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(Article begins on next page)

Knowledge management and open innovation in agri-food crowdfunding

Valentina Cillo

Link Campus University, Roma, Italy

Riccardo Rialti

*Department of Economics and Management,
Università degli Studi di Pisa, Pisa, Italy and*

*Department of Economics and Business Sciences,
Università degli Studi di Firenze, Firenze, Italy*

Bernardo Bertoldi

Department of Management, Università degli Studi di Torino, Torino, Italy, and

Francesco Ciampi

*Department of Economics and Business Sciences,
Università degli Studi di Firenze, Firenze, Italy*

Abstract

Purpose – The purpose of this paper is to analyze the relationship between knowledge management capabilities and successful open innovation within agri-food businesses. This particular piece of research focuses on agri-food businesses which utilize crowdfunding platforms.

Design/methodology/approach – The research adopts a survey-based methodology, which is useful in enhancing the generalization of results. The final sample includes 80 cases for the analysis. The model and the hypotheses were tested through a hierarchical regression model.

Findings – This research assesses the importance of knowledge management capabilities for successful open innovation in crowdfunding for agri-food businesses. In particular, it emerged that IT-based knowledge exploitation capabilities are enablers of open innovation strategies. Additionally, it emerged that knowledge exploration capabilities can positively mediate the relationship between IT-based knowledge exploitation capabilities and open innovation in the context of agri-food businesses.

Originality/value – To the authors' best knowledge, few researchers have explored this topic and, as such, there is a need to better conceptualize this intriguing phenomenon and to provide empirical evidence to support it.

Keywords Knowledge management, Open innovation, Knowledge exploitation, Knowledge exploration, Crowdfunding, Agri-food business

Paper type Research paper

1. Introduction

The current turbulent economic environment has given rise to a large amount of managerial literature which addresses the ways in which the new paradigm of innovation has emerged. This new paradigm has been labeled “open innovation” (Soto-Acosta and Cegarra-Navarro, 2016). As innovation is becoming increasingly complex and expensive for individual businesses, there is a contemporary need for businesses to shift to a paradigm in which partners, knowledge institutions, governmental bodies and even competitors work together to develop new products and processes quickly and effectively (Chesbrough, 2003). As stressed by open innovation scholars, innovation has thus become an unavoidable interplay of various parties who combine their knowledge and turn problems into design requirements. Thus, the importance of knowledge management capabilities has arisen (Santoro, Ferraris, Giacosa and Giovando, 2018). Specifically, a business's capability to explore and exploit the knowledge given to it by partners and consumers is necessary in order to allow

it to transform ideas that emerge from its environment into innovations. Without these processes, businesses would not be able to effectively reap the benefits of the large amount of information at their disposal (Santoro, Vrontis, Thrassou and Dezi, 2018).

In recent times, open innovation has also become increasingly important in the agri-food sector (Santoro *et al.*, 2017). According to Sarkar and Costa (2008), this specific sector demonstrates rapid growth in the number of open innovation projects occurring within it (Huizingh, 2011). Indeed, consumers' food-related needs in an increasingly globalized economy are constantly changing and evolving. Nowadays, consumers tend to look for customized offerings that can offer them personalized consumption experiences (Quan and Wang, 2004). For example, around the world, consumers increasingly opt for specialized diets which address their desires to eat organic, low-fat, or low-carb foods, or eliminate ingredients based on food sensitivities, allergies, or personal convictions. Approximately two-thirds of respondents (64 percent) in Nielsen's new Global Health and Ingredient-Sentiment Survey reported that they follow a diet that limits or prohibits their consumption of at least some foods or ingredients. Moreover, the majority of consumers are advocates of positive nutrition, with 56 percent using food and/or drink to improve their health. The need for the agri-food industry to collect and analyze ideas from consumers, and to subsequently develop suitable new products, has thus emerged rather abruptly. To address these challenges, agri-food businesses must increase their innovative capacity; investment in open innovation practices thus emerges as a remedy for this problem. Open innovation, as previously discussed, is the ensemble of practices that allows the businesses, even in the agri-food sector (Klerkx and Leeuwis, 2009), to collect ideas from an external environment which is capable of triggering innovation processes and which can then increase businesses competitiveness. The main cause of this phenomenon in the agri-food sector is related to the current need for constant innovation (Huizingh, 2011). Consequently, collaboration with partners is becoming more and more important for agri-food business, particularly smaller ones, as it allows them to conserve their expendable resources in terms of innovation development (Bigliardi and Galati, 2013). Yet, as in any kind of business, agri-food businesses can benefit from open innovation practices only if they put in place knowledge management capabilities (Garcia-Villaverde *et al.*, 2018). Indeed, knowledge management capabilities – such as the capability to explore and exploit available knowledge (Ciampi, 2017a; Rialti, Marzi, Silic, and Ciappei, 2018; Rialti *et al.*, 2019) – are fundamental in order to collect, systematize, categorize, diffuse and exploit the knowledge that may be generated by external sources (O'Connor and Kelly, 2017). As a matter of fact, without proper knowledge management processes and capabilities, it may not be possible to generate relevant insights from external knowledge.

Notwithstanding this, the fact that agri-food is a relatively mature and slow-growing sector always needs to be considered by researchers. Small agri-food businesses display a relatively low level of R&D investment and are quite conservative in the types of innovation that they introduce to the market (Costa and Jongen, 2006). As such, open innovation is fundamental to agri-food businesses for three main reasons: agri-food businesses are frequently SMEs and thus lack the economic capabilities to innovate autonomously (Van de Vrande *et al.*, 2009; Ciampi and Gordini, 2013, Ciampi, 2017b,c); agri-food products are frequently subject to regulation from international authorities in order to ensure product quality standards (Vos, 2000) and innovation should therefore also derive from the insight of these authorities; and some food production processes trace their origins back to more traditional methods, making it difficult for agri-food business managers to alter well-established products in order to follow market trends (Fortuin and Omta, 2009; Vitrolles, 2011). Suggestions from outside of the organization can, in this case, be extremely helpful in identifying potential solutions and compromises. While there are businesses that are currently trying to implement open innovation-related practices, the majority of agri-food businesses show much lower innovation-absorption capabilities than

their larger counterparts, as well as a lack of effective technology transfer and flexible innovation management rules.

Not with standing this, recently a new trend is accelerating the diffusion of agri-food business innovation strategies – the use of crowdfunding-platform-based open innovation strategies. As it is possible to assess from the expression crowdfunding itself, this kind of innovation strategy is based on the use of the “wisdom of crowds” to gather potential new ideas (West and Bogers, 2014, p. 820). Hence, the use of crowdfunding platforms represents an appropriate way to attempt to implement open innovation (Gassmann *et al.*, 2010; Bogers and Jensen, 2017). The main motivation concerning the diffusion of these strategies in agri-food businesses is related to the characteristics of crowdfunding platforms themselves. Indeed, crowdfunding platforms are usually easy-to-use websites offering the user the possibility of consulting a crowd of individuals about a specific idea and eventually receiving funding to finance the idea itself. This is why agri-food business owners and managers – which are frequently characterized as having low expertise in information technologies – tend more and more to use crowdfunding platforms (Bresciani *et al.*, 2013). Crowdfunding, in effect, presents few cost-related risks and many potential benefits, at least in terms of idea generation (Tardivo *et al.*, 2017). In any case, as crowdfunding platforms exist in a digital environment, knowledge management capabilities to explore and exploit information from the internet are extremely relevant in order to achieve positive outcomes from crowdfunding strategies; this is coherent with open innovation literature (Scuotto *et al.*, 2017).

As a consequence of agri-food businesses’ resistance to innovation and innovation processes, open innovation in agri-food business has received little attention from pertinent literature. Specifically, scant attention has been paid to empirical exploration of the importance of knowledge management processes and capabilities for successful open innovation in agri-food businesses using crowdfunding (Tardivo *et al.*, 2017). Despite this, as previously discussed, due to agri-food businesses’ lower propensity for innovation and due to the limited resources for in-house R&D, it becomes necessary for agri-food businesses to develop innovatively in conjunction with a broader network of partners in order to provide them with scientific and technological inputs coherent with the notion of open innovation (Knudsen, 2007). This is particularly true in the current dynamic environment, where businesses must increasingly explore and exploit both inward and outward flows of knowledge (Santoro, Vrontis, Thrassou and Dezi, 2018). Building on these premises, the aim of this research is to extend knowledge pertaining to open innovation in agri-food businesses. Specifically, we will explore whether knowledge management capabilities, namely information-technology-based (IT-based) knowledge exploitation capabilities and knowledge exploration capabilities, play a role in the successful implementation of open innovation. We build on the assumption that IT-based knowledge exploitation capabilities could allow firms to extract useful knowledge from the plethora of knowledge available to them (Del Giudice and Della Peruta, 2016) and, moving on from these premises, this research aims to explore the impact of knowledge management capabilities on successful open innovation. As a result of the growing usage of crowdfunding platforms by agri-food businesses, agri-food businesses utilizing crowdfunding platforms have been selected as the subjects of this research. Indeed, it is necessary to investigate if knowledge exploration and exploitation capabilities are relevant to transform the ideas coming from the crowd in successful open innovations (Poetz and Schreier, 2012; Bresciani, 2017).

Consequently, the research question guiding this study is:

RQ1. Are knowledge exploration capabilities and IT-based knowledge exploitation capabilities relevant for successful open innovation in agri-food businesses trying to collect ideas from crowdfunding platforms?

The paper is structured as follows: first, we review existing literature concerning open innovation and knowledge management concepts within the food industry; we then analyze

the impact of crowdfunding on open innovation (specifically exploring the ways in which crowdfunding is linked to open innovation and why it is important to consider knowledge management capabilities in the context of agri-food businesses using crowdfunding); and, finally, we develop and test our model, summarizing the conclusions of our analysis, drawing implications for the future of open innovation within the food sector, and highlighting areas in which more empirical research is needed.

2. Theoretical background and hypotheses development

2.1 *Open innovation in the agri-food business: a review of the literature*

Current changes in the nature of both demand and supply, coupled with an ever-increasing level of competitiveness, have rendered innovation an unavoidable corporate activity (Pironti *et al.*, 2010; Ferraris *et al.*, 2017). However, innovation development is a very expensive and time-consuming process and, as a consequence of this, a new paradigm branded “open innovation” has been recognized by academic literature. According to this paradigm, partners and stakeholders of the business may participate in innovation processes. Ideas are then generated, taking into consideration the environment in which the business is situated, and the cost of this development is shared by all of the involved partners and stakeholders (Gassmann *et al.*, 2010). Thanks to open innovation, businesses are able to develop successful new products much more quickly and with lower costs. In addition to this, products developed in collaboration with partners and stakeholders are often observed to be more adherent to consumers’ preferences (Christensen *et al.*, 2005; Soto-Acosta and Cegarra-Navarro, 2016).

As a result of the consumer’s demand for more personalized products, the exploitation of the open innovation technique is becoming increasingly vital in ensuring the agri-food industry’s competitiveness and profitability. Successful applications in areas such as biotechnology, nanotechnology and preservation technology offer an unprecedented number of opportunities for value-adding applications in the food industry, many of which have the potential to satiate the modern consumers’ demands (Juriaanse, 2006; Baragheh *et al.*, 2012). While the necessary stringency of legal requirements related to safety typically transforms food products and process innovation into a highly complex, time-consuming and risky endeavor, open innovation may at least offer businesses the opportunity to identify consumers’ requests quicker and with lower costs (Christensen *et al.*, 2005; Gassmann *et al.*, 2010). Indeed, the pressure on these businesses forces them to continuously adapt to environmental shifts (Greenwood and Hinings, 1996) and, with this in mind, open innovation could allow agri-food businesses to provide faster and more innovative responses to market threats and opportunities (Franceschelli *et al.*, 2018). For example, International Flavors and Fragrances taps into the creative potential of its customers when conceptualizing and designing products. Using an internet toolkit with a large database of flavors, the company involves the customer when creating a new flavor. Co-creation allows the company to increase its ability to meet individual customer requirements and to reduce time-to-market.

Many emerging technologies have the potential to sustain (or complement) a wave of successful new agri-food applications (Manning, 2013). Technologies are frequently developed outside of the processing industry and this is demonstrative of the importance of open innovation. Indeed, agri-food businesses which maintain an open mind with regard to innovations emerging from outside of their industry may adopt these innovations more easily (Bitzer and Bijman, 2015). Additionally, the motivating forces behind many agri-food start-ups in the sector are closely related to the growing number of chain actors, the contradictory requirements of chain actors, the heterogeneous needs/new trends in consumer demand, the mass customization market and legislation (Bigliardi and Galati, 2013; Giacosa *et al.*, 2017). The market issues and the number of contributors from different sectors involved in food production, together with their difficulty in single-handedly meeting all of the heterogeneous

requirements of intermediate customers, end-users and legislators, determine that innovation activities must be carefully coordinated (Costa and Jongen, 2006). It is worth noting that, in many cases, these problems can be resolved simply through proper information-sharing processes (Bresciani, 2017). Despite this viable solution, open innovation approaches work well for the high-tech industry, but do not usually perform as well for low-tech industries, such as agri-food. Given the high number of actors in different areas involved in agri-food supply, as well as their difficulties in single-handedly meeting all the heterogeneous requirements of intermediate customers, end-users and legislators (Costa and Jongen, 2006; Grunert, 2005), cross-boundary innovation management should thus be a widespread practice in food value chains and networks. As Mortara *et al.* (2010) argued, the agri-food sector recognizes the potential power of open innovation: the “outperformers” in the food industry use external sources of innovation. From this perspective, open innovation in agri-food has been deemed to be a successful approach in achieving sustained high growth while containing innovation costs. By cooperating in networks, firms have better access to new knowledge, which enhances the innovative potential of any businesses. Moreover, by cooperating with different partners along the value chain, agri-food businesses are able to cover a larger part of the chain. This can lead to increased added value for customers as a total solution can be offered. At the same time, by combining (financial) resources in which cost and risk reduction play a crucial role, new knowledge which would have proved to be impossible for each member to obtain alone (Vanhaverbeke *et al.*, 2007) can be developed. In today’s market, open innovation is an extremely relevant strategy because it may foster the creation of value both for agri-food businesses and for consumers (Keszey, 2018). Businesses, in fact, may obtain value from the insights that can be collected from consumers and partners. Thus, businesses may save money on new product development expenses and earn additional revenues by offering products in which consumers may be interested (Vrontis *et al.*, 2016). Consumers, instead, may gain agri-food products more adherent to their preferences and better consumption experiences (Rialti, Caliandro, Zollo and Ciappei, 2018).

Nevertheless, as for any business operating in any sector, knowledge management capabilities are fundamental for agri-food businesses to reap the benefits related to open innovation (Bresciani, 2017; Tardivo *et al.*, 2017). Coherent with the literature on the importance of knowledge management and information, agri-businesses need knowledge management capabilities to collect, systematize, categorize and filter the information they receive from external sources (Del Giudice and Della Peruta, 2016). In particular, these capabilities are fundamental to identifying the piece of information containing insights with regard to potential emerging opportunities that may be exploited by agri-food businesses (Scuotto *et al.*, 2017).

As a result of the importance of new knowledge management in agri-food businesses, the next section will explore the ways in which knowledge management capabilities can be considered the key to unlocking successful open innovation in agri-food businesses.

2.2 Knowledge management capabilities: the key to successful open innovation in agri-food businesses

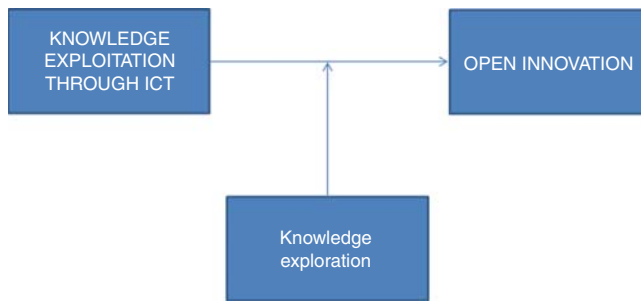
The trend toward open innovation requires an integrative perspective and calls into question traditional perspectives on firm boundaries around knowledge exploration, retention and exploitation – both inside and outside businesses boundaries (Chesbrough, 2003; West and Lakhani, 2008; Natalicchio *et al.*, 2017). These dynamics describe “knowledge capabilities” as a firm’s ability to manage different knowledge processes. Quantitative empirical studies on external knowledge sourcing provide evidence to show that involving a large number of external sources of knowledge in open innovation is a promising choice for both for large and small businesses (Laursen and Salter, 2006; Wang *et al.*, 2017). Consistently, open innovation scholars agree that the external sourcing of knowledge need not replace in-house R&D and specifically highlight the importance of “absorptive capacity,” which allows firms to identify,

absorb and make use of external knowledge together with internally generated knowledge (Cohen and Levinthal, 1990; Dahlander and Gann, 2010). A large number of works are concerned with the role of the diverse relationships and cooperation developed by firms with other stakeholders to allow them to “absorb” external knowledge (Cohen and Levinthal, 1990; Meissner and Carayannis, 2017). These authors propose that the capability of a business to explore and exploit external knowledge is a critical determinant of its capacity for open innovation: a business will be more or less able to exploit the technological opportunities of its environment depending on its knowledge base and the learning process that occurs within this. Consequently, it is evident that thanks to knowledge management capabilities a business may identify faster and with greater accuracy the information it may require to exploit the opportunities related to the open innovation processes; this is also relevant in the case of small businesses (Casprini *et al.*, 2017).

Even in the agri-food business, knowledge management capabilities are important for open innovation: the capability to absorb information from external knowledge is indeed fundamental in agri-food because it may compensate for lower internal research capabilities (Bitzer and Bijman, 2015). In fact, as a result of lower innovation-absorption capabilities and limited resources for in-house R&D, agri-food businesses must also maintain a broad network of partners to provide them with scientific and technological input (Knudsen, 2007). This phenomenon can be seen in the results of Community Innovation Surveys conducted with more than 1,300 European innovative agri-food firms. As most food firms have neither the competencies nor the capital needed to innovate on their own, they must find partners to join forces in open innovation collaborations (Keszey, 2018).

Hence, as proposed by open innovation literature, agri-food businesses should invest in the development of proper knowledge management capabilities in order to fully exploit the potential of open innovation. They should first invest in their IT-based knowledge exploitation capabilities (Vrontis *et al.*, 2016). In fact, because nowadays most external knowledge is shared through the internet, agri-food businesses should be able to increase their capability to collect and analyze it, even if this requirement may mean the need for agri-food businesses to increase their digitalization (Bresciani, 2017; Tardivo *et al.*, 2017). From this perspective, because IT is fundamental to processing information and extracting meaningful insights from data sets, the knowledge management capabilities related to these technologies should effectively foster the progression of open innovation (Natalicchio *et al.*, 2017). Any investment in IT can thus be considered crucial to the business’s survival. Second, agri-food business should also concentrate on increasing their knowledge exploration capabilities. In fact, knowledge exploration capabilities are also fundamental in order to systematize the ideas originating from external sources (Del Giudice and Straub, 2011). This phenomenon is coherent with open innovation literature; indeed, businesses’ knowledge exploration capabilities have also been observed to have an impact on open innovation, with the ability to explore knowledge being seen as an influencer in the relationship between knowledge exploration and open innovation success (see Figure 1). This is particularly true if we take into account the fact that knowledge exploration is a capability that deeply influences the relationship between knowledge exploitation and the successful implementation of a process. Additionally, both knowledge exploitation and exploration capabilities are fundamental in allowing firms to reap the benefits of ideas emerging from the environment in which they are situated (Meissner and Carayannis, 2017).

Notwithstanding this theoretical evidence, several aspects about this phenomenon still need to be analyzed. In particular, the literature has paid scant attention to the empirical exploration of the impact of IT-based knowledge exploitation capabilities and knowledge exploration capabilities on open innovation in the agri-food industry (Bresciani, 2017; Tardivo *et al.*, 2017). Similarly, few existing research studies have focused on crowdfunding



Source: Authors' elaboration

Figure 1.
Conceptual model

by agri-food businesses (Keszey, 2018). In this sense, in order to address this gap, we explored the following conceptual model.

For the above reasons, we propose the following hypotheses:

- H1. IT-based knowledge exploitation capabilities are significantly linked to open innovation in crowdfunding by agri-food businesses.
- H2. Knowledge exploration capabilities moderate the relationship between IT-based knowledge exploitation capabilities and open innovation.

Hence, this research tries to address the current literature gap concerning the need to explore the importance of knowledge exploration and exploitation capabilities to agri-food businesses, in an attempt to reap the benefits associated with open innovation (Laursen and Salter, 2006; Aloini *et al.*, 2015). As previously suggested, our research is rooted in a very specific context – that of businesses that use crowdfunding platforms. Crowdfunding is closely related to open innovation and agri-food businesses using crowdfunding platforms should pay particular attention to knowledge management processes in order to better manage their relationships with any kind of external partner.

3. Research context: agri-food businesses using crowdfunding platforms

The concept of “crowdfunding” is related to that of “crowdsourcing,” which refers to the outsourcing of specific tasks to the “crowd” – such as the development, evaluation, or sale of a product – by way of an open call sent out over the internet. The type of contributions by the member(s) of the crowd, and the related reward, may vary depending on the internet platform, the type of business and the project itself. Indeed, as new platforms are created across countries, in conjunction with low regulation, new features and business models are continuously emerging (Cairo *et al.*, 2015). The types of funding can range from donations, to equity-financing, to idea contributions, thus giving rise to processes with different degrees of complexity and different contractual relationships between the firm and the individual investor.

Crowdfunding has proved to be a useful tool through which to connect entrepreneurs, researchers, consumers and potential funders. This is possible thanks to intermediation internet-based platforms, which provide an environment in which it is possible to collect and canalize scattered unlocked private capital and, mostly, to share business ideas while also mitigating the issue of geographical proximity in the innovation process. In light of these possibilities, crowdfunding platforms may be extremely useful in open innovation. These are indeed platforms through which individuals from entirely disparate backgrounds can share different ideas. Crowdfunding platforms may thus offer businesses the opportunity to converse fairly with external partners and consumers. As a result of crowdfunding

platforms, businesses may gain access to new suggestions for innovation and new products. Although there are many advantages, adopting open innovation throughout crowdfunding platforms is a challenging process (Chesbrough, 2003). Collaborating with a number of partners is extremely complex, owing to the evident need for coordination. Prior research shows that the failure rate of bilateral alliances is quite high, ranging from 50 to 75 percent (Vanhaverbeke *et al.*, 2007; Wang *et al.*, 2017). Cooperating in groups with an increased number of participants raises the likelihood of conflicting interests and, as a consequence, could lead to a breakdown of the cooperation (Park and Russo, 1996).

As in any kind of business, including the agri-food business, crowdfunding platforms can present a huge opportunity. As a matter of fact, given that agri-food businesses are often considerably slower in product and process innovations in comparison with other kinds of businesses, crowdfunding platforms may grant agri-food businesses the opportunity to collect new ideas from partners and consumers that otherwise would not have been afforded to them (Moenninghoff and Wieandt, 2013). Only consumers know the kinds of modifications they desire in a product and, similarly, external partners could assume this role and thus contribute to shaping process innovation with their suggestions or through offers of new technologies (Manning, 2013). Thanks to these contributions from “the crowd”, even agri-food businesses – which usually base their processes and products on traditional and established production processes – may innovate and follow contemporary trends. Traditional food products can then be modified to meet consumers’ new tastes. In a similar fashion, traditional production processes may be modified according to new techniques emerging in alternate industries. Additionally, crowdfunding can be instrumental to agri-food businesses in raising additional capital. Yet, as previously assessed, without proper knowledge management capabilities, open innovation benefits that stem from crowdfunding cannot be seized by agri-food businesses (Bresciani, 2017). Indeed, knowledge management processes are fundamental to the identification of the right ideas and the assessment of their potential. This notwithstanding, crowdfunding using agri-food businesses has received scant attention in pertinent academic literature (Santoro *et al.*, 2017). Thus, this research tries to address this gap by focusing on these businesses and the processes stimulating open innovation in them.

4. Methodology

4.1 Sample and research design

This research involves data gathered from European agri-food businesses involved in crowdfunding campaigns on Kickstarter and Indiegogo platforms.

Data were collected using a questionnaire formed by 30 close questions based on existing validated constructs introduced on the basis of a careful literature review. To avoid concerns regarding common method bias, the survey was administered to individuals in senior positions within the organizations, defined either by their ownership or decision-making capabilities. These individuals were perceived to be the most suitable participants for this research given the fact that they make all critical decisions in the SMEs involved (Nejati *et al.*, 2014). This is particularly relevant in Italy, where SMEs have historically played a major role in the economy (Goodman *et al.*, 2016). In fact, according to the OECD (2017) SMEs contribute around 60 percent of the gross domestic product as well as employment in Italy.

An e-mail with an invitation to participate in the survey, along with a letter containing an explanation of the study’s purpose, was sent. In total, 192 firms expressed their interest in participating in the study. A survey, composed of several questions, was sent to these firms; this was answered and returned by 80 firms, which represents the final sample (response rate 41.6 percent). This satisfies sample size requirements in hierarchical regression models (Wolf *et al.*, 2013).

Single questions within the questionnaire were separated in order to reduce the risk of rationalizing the answers of the respondents. Moreover, we placed dependent and independent variables in different positions within the questionnaire to limit potential common method variance.

The 30 close questions were assessed using the seven-point Likert-type scales ranging from 1 (strongly disagree) to 7 (strongly agree). A higher score on each scale mean a greater consonance with the question (Khedhaouria and Jamal, 2015).

The questionnaire was tested on a sample of 23 decision makers of local SMEs in order to avoid bias in the data collection process. This small number was retained sufficient for a pilot test which became a “dress rehearsal of the instrument with a small but relevant sample” (Lewis *et al.*, 2005, p. 392). The results from the pilot test showed no particular bias, and respondents had no difficulties understanding the questionnaire and its items.

The data were collected over a period of eight months.

4.2 Variables employed

Data acquired from the questionnaire was used to develop the variables of the quantitative study. Variables were developed using multi-item scales, in accordance with the precedents set in relevant academic literature, in order to ensure their validity. For instance, the respondent was asked to evaluate several statements using a seven-point Likert scale.

Knowledge exploration, given as an independent variable, was used to measure the ability of a firm to develop new products or services, create dialogues, learn and communicate practices, and explore knowledge externally (Parida *et al.*, 2012). To assess knowledge exploration, we asked respondents to indicate the importance of exploring external knowledge, developing innovative ideas and knowledge regarding products and processes, and exploring innovative ideas and knowledge externally, all of which are coherent with Lichtenthaler and Lichtenthaler's (2009) scale. We then employed the variable of ICT knowledge exploitation which, according to existing literature, plays a part in knowledge storage and sharing. We asked respondents to evaluate in detail their use of collaborative technologies for knowledge sharing – the ICT adoption was theorized by Merono-Cerdan and colleagues (2007). In terms of open innovation, a combination of internal and external dimensions was focused on. In this regard, we asked respondents to indicate the level of: partner intensity (Laursen and Salter, 2006; Aloini *et al.*, 2015); and openness variety (Laursen and Salter, 2006; Aloini *et al.*, 2015) (Table I).

We assessed the internal consistency of each independent variable (Cronbach's α open innovation = 0.841; Cronbach's α knowledge exploitation capabilities thanks to IT = 0.898; Cronbach's α knowledge exploration = 0.937), which showed promising results.

We then controlled several variables that had the potential to influence other variables and our subsequent analysis: we controlled for the size of the firm (calculated as the number of employees in the firm) because it could be considered indicative of greater capabilities; second, we controlled for the age of the firm (calculated as the number of years since founding) because this infers the experience of the firm accumulated throughout the years. The log terms of these two variables were processed in the models.

4.3 Results

On the basis that knowledge exploration and exploitation capabilities are relevant to improve agri-food businesses orientation toward open innovation (Laursen and Salter, 2006; Aloini *et al.*, 2015), this research extends the current literature review analyzing if IT-based knowledge exploitation capabilities are significantly linked to open innovation in agri-food businesses that adopt crowdfunding platforms. At the same time, the research

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Dimension	Sub-dimensions	Related literature
Open Innovation (Laursen and Salter, 2006)	Partner intensity	Laursen and Salter (2006), Aloini <i>et al.</i> (2015)
	Openness variety	Laursen and Salter (2006), Aloini <i>et al.</i> (2015)
	Interaction with experts on Intellectual Property Rights (IPR)	Bessant and Rush (1995), Hurmelinna-Laukkanen and Puumalainen (2007)
Knowledge Exploration (Lichtenthaler and Lichtenthaler, 2009)	Readiness to collaborate	Ahn <i>et al.</i> (2016)
	Absorptive capacity	Lichtenthaler and Lichtenthaler (2009)
Knowledge Exploitation Capabilities in IT (Khilji <i>et al.</i> , 2006; Merono-Cerdan <i>et al.</i> , 2007)	Inventive capacity	Lichtenthaler and Lichtenthaler (2009)
	Converting knowledge into new products or services	Khilji <i>et al.</i> (2006)

Table I.
Variables and items

Source: Authors' elaboration

analyze to what extent knowledge exploration capabilities business need to effectively enjoy crowdfunding platform moderate the positive relationship between IT-based knowledge exploitation capabilities and open innovation.

The current literature offers qualitative studies or quantitative studies on corporate businesses. Whereas, this analysis employs a quantitative study on SMEs operating in agri-food sector.

Descriptive statistics show that most of the firms within the sample were small or medium (the average number of employees was 98.90), spend internal R&D (10 percent on average), and were rather innovative in terms of knowledge exploration capabilities (5.369), knowledge retention (5.10) and knowledge exploitation capabilities thanks to IT (5.108). Since small agri-food businesses display a relatively low level of R&D investment and are quite conservative in the types of innovation that they introduce to the market (Costa and Jongen, 2006), IT could affect SMEs innovation performances.

As the results show, IT enables knowledge exploration capabilities, knowledge retention and knowledge exploitation capabilities. This positively affected open innovation performance in terms of partner intensity, openness variety and Interaction with experts on Intellectual Property Rights (5.25). They were shown to have a good performance in terms of time taken to successfully gain crowdfunding campaign goals (65 percent).

This confirms that to become innovative agri-food businesses should develop a broader network of partners in order to obtain scientific and technological inputs (Knudsen, 2007; Messeni Petruzzelli *et al.*, 2010) (Table II).

The hypotheses were tested using regression analysis, and the results are presented in Table III. We developed three models to test both the direct effect of knowledge exploitation through IT on open innovation and the moderating effect of knowledge exploration.

	<i>n</i>	Min.	Max.	Mean	SD
Size	80	2	172	98.90	252.502
Age	80	3	95	25.61	24.117
Open innovation	80	2	7	5.255	1.270
Knowledge exploitation thanks to IT	80	2	7	5.108	1.173
Knowledge exploration	80	2	7	5.369	1.027

Table II.
Descriptive statistics

Source: Authors' elaboration

Variable	Open innovation Model 1	Open innovation Model 2	Open innovation Model 3
LOGSIZE	-0.130 (-1.315)	-0.077 (-1.216)	-0.072 (-1.166)
LOGAGE	-0.037 (-0.370)	0.000 (-0.005)	0.008 (0.132)
R&D	0.179 (1.958)	0.069 (1.170)	0.044 (0.768)
Knowledge exploitation thanks to IT (KEI)		0.180 (2.877)*	0.396 (5.904)***
Knowledge exploration (KE)		0.340 (5.459)***	0.493 (6.285)***
KEI×KE			0.623 (7.325)***
R^2	0.051	0.620	0.647
Adjusted R^2	0.027	0.603	0.629
F-value	2.125	37.785***	35.120***

Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Source: Authors' elaboration

Table III.
Results of regressions

In Model 1 only the control variables are entered, and there is no significant impact. In Model 2, the effect of knowledge exploitation thanks to IT and open innovation are considered, and knowledge exploitation as a result of IT is positively and significantly associated with open innovation (0.180; $p < 0.05$). Model 3 considers the moderating effect of knowledge exploration capabilities on the relationship between knowledge exploitation capabilities as a result of IT and open innovation, which is positive and significant (0.623; $p < 0.001$). Finally, we can conclude that HP 1 and HP 2 are both correct as they have been confirmed by our analyses.

5. Discussion and implications

Consumers are changing their eating habits and patterns, and are starting to follow specialized diets that require the elimination of certain ingredients. Moreover, these consumers give more importance to organic foods as well as low-fat and low-carb products (Faraoni *et al.*, 2018). As a consequence, agri-food businesses are faced with the challenge of satisfying these new customer desires and increasing their investments into innovation has been identified as a possible solution. Thus, open innovation through crowdfunding platforms has emerged as a possible solution (Bresciani, 2017; Tardivo *et al.*, 2017).

Building on the existing academic literature, this study analyzed IT-based knowledge exploitation, knowledge exploration and open innovation in agri-food businesses using crowdfunding platforms (Manning, 2013; Santoro *et al.*, 2017). The analysis of the data collected allowed us to reach several conclusions.

The first conclusion to be drawn from our review and analysis was that knowledge management processes influence open innovation in agri-food businesses using crowdfunding platforms, and it is thus reasonable to assume that crowdfunding is positively related to open innovation (Khilji *et al.*, 2006). In particular, we found evidence demonstrating the positive effect of knowledge exploration on the relationship between open innovation practices and IT-based knowledge exploitation. This reflects the capacity of the business and its related ability to apply knowledge that has been explored and retained inside or outside the firm (Khilji *et al.*, 2006). Hence, we can indirectly infer that crowdfunding strategies may work at the moment agri-food businesses have developed the right knowledge management capabilities. In fact, due to these capabilities agri-food businesses may collect partners, analyze, and use knowledge coming from crowdfunding partners.

The second conclusion which may be indirectly drawn from our review and analysis is that active investments and “the crowd” may jointly improve access to new knowledge. Entrepreneurs offer investors the opportunity to become active in an initiative while simultaneously offering them rewards. This strategy can provide valuable feedback for the

entrepreneur concerning potential market demands and product characteristics that may be most appropriate for the market at the time. This active involvement may be structured in the ways discussed earlier, under the concept of crowdsourcing, allowing investors to become active simply by giving.

Concerning the contribution to the pertinent literature, this study's academic contribution is its revelation of information pertaining to agri-food businesses and their relationships with innovation and crowdfunding. As previously mentioned, despite the fact that a lot of studies have investigated the results obtained by companies that use new methods to raise economic resources and their effects on innovation, few studies focus their attention on the agri-food sector. More specifically, this study contributes by opening up new debates concerning the role of crowdfunding in developing innovation in the sector and sheds some light on the ways in which important synergies can be created thanks to this innovative way of finding resources (Manning, 2013). Additionally, knowledge management capabilities to foster the circulation of ideas between experts, entrepreneurs and individuals who all have interests in the same sector, allowing the agri-food business exploit the potentially available information, has emerged as an important development.

These research implications suggest useful highlights for managers and policy makers. An interesting question concerns the informational content for entrepreneurs who seek to obtain crowd-committing capital. It is important to consider the extent to which this affects precision when considering the potential demand that entrepreneurs may receive for a product, as well as the crowd remuneration scheme that could generate the most information about a potential demand.

With specific regard to SMEs, since innovation is at the core of inclusive growth European institution strategies, improving open innovation throughout crowdfunding could lead to more productive business that can pay better wages and offer better working conditions to their workers, thus helping reduce inequalities. In this vein, ICT could accelerate the diffusion of knowledge and is enabling the emergence of new business models (Ciampi, 2015; Ciampi *et al.*, 2018), which may enable firms to scale very quickly, often with few employees, tangible assets or a geographic footprint (OECD, 2017). This means that governments should support the upgrading of digital skills in SMEs (Ciampi, 2018).

To conclude, this research confirms that the shift toward an "open innovation" paradigm has reduced the need for innovation-related capital investments, making business innovation more accessible to SMEs (OECD, 2016).

6. Conclusions, limitations and suggestions for future researchers

The present research contributes to existing literature by addressing the mechanism of open innovation in crowdfunding by agri-food businesses (García-Villaverde *et al.*, 2018). In particular, it investigates the importance of IT-based knowledge exploitation capabilities on open innovation strategy success and the mediating role of knowledge exploration capabilities.

Yet, in spite of the findings, our analysis still provides avenues for future research. One urgent question is that of the study's link to intellectual property rights. Indeed, agri-food entrepreneurs making use of crowdfunding invariably need to disclose some of their ideas to the crowd well in advance, creating risks of idea-stealing as a result of the fact that potentially valuable information must be put into the public domain. In our next piece of research, we will go on to examine which kinds of business model (for crowdfunded ventures and crowdfunding platforms) perform better in terms of providing access to new knowledge through cooperative networks. Moreover, open innovation strategies (also the ones based on crowdfunding) come in a variety of forms and, as such, are also met with a wide variety of potential outcomes (Wang *et al.*, 2017). Consequently, there is an apparent need for a better understanding of open innovation in the food sector, which should be

addressed through the execution of better focused case studies and more empirical research. Finally, we suggest scholars employ crowdfunding variables in their empirical analysis. In fact, the main limitation of this research is related to not using a crowdfunding-related variable.

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Corresponding author

Riccardo Rialti can be contacted at: riccardo.rialti@unifi.it

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