingency theory as a theoretical lens in order to develop such framework.

The remainder of this paper is organized as follows. First, we discuss the theoretical background and relevant literature. We then introduce our research framework and related hypotheses. The next section provides an overview of the variables used in this study and the sample composition. The results are subsequently presented and discussed. The paper ends with the conclusion and some reflections on future research.

2 Theoretical Background and Literature Review

The open innovation model, introduced for the first time by Chesbrough in 2003, can be understood as *'the antithesis of the traditional vertical integration model in which internal innovation activities lead to internally developed products and services that are then distributed by the firm'* [7]. In the open innovation model, firms purposely use flows of knowledge coming in and out of their boundaries in order to accelerate internal innovation and expand the markets for external use of innovation [Chesbrough, 2006 in 7]. They thus engage with different types of partners to acquire ideas and knowledge in order to extend their internal knowledge base [4, 8].

Scholars have identified different forms of openness. Laursen and Salter [2] define firm's openness in terms of two dimensions: the breadth i.e. the number of external sources or search channels that the firm relies upon in its innovative activities and the depth i.e. the extent to which the firm uses in fact these different sources and channels. Bahemia and Squire [6] add a third dimension to openness: the ambidexterity which refers to the number of new versus existing partners. Dahlander and Gann [4] makes a distinction between four types of openness based on the pecuniary or non-pecuniary nature of the flows and on the direction of these flows (i.e. outside-in or inside-out). Others describe the firm's openness following different open innovation related practices or activities such as venturing, outward and inward IP licensing, technology scouting, horizontal technology collaboration, vertical technology collaboration, and technology sourcing [9, 10].

Independently on how firm's openness is defined, previous research support that there is nothing such as the perfect mode of openness. Every mode has its benefits and drawbacks. As an example, firms who are more open to external sources are more likely to expand their technological opportunities thereby increasing their level of innovative performance than those who are less open. But while doing so, these firms must dedicate large amount of resources and time to build the necessary processes which creates extra costs which the closer firms do not have [2, 11]. Moreover, firms appear to be differently equipped to grasp the benefits and face the potential drawbacks inherent to openness. For example, some scholars suggest that firms with stronger intellectual property (IP) protection exhibit a more open behavior as they are able to respond to opportunistic behavior more efficiently [Gallini, 2002 in 4, 12]. As such,

authors suggest that the firm's mode of openness should be in line with the firm's internal context while favoring the benefits rather than the drawbacks intrinsic to the mode [11]. This approach is actually supported by contingency theory which states that *'there is no one best way to organize, and that any one way of organizing is not equally effective under all conditions'* [Galbraith, 1973 in 6]. It therefore assumes that a firm's structure and strategy must fit its context in order to maintain high performance [11].

Some recent studies have started to look at the underlying drivers of firm's openness. Lichtenthaler and Ernst [13] have identified the firm's technology aggressiveness (i.e. firm's high specialization in R&D activities and strong focus on radical innovation) as an important determinant of open innovation. Based on the results of a survey of 154 middle and large firms, they have shown that technology aggressiveness is negatively related to the extent of external technology acquisition. In attempting to develop a conceptual framework on how different contingencies affect the acquisition of knowledge from external parties, Bahemia and Squire [6] have explained how the appropriability regime, the type of innovation and the product complexity influence the firm's degree of openness for innovation. More recently, Drechsler and Natter [5] have shown that a lack of market and technological knowledge, ineffective IP protection mechanisms and competitor threats (e.g. market entries and imitation) prevent firms from being more open. With the same survey, they also have demonstrated that firm's needs for financial funding in innovation and the effectiveness of a firm's IP protection mechanisms are the most important factors that increase the firm's degree of openness. Still, a holistic model of open innovation that includes the open innovation process's determinants at the firm, industry and environmental level is lacking [5, 14]. More particularly, researchers emphasize the need to develop a capability-based understanding of firm's openness [4, 10, 13]. Firms that do open up their innovation process are confronted to new challenges e.g. managing dispersed virtual R&D teams. They therefore need to develop new capabilities and/or adopt new practices in order to successfully benefit from open innovation [8, 13, 14].

3 Hypotheses development and research framework

Similarly to the research framework of Drechsler and Natter [5], our research framework revolves around the concept of firm's openness in innovation (see figure 1). In our study, firm's openness in innovation refers to the extent to which the firm relies on external parties to acquire knowledge; or what is also commonly known as 'inbound open innovation' [6]. We thus leave aside the outbound open innovation i.e. the inside-out flows of knowledge through e.g. commercialization of technology to other companies as empirical studies have found that companies perform more inbound than outbound activities [15]. We conceptualize firm's openness following three dimensions. The first two dimensions are the external search breadth and external search depth concepts proposed by Laursen and Salter [2]. They define external search breadth as the number of external sources or search channels that the firm relies upon in its innovative activities and external search depth as the extent to which the firm uses the different sources and channels. The third dimension of firm's openness relates to the concept

of ambidexterity which is proposed by Bahemia and Squire [6] and which refers to the number of new versus existing partners.

Network competence

Despite the current trend to open up the innovation process, many firms do not switch to the open innovation model; and this even though they acknowledge the potential benefits that they could retrieve from such model [13]. One possible explanation of such behavior relates to the existence of potential challenges that ‘mine’ the path towards open innovation. When firms engage in open innovation, they may have to deploy large efforts in screening and testing several sources and solutions [11]. In addition, when firms open up their boundaries to external people, organizations and institutions, they expose themselves to the risk that one actor would act opportunistically [4]. Moreover, collaborating with external actors is not straightforward. Differences in mentality between parties, distribution of ownership of the assets and intellectual property resulting from open innovation, and allocation of responsibilities towards losses are all issues that need to be properly dealt with to assure the success of the firm’s open innovation activities [16]. When adopting an open innovation approach, firms must thus heavily invest in setting up appropriate coordinating and governance mechanisms in order to deal with these issues. Also, the need for such mechanisms increase with the number of relationships the firm maintains [4, 11, 16]. As such, open innovation processes may be associated with a variety of costs (e.g. cost of competition and cost of coordination) [4]. These costs may explain why many firms delay the adoption of open innovation activities, especially in the case where they outweigh the benefits that firms could potentially retrieve from these activities.

Still, some firms do engage in open innovation processes and retrieve competitive advantages from them e.g. higher innovation performance [2]. The resource-based view of strategic management offers a valuable theoretical perspective to understand the differences between firms’ behavior towards open innovation. The resource-based view considers a firm as a group of resources which together explain the firm’s competitive advantage or disadvantage. Resources refer to all assets, capabilities, organizational processes, knowledge, etc. controlled by a company. The resource-based view argues that because resources are significantly heterogeneous across firms, each firm's resource set is in some ways unique. Resources that help the company to acquire sustainable competitive advantage must be valuable, rare, inimitable, and non-substitutable [17, 18].

Several authors have attempted to identify resources that provide firm’s competitive advantage in open innovation. Some of them [e.g. 8, 19, 20] have followed a competence approach where organizational competences or capabilities become the source of competitive advantage [18, 21]. An organizational capability is defined by Helfat and Peteraf [22] as *‘the ability of an organization to perform a coordinated set of tasks, utilizing organizational resources (i.e. asset or input to production), for the purpose of achieving a particular end result’*.

One organizational capability which has been recognized as a major source of competitive advantage in open innovation is network competence [20]. Network competence refers to a firm's ability to establish and use relationships with other organizations [23]. It has been studied in different research fields (e.g. strategic alliances, innovation literature) and has been referred to in different ways. For example, Lorenzoni and Lipparini [24] define 'relational capability' as a firm's ability to interact with other companies. Walter, Auer et al. [25] regard 'network capability' as a firm's ability to initiate, maintain, and utilize relationships with various external partners. Regardless of how the concept of network competence is defined, it usually refers to two components: network formation and network management.

Network formation relates to the phase during which the firm decides to develop inter-organizational relationships. Based on an internal, network and environmental analysis, the firm selects the appropriate partner(s) [20].

Network management relates to developing appropriate coordination and communication mechanisms as well as social competence. Coordination aims at connecting the firm with other organizations through the establishment and use of formal roles and procedures [20, 25]. It specifies the activities (i.e. tasks), the responsibilities of each party involved, and how resources and personnel must be allocated in order to enable the realizations of the plans developed [20]. Communication entails conveying relevant knowledge and information in an open, honest and timely manner to the firm's partners. It includes deploying communication modes between the firm and its partners which fit each specific inter-organizational context. It also includes the development of internal communication mechanisms as they help to avoid redundant process and miscommunication between partners [Cohen and Levinthal, 1990 in 25]. Social competence is about creating close or strong personal bonds with the individuals upon which the inter-organizational relationships are to be developed [20, 25]. It depends on the efforts provided by the firm's staff involved in the inter-organizational relationship to e.g. respond in a proactive manner to the partner's concerns, spend time to establish contacts with the partner and attempt to fulfill the needs of the partner.

So defined, network competence helps the firms to face the various challenges, costs and contingencies linked to open innovation. We therefore hypothesize that a firm's with a higher network competence exhibits higher openness. More specifically:

The ambidexterity dimension of firm's openness refers to the extent to which the firm develops new relationships. It relates in reality to the balance between the firm's exploratory search behavior and the firm's exploitative behavior [6]. While exploration involves searching new knowledge and skills away from current organizational routines and knowledge bases in order to find emerging innovations, exploitation involves using knowledge that is closely related to

the preexisting knowledge bases in order to improve efficiency and returns from current strategies [26, 27]. Exploration is known to be associated with collaboration with new partners whereas exploitation with collaboration with existing partners [6]. Or in the terms of the theory of ‘tie strength’ of Granovetter [28], exploration depends upon the development of weak ties whereas exploitation upon the development of strong ties. In literature, strong ties are known to serve as social control mechanisms besides acting as channels for high-quality information and tacit knowledge [27]. They enhance trust, mutual gain, reciprocity and a long-term perspective [Larson, 1992 in 27]. They thus reduce risk of opportunism as they push partners to focus on common and long-term benefits rather than on their individual short-term interests [27]. On the contrary, weak ties do not serve as social control mechanisms like strong ties do. As such, firms that show a higher exploration behavior than an exploitation behavior, or in other words, a high ambidexterity, are more exposed to risk of opportunism. We therefore propose that, in order to protect themselves, these firms need to develop a higher network competence than firms with low ambidexterity. Hence the following hypothesis:

Hypothesis 1a: Firms that possess high network competence will show a higher ambidexterity than firms that possess low network competence

The breadth dimension of firm’s openness refers to the range of organizations with which the firm develops relationships for learning and innovation. These organizations can be suppliers, customers, competitors, firms from other sectors, public and private research institutes including universities, training institutes and consultants [2, 23]. In knowledge and social capital theory, shared meaning and understanding are required between people involved in collaborative efforts in order to achieve joint goals [29, 30]. A lack of shared meaning and understanding is associated with incomprehensibility which may become a source of frustration and conflicts. It can thus jeopardize successful collaboration and knowledge transfer. The development of shared meaning and understanding hinges on individual as well strategic, cultural and organizational similarities [17]. Shared language, vision and culture, similar ‘dominant’ logics and knowledge bases are all resources that provide shared meaning and understanding [31, 32]. In such perspective, and because breadth is intrinsically associated with heterogeneity, firms that show higher breadth are more confronted to cognitive challenges than those that show lower breadth. The existence of these challenges is well illustrated in research investigating collaborative processes within triple-helix arrangements, between firms and universities [e.g. 33, 34], and between different communities of practice [e.g. 35]. As such, we propose that, in order to be successful with the open innovation process, firms that exhibit high breadth must necessarily develop high network competence. Thus the following hypothesis:

Hypothesis 1b: Firms that possess high network competence will show higher breadth than firms that possess low network competence

The depth dimension of firm's openness refers to the degree of a firm's reliance on its external information and knowledge sources. In the light of power dependence theory, a high level of reliance on external sources may lead to a situation of power asymmetry between the firm and its external partners. Because the firm attributes a high value to the knowledge and information coming from its partners, it positions itself in an inferior position. External partners thus acquire a strong bargaining and negotiating power over the firm [17]. Because such power asymmetry may decrease the level of cooperation and satisfaction and increase the level of tension and conflict in relationships [36], the firm must seek to counteract it in order to retrieve benefits from these relationships. We thus propose that, in order to be successful with the open innovation process, firms that exhibit high depth must necessarily develop high network competence. Hence the following hypothesis:

Hypothesis 1c: Firms that possess high network competence will show higher depth than firms that possess low network competence

Top management support

Following Gianiodis, Ellis et al. [37], '*open innovation is a firm-level strategy that enables organizations to appropriate value*'. It requires the establishment of an organizational climate, business processes and activities in line with open innovation principles [12]. The strategic direction of organizations as well as the development of the firm level enablers for open innovation is known to be in the hand of senior management [16]. Senior managers must bring new thinking and clear mandates regarding open innovation processes [38]. They must make clear their commitment to open innovation processes and develop appropriate incentives and communication conducive to open innovation [12]. We thus propose the following hypothesis:

Hypothesis 2a: Support from the top management for open innovation is positively related to the firm's openness in terms of ambidexterity

Hypothesis 2b: Support from the top management for open innovation is positively related to the firm's openness in terms of breadth

Hypothesis 2c: Support from the top management for open innovation is positively related to the firm's openness in terms of depth

Strategy

Strategy can be described as the '*creation of a unique and valuable position*' [39]. It articulates the ends in terms of products or services, customers' needs and market that the firm wishes to strive for and the means that the firm will need to deploy in order to reach these ends [39, 40]. Firm's openness is known to be driven by the firm's objectives and strategies as it allows the firm to access knowledge – and potentially other resources – that may be crucial for reaching its corporate goals [8, 41, 42]. Similarly to Koka and Prescott [41], we classified firm strategy in

terms of Miles and Snow typology i.e. prospector, defender and analyzer in order to develop our directional hypotheses.

Prospectors usually enact in dynamic environments and have a reputation of innovators. They have the ability to find and exploit new products and new market opportunities. They are therefore the first movers, the creators of change, and innovators of new technologies. Defenders focus on producing a limited range of traditional products directed to a narrow segment of the total potential market. They prevent competitors from entering through e.g. competitive pricing and high-quality products. Analyzers are firms that reside between prospectors and defenders which are situated at either end of the continuum of adjustment strategies. They focus on a stable base of traditional products and markets like defenders do and engage in new products or new markets like prospectors do but only when the viability of these products and markets has been demonstrated [41, 43].

Firms that follow a prospector strategy require expanding their domains of knowledge or knowledge bases in order to create '*multiple, prototypical technologies*' thereby increasing their chance to respond to their changing domains successfully [43]. On the contrary, defenders focus on specific domains of knowledge so they become leaders in those areas [43, 44]. As such, and because analyzers are situated in between prospectors and defenders, we propose that firms that exhibit a prospecting strategy will show higher breadth compared to analyzers and defenders. Moreover, defenders have the need to access to fine-grained, reliable industry specific information. They therefore need to develop a few strong ties leading to exploitation of their core technology. On the contrary, prospectors are at an advantage when developing weak ties as the development of strong ties require investments in time and resources which does not allow the firm to maintain many relationships at the same time, thus limiting its scanning efforts of the environment [27, 41]. We thus propose that firms that exhibit a prospecting strategy will show higher ambidexterity compared to analyzers and defenders. Finally, we also propose that firms exhibiting a prospecting strategy will show higher depth compared to analyzers and defenders. Following Bahemia and Squire [6], depth is about the level of cooperation between the firm and its external sources of knowledge and information [6]. As cooperation goes hand in hand with knowledge sharing which may generate new knowledge and ideas [45], prospectors will show higher depth than analyzers and defenders known to be less driven by extending their pools of innovative ideas. We propose therefore the following hypotheses:

Hypothesis 3a: Prospectors will show higher ambidexterity than analyzers and defenders

Hypothesis 3b: Prospectors will show higher breadth than analyzers and defenders

Hypothesis 3c: Prospectors will show higher depth than analyzers and defenders

Our research framework depicted in figure 1 summarizes our hypotheses for this study. It suggests that firm’s openness in innovation depends on three main firm specific factors: (a) the firm’s network competence, (b) the firm’s top management support, (c) the firm’s innovation strategy.

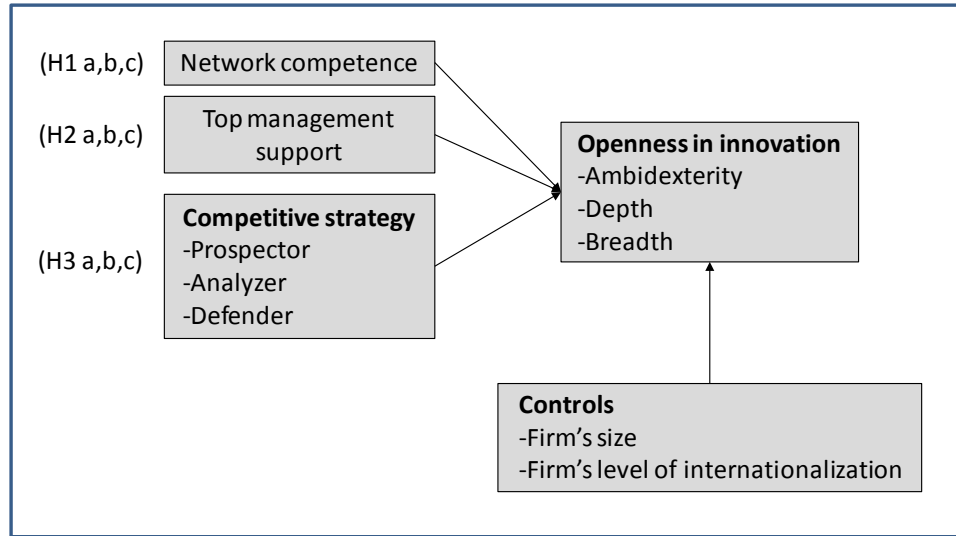


Figure 1. Research framework and hypotheses

4 Research methodology

Research setting

We collected data from the food and drink industry exclusively. The choice to focus on this single industry is explained by the food sector being composed of more than 99% of SMEs – our focus in this study [46]. Moreover, it is known that sectoral specificities exist regarding knowledge, learning and actors [47]. The food sector, which can be categorized as a low low-tech industry characterized by a low rate of innovations, is not an exception [48].

Sample and data collection

The data collection took place within the FP7 project NetGrow. The sample consisted of Belgian, French, Swedish, Irish and Italian food and drink firms. It was exclusively composed of SMEs which we define following the European Commission (2009) as a firm with less than 250 employees. The data were collected between October 2012 and February 2013 using an online questionnaire. The questionnaire was first pilot tested in each participating countries (4 pilot test with SMEs in each country), subsequently revised based on the pilot test results to be finally translated in the national language(s) of each participating country. Respondents’ contact details were obtained from national databases (e.g. Belgian ...) which, depending on the country, were publicly available or needed to be purchased. The targeted respondents were the

SMEs owner-manager. In some countries, the contact details of the owner-managers were readily accessible from the databases. In that case, contact was directly taken with them. In others, only the general company details were accessible from the databases. In that case, individual calls were made for each company in order to get the contacts details of the owner-managers. In some cases, the contact details of another type of informants (e.g. R&D managers, marketing managers) were given instead of the ones of the owner-managers. Nevertheless, these informants also appeared to be knowledgeable regarding the collaboration practices of the firm. Depending on the country, we either sent e-mails directly to the respondents with a personalized covered letter that proposed to provide a summary of the results to the respondents if they wished to, or we contacted them by telephone in order to first explain them the purpose of the study and what they would gain from it. In the later case, when the respondents told us on the telephone they wanted to participate in the survey, we sent them subsequently the questionnaire by e-mail also accompanied with a personalized letter. The choice to opt for one or the other approach depended on the country specific situation. In both approaches, a reminder was sent via e-mail for those who had not completed the survey. Together with the five countries, we received 227 questionnaires back giving us an average response rate of 2.41%. We excluded 151 questionnaires from the analysis because of missing data.

Measures

The online questionnaire was designed using existing scales as well as adapted and new scales to collect the data. The measurement of the different dependent and independent variables used in this study are summarized in the next section.

Independent variables

- **NETWORK COMPETENCE:**

Research on the development of network competence – and related concepts e.g. alliance capability – does not directly measure the concept directly. Instead, the learning mechanisms or the management practices related to collaboration, alliances, etc. have been used as a representation of network competence and its related concepts [12, 49, 50]. In this study, we followed the same approach to measure network competence (NETCOMP). We measured it based on 7 collaboration management practices collected and adapted from Heimeriks, Klijn et al. [50]. In line with the original scale, the different practices were measured using a binary (0-1) measure which indicated whether or not the firm had that practice in place. Network competence was then measured through summing up the total number of practices in place within the firm. The measure employed was tested for internal consistency reliability by applying the Cronbach's alpha test. We obtained a satisfactory Cronbach's alpha value of 0.707 (i.e. the value exceeded the threshold of 0.60, acceptable for exploratory studies) [51].

- **TOP MANAGEMENT SUPPORT:**

Top management support (TMS) was measured through a one-item construct adapted from [18]: “*My firm believes that networking and collaboration with other organizations play a role in the future success of the firm*”. In line with the original scale, respondents were asked to state whether they disagreed or agreed with this statement through a seven-point Likert scale (with 1 = strongly disagree and 7 = strongly agree).

- **STRATEGY:**

To measure strategy, we created three statements corresponding to one of the three typologies of strategy of Miles, Snow et al. [43] i.e. prospector, analyzer and defender (see appendix). Respondents were asked to choose for the most in line with their firm’s innovation strategy. For the multiple regression analysis (see section 5), dummy variables were created: analyzers (PROANA) and defenders (PRODEF) were the categories and prospectors the omitted category.

Dependent variables

- **OPEN INNOVATION BEHAVIOR:**

To measure two of the three dimensions of the firm’s open innovation behavior i.e. breadth and depth, we drew our inspiration from the study on firm’s openness for innovation of Laursen and Salter [2]. Like them, we measured *breadth* (BREADTH) as a combination of sources of knowledge for innovation. In our study, we identified 13 different sources of knowledge – instead of 16 – based on literature (see appendix). Each of these sources were coded in a binary variable which indicated whether the firm used that source (1) or not (0). Like Laursen and Salter [2], we added up the value obtained for each source – with a minimum of 0 and a maximum of 13 – to measure breadth. In order to measure *depth* (DEPTH), we also followed a similar approach to the one employed by Laursen and Salter [2]. Respondents were asked to state how frequently their firm collaborated or used each of the 13 sources of knowledge in order to source knowledge for the purpose of innovation (0 = never, 1 = sometimes, 3 = often, 4 = every time). Similarly to Laursen and Salter [2], each of the 13 sources of knowledge were coded with 1 when the respondent reported that its firm collaborated or used that source ‘often’ or ‘every time’ and with 0 when he/she reported its firm to ‘never’ do so or ‘sometimes’. Adding to the approach of Laursen and Salter [2], a distinction was made between the 5 following types of resources: scientific knowledge, technical information and resources, managerial/legal know-how, market information and facilitation, and financial resources. The main rationale for this distinction was its parallel to the established division between types of innovation [52] and the importance of scarce financial resources for openness [5]. As such, five types of ‘sub-breadth’ and five types of ‘sub-depth’ were measured based on each type of knowledge. An overall breadth dimension was measured by taking the average of the five sub-breadths. A similar approach was used to measure the overall depth. Both our constructs had a high degree of internal consistency (Cronbach-alpha=0.929 (for overall breadth) and Cronbach-alpha=0.856 (for overall depth)). To measure the final dimension of the firm’s open innovation behavior i.e. *ambidexterity* (AMBIDEX), we needed to develop a new construct as this concept has only been recently introduced in the literature and has not received much attention yet in empirical studies [6]. We therefore introduced the following one-item construct based on the

definition of the concept itself (see previous sections): “*We frequently develop relationships with new partners with the aim to innovate*”. Respondents were asked to state whether they disagreed or agreed with it through a seven-point Likert scale (with 1 = strongly disagree and 7 = strongly agree).

Controls

- *FIRM’S SIZE:*

Previous research suggest that firm’s size influence the firm’s open innovation approach, but the findings are mixed [15, 37]. Firm’s size – which is in fact an indicator of the firm’s resources (e.g. financial resources, manufacturing and R&D capacity, size of its workforce) [53] – may allows the firm to invest more resources in the development of relationships. We therefore included *firm’s size* (FIRMSIZE measured in the log value of the number of employees) as a control in this study [2, 5, 54].

- *INTERNATIONALIZATION:*

Previous research suggest that the firm’s level of internationalization is associated with a higher degree of openness [e.g. 11]. We therefore included it as a control in this study (INTERN) and measured it via a single-item construct: respondents were asked to state whether their primary geographical market was local/regional, national, European or world-wide.

5 Analysis and results discussion

Descriptive analysis

The data were analyzed using SPSS 15.0. We first used the descriptive statistics in order to explore the data. Some interesting insights could be gained from the descriptive statistics regarding firm’s openness in terms of breadth and depth. First, many missing data could be seen regarding both breadth and depth. Only 76 respondents (i.e. 33.48% of the received questionnaires) completed fully the questions regarding breadth and depth. This did not surprise us as these questions were rather lengthy. Second, there was a high proportion of firms that did not exhibit any openness in terms of breadth (19.7% of the firms). This proportion was even higher when looking at openness in terms of depth (35.5%).

Hypothesis testing

Hypotheses were tested using multiple linear regression analysis. We first checked whether the different assumptions for general regression models (i.e. linear relationship between dependent and independent variables, normal distribution and homoscedasticity of residuals, and multicollinearity) were fulfilled [51]. Linearity was checked by examining the residuals. No pattern appeared indicating a non-linear relationship except for depth (V-shaped). Normality was verified through the Kolmogorov-Smirnov test. All sig. values except the one for depth (sig.=0.002) appeared to be greater than 0.05 indicating a normal distribution of the

variable[51]. We checked for homoscedasticity by plotting the regression standardized predicted value with the regression standardized residual. No pattern could be found which indicates the presence of homoscedasticity except regarding depth. To detect multicollinearity, we used collinearity diagnostics. No condition index was equal or above 30 indicating the absence of multicollinearity.

The results of the regression analysis regarding ambidexterity as an independent variable are reported in table 1. The model explained 19.2% of the variance in ambidexterity (adjusted $R^2=0.192$). H1a was confirmed in the regression results, suggesting that network competence matters to the firm’s openness in terms of ambidexterity. Our analyses showed that network competence had a positive, significant relation to ambidexterity ($\beta=0.196$, $p<0.01$). The regression results also confirmed H2a, suggesting that top management support for open innovation relates to the firm’s openness in terms of ambidexterity. The results evidenced that top management support had a positive, highly significant relation to ambidexterity ($\beta=0.406$, $p<0.001$). No significant relation between the dummies for strategy and ambidexterity was confirmed in the regression results, hence H3a was not supported. Still, the results indicated a negative relation between the dummy PRODEF and ambidexterity ($\beta=-0.088$) suggesting that prospectors show a higher ambidexterity than defenders. This was in line with what we expected.

Table 1. Regression Analysis: Impact of network competence, top management support and strategy on ambidexterity
Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.579	.513		5.023	.000
TMS	.435	.072	.406	6.064	.000
INTERN	-.039	.099	-.027	-.394	.694
1 PROANA	.143	.323	.033	.441	.659
PRODEF	-.274	.245	-.088	-1.117	.265
NETCOMP	.211	.076	.196	2.777	.006
FIRMSIZE	-.278	.172	-.125	-1.614	.108

a. Dependent Variable: AMBIDEX

Table 2 reflects the regression results regarding breadth as an independent variable. The model explained 30.7% of the variance in breadth (adjusted $R^2=0.307$). The relation between network

competence and breadth was positive and significant ($\beta=0.311$, $p<0.01$). This confirmed H1b i.e. that network competence influences the firm’s openness in terms of breadth. Our analyses showed that top management support had a positive and marginally significant relation to breadth ($\beta=0.032$, $p<0.05$), thus H2b, i.e. existence of a positive relation between top management support for open innovation and the firm’s openness in terms of breadth, was also supported. Like for ambidexterity, no significant relation between the dummies for strategy and breadth was confirmed in the regression results, thus H3b was not supported. Still, the results indicated a negative relation between both dummies i.e. PRODEF, PROANA and breadth ($\beta=-0.026$ (for PRODEF), $\beta=-0.070$ (for PROANA)) signifying that prospectors show a higher ambidexterity than analyzers and defenders. This was in line with what we anticipated.

Table 2.Regression Analysis: Impact of network competence, top management support and strategy on breadth

Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-1.339	1.473		-.909	.367
TMS	.487	.222	.247	2.193	.032
INTERN	.397	.293	.156	1.358	.179
1 PROANA	-.590	.956	-.070	-.617	.539
PRODEF	-.146	.736	-.026	-.198	.844
NETCOMP	.564	.191	.311	2.960	.004
FIRMSIZE	.629	.484	.159	1.298	.199

a. Dependent Variable: BREADTH

Finally – and although we acknowledge that the normality and the homoscedasticity assumptions are violated – the regression results regarding depth as an independent variable are still provided in table 3. 16.4% of the variance of depth was explained by the model (adjusted $R^2=0.0164$). Only H2c relating to the existence of a positive relationship between top management support and depth was confirmed with the regression results. Our analysis showed that the relation between this variable and depth was positive and marginally significant ($\beta=0.320$, $p<0.05$). The regression results did not confirm either H1c or H3c. Thus both the relationships between network competence and depth and strategy and depth were not supported. Still, the results indicated the expected positive relation between network competence and depth and the expected negative relations between the dummies for strategy and depth.

Table 3. Regression Analysis: Impact of network competence, top management support and strategy on depth**Coefficients^a**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-.769	.542		-1.418	.161
TMS	.211	.082	.320	2.587	.012
INTERN	.004	.108	.005	.038	.970
1 PROANA	-.073	.352	-.026	-.208	.836
PRODEF	-.015	.271	-.008	-.056	.956
NETCOMP	.110	.070	.181	1.567	.122
FIRMSIZE	.220	.178	.166	1.234	.222

a. Dependent Variable: DEPTH

In all three models (i.e. ambidexterity, breadth and depth), no significant relation between the controls (i.e. firm's size and internationalization) and the three independent variables were detected in the regression results.

6 Discussion

The purpose of this study was to contribute to literature seeking to understand the drivers of firm's openness. Through a literature review, different firm specific factors were identified as potentially explaining the degree of firm's openness. Their relation with the degree of firm's openness was then investigated through a quantitative study in the food sector.

Our results reveal that network competence drives the firm's openness in terms of ambidexterity and breadth – two of the three dimensions of openness identified in literature – thus confirming the importance of developing a capability-based understanding of openness [4, 10, 13]. More open innovation requires capabilities and skills different than those for closed innovation; firms will switch to a more open innovation model when they have developed a certain level of these capabilities and skills. Beside the importance of network competence for firm's openness, our study also shows that the commitment of senior managers towards open innovation is crucial. To our surprise, no significant relationship was identified between the firm's strategy and firm's openness, thus reinforcing the idea that firm's openness is especially driven by possessing the necessary resources in terms of capabilities and staff for engaging in

open innovation activities. Concerning the control variables, our analysis did not clarify any significant relation between the firm's size and openness, thus not supporting the findings of other studies where larger firms appeared to be more open than smaller ones [e.g. 5]. Neither a significant relation between the firm's degree of internationalization and openness could be found. Last but not least, data for the empirical study were collected in the food sector exclusively. This study also thus answer conjointly the calls for more empirical studies on open innovation in low-tech sector and in SMEs [e.g. 10, 14].

7 Limitations, implications and future research

Limitations

Some limitations must be acknowledged in this study. The first limitation concerns the appropriateness of the linear regression model for studying the relations between our set of independent variables and our three dependent variables. Different assumptions for general regression models appeared to be violated for depth (linearity, normality, homoscedasticity). This might be due to the fact that the depth measure suffers from over dispersion (i.e. mean=0.7079 is smaller than variance=0.860) potentially caused by the large percentage of firms that have zero values as the dependent variables. This calls for another model for estimating our research framework¹. The second limitation concerns the measures used to capture the main concepts of the study. While the measures of breadth and depth are based on measures developed in previous studies [e.g. 2], the measure of ambidexterity was developed for the purpose of this study based on the definition of the concept. As ambidexterity was measured via a simple one-item construct in this paper, future research may want to focus on developing and validating a measure of ambidexterity. In order to measure network competence in our study, we followed the same approach employed by many researchers [49, 50], which is to measure it indirectly through the management practices related to collaboration present within the firm. Other researchers may wish to measure it directly. Surprisingly, and in divergence with previous studies [e.g. 13], our findings did not support the existence of a relation between the firm's strategy and firm's openness. As we measured firm's strategy based on items relating to the three strategy types of Miles and Snow [43] (i.e. prospector, defender and analyzer), other researchers may want to use other measures of strategy when investigating firm's strategy as a potential driver of openness. The third limitation relates to the study being based on cross-sectional data only. The study did not contribute to the understanding of the relations between the selected firm specific factors and the firm's open innovation behavior over the course of time. Future studies may want to use longitudinal data in order to understand the dynamic of these relations. Fourth, we deliberately chose to focus on the firm level antecedents of openness in this study. In line with contingency theory, we strongly encourage future studies to include both the internal context as well as the external context of firms when seeking to understand the origin of open innovation. Finally, we

¹ *With this paper, we aimed at presenting some preliminary results. Data are at the present time still being collected. The limitation due to the non appropriateness of the linear regression model will be taken into account when analyzing the full data set.*

acknowledge the small number of valid cases on which the empirical study was conducted. In order to confirm our findings, studies relying on a bigger data set should be conducted.

Theoretical implications

Based on our theoretical model and our findings from the empirical study, the following theoretical implication stems from this paper. Moving from a closed innovation model to an open one requires the firm to proceed with deep organizational changes [1, 12, 15]. It must transform its boundaries into a '*semi-permeable membrane*' through which information and knowledge necessary for innovation can flow between the external environment and the firm [15]. Such a transformation exposes the firm to new challenges of which some are related to the knowledge sharing process itself (e.g. increased risk of opportunism, power imbalances, cultural mismatches) while others are related to the integration of the newly information and knowledge within the firm innovation process and their transformation into valuable outputs. Open innovation activities thus necessitate new structures, sets of capabilities if they are to be successful. Researchers have only recently started to look at how open innovation principles are implemented in practice [1]. Our study contributed to this aspect of the knowledge body of open innovation by confirming the importance of network competence for openness. Firms appear to open up for innovation when they have developed a certain level of network competence which allows them to retrieve benefits from external relationship for innovation while at the same time preventing any damages to occur that might result from opening up their boundaries. Stemming from the research of Lichtenthaler and Lichtenthaler [8], we believe that a knowledge capability such a network competence not only influences the firm's decision to open or close their innovation processes, but also might explain the heterogeneity in innovation open performance. The role of network competence in explaining firm performance in open innovation might be thus a fruitful avenue for future research.

Practical implications

To conclude, we turn to the practical implication of our study. As several case studies reveal [e.g. 55], implementing open innovation requires managers to put in place the appropriate mechanisms and structures to create a climate conducive to open innovation. One such mechanism appears to be network competence. Managers should seek to improve such competence in they wish to implement successfully the open innovation model.

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views and the Community is not liable for any use that may be made of the information contained therein.

APPENDIX: MEASUREMENT SCALE ITEMS

Network competence:

<i>Items</i>	<i>Categories</i>	<i>References</i>
Full-time partnership manager	0 (No), 1 (Yes)	[50]
Partner selection procedures		
Joint business planning sessions		
Codified best practices (collaboration, partnerships)		
Intranet for collaboration and partnership resources, etc.		
In-house training courses about collaboration, management of partnerships (<i>In-house company courses</i>)		
Training courses by external experts about collaboration, management of partnerships (<i>Courses by external experts</i>)		

Firm's strategy:

<i>Typology of strategy</i>	<i>Items</i>	<i>References</i>
Prospector	We are often first to market and respond rapidly to new opportunities	[43]
Analyzer	We are seldom first to market, but are a fast follower	
Defender	We focus on our niche in the market and pay attention to industry changes only if they have a direct influence on our areas of operations	

Open Innovation behavior (breadth and depth):

<i>Items</i>	<i>References</i>
Suppliers (raw materials, machines, packaging)	[2, 23]
Customers	
Competitors	
Other firms in other sectors	
Universities and public research institutes	
Private research institutes	
Chambers of commerce and trade organizations	
Industry associations and sector organizations	
Clusters	
Scientific and technology parks	
Business clubs	
Training institutes and consultants	
Fairs, exhibitions and conferences	

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