Financing innovation in agri-food industries: an analysis of the Italian micro, small and medium enterprises

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Abstract

Purpose – This work aims to investigate the current financial structure of Italian agri-food micro, small and medium enterprises (MSMEs) to understand how MSMEs face innovation challenges, which are also required to support sustainable development.

Design/methodology/approach – To reach the goal, an empirical longitudinal analysis is performed on a sample of Italian agri-food firms. In detail, to highlight the changes in the use of financial sources between 2013 and 2019, a descriptive ratio analysis is carried out on the data extracted by the AIDA database. In addition, statistical analyses were performed, including *t*-tests and U Mann–Whitney. Finally, a fixed-effects model is created to analyse the panel data. To ensure homogeneity, the sub-sectors of production and transformation are separately considered.

Findings – The financial structure analysis shows an increase in the equity percentage in the funding sources, attributable to an attempt to compensate for the reduction of banks' funding. However, even though this change has not compromised firms' profitability, the undercapitalisation of companies is still present. Therefore, more equity investments are required to support the innovation process.

Originality/value – The value of the present research is to highlight the choice of using new alternative financing sources instead of traditional banks' credit to implement sustainable and innovative development Italian agri-food sector (AFS). This choice is forced by reducing finance from banks and other financial institutions because of the credit crunch. This issue is even more relevant, considering that MSMEs have structural financial problems but have to fulfil the mission of pursuing innovation in the same way as large companies. Therefore, this paper expands the literature on agri-food, delving into an issue typical of MSMEs and combining agri-food with the need for innovation.

Keywords Financial strategies, Alternative financial sources, Agriculture, Food and beverage industries, MSMEs

Paper type Research paper

1. Introduction

Taking into account employment and financial performance, the agri-food sector (AFS) is one of the leading industries in the European economy (Tanda, 2018; Food Drink Europe, 2020). Even during (and after) the global financial crisis in 2007 or the Coronavirus pandemic in 2020, this sector has always had an anti-cyclical trend that depends on the necessity to

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guarantee food security also in uncertain times (Carraresi and Banterle, 2015; Fan *et al.*, 2020), showing a great resilience (Paoloni *et al.*, 2021). However, the relevance of the AFS is not only related to the economic contribution, but it must also be considered a fundamental sector to support sustainability for different reasons. Looking, for example, at the Sustainable Development Goals (SDGs) defined by the United Nations in the 2030 agenda, it is immediately possible to see how goal n. 2, "Zero Hunger", is essential to achieve end hunger and any form of malnutrition (target 2.1–2.2). To reach the purpose of the second SDG, it is necessary to improve the productivity of the whole AFS (International Fund for Agricultural Development, 2015). In this scenario, innovation could play a relevant role due to the necessity to maintain process controls better, exploit economies of scale and guarantee food safety, variety and quality (Traill and Meulenberg, 2002). Therefore, as also suggested in the United Nations goal number 2a, increased investment in innovation in AFS is required to achieve the target (United Nations, 2019).

The same considerations can also be made at the national level: Italian agri-food plays a fundamental role in the European economy. For example, in 2018, Italy was the first European country for agriculture's added value with €32.2 billion (ISTAT, 2019), and the food and beverage industries have a turnover that has been increasing for the previous few years, passing from €95 billion in 2013 to €114 billion in 2018 (ISTAT, 2019). Furthermore, during the Coronavirus pandemic, AFS confirmed its relevance of AFS: despite the strong contraction of its gross domestic product in 2020, the AFS consolidated its weight within the national economy (ISTAT, 2020b), and, at the same time, it is seen as an important driver for sustainability in Italy (Rialti *et al.*, 2022).

After comprehending the relevance of AFS in economic and sustainability terms and the importance of innovation to achieve these goals, a related problem is often pointed out: how innovation in AFS can be financed.

Financing innovation in AFS is complex; many obstacles exist related to financing technological development (Hall, 2002). The main obstacles are the lack of own funds or external funding and high innovation costs (Valdés *et al.*, 2021). This is especially true for the Italian context (Santoro *et al.*, 2017), where the AFS is mainly composed of micro, small and medium enterprises (MSMEs) that generally have difficulties accessing finance to innovate (Larsen and Lewis, 2007; Baldwin and Gellatly, 2003), especially after the 2007 global financial crisis (Nassr and Wehinger, 2015). These firms suffer from an inherent fragility and need to find alternative financial sources to finance an innovation process that large companies manage to finance through bank debt (Maheshwari *et al.*, 2021; Kumar *et al.*, 2022).

Analysing the existing literature on AFS, a gap related to how MSMEs could finance innovation exists. Only some works (e.g. Knezevic *et al.*, 2021) have focused on this relevant issue and none systematically, but mainly by concentrating on a particular type of resource. This paper aims to bridge this gap by comprehensively analysing which financial resources MSMEs belonging to AFS can equip themselves with to innovate. The choice fell on Italian AFS as a European leader. Therefore, the present work's research question (RQ1) is formulated as follows.

RQ1. How do AFS Italian MSMEs finance the innovation?

A longitudinal study of 4,815 Italian MSMEs is performed to answer the research question, focussing on the period 2013–2019. Statistical tests have been carried out to test the ratio analysis results and deepen the literature findings to understand how MSMEs could finance innovation and how this process can impact them. Specifically, *t*-test, U Mann–Whitney test and regression analysis have been performed.

This study has the peculiarity of linking these three elements harmoniously, i.e. MSMEs belonging to the AFS, innovation and financing sources, without limiting the analysis on the relationship between two of them (e.g. papers related to the relationship between AFSs and

innovation see, i.e. Spanaki *et al.*, 2022; Rialti *et al.*, 2022; related to MSMEs belonging to AFS and financial strategies see Mazzoleni and Pollonini, 2021). The paper contributes to the literature by extending the research to corporate financing of MSMEs in AFS, focussing on innovation. Since an innovation path is required in AFS, this paper highlights the use of equity and alternative equity-like sources in MSMEs, which have structural differences in how to finance innovation compared to big firms that use the traditional debt-financing method. This topic still needs to be addressed in the literature. From a practical point of view, given the high demand for innovation in AFS to support sustainable development, it is important to provide information to MSMEs' managers, who could lack managerial and financial expertise (Myers and Majluf, 1984; Rossi *et al.*, 2012), to help them understand how to finance such innovative paths.

The paper is structured as follows. Section 2 presents an overview of the European MSMEs and their financial strategies. In the same paragraph, particular attention is given to innovation and financial structure could support this process. Section 3 is devoted to illustrating the research design, section 4 presents the findings. The results are deeply analysed and discussed in section 5, summarising and systemising all the figures. Finally, conclusions are drawn to answer the research question (paragraph 6), implications and contributions are presented to enhance the value of the work (paragraph 7), and limitations and future lines of research are discussed to open up new debates (paragraph 8).

2. Literature review

In this paragraph, two topics are investigated; the first subparagraph presents the relevance of the AFS, highlighting some of its characteristics, including the dominating presence of MSMEs, whereas the second paragraph is dedicated to the role of innovation in AFS. The literature analysed in these paragraphs made it possible to formulate the hypotheses to be tested.

2.1 Agri-food sector: MSMEs peculiarities and criticisms

The agri-food industries consist of all those businesses ranging from "the farm to the fork", thus including both the production and distribution phases (Mor *et al.*, 2018). Depending on the type of product and production, different actors can be included in this sector: farmers, breeders, fishermen, input suppliers, cooperatives, village-level societies, transporters, processing units, wholesalers, distributors, retailers, exporters, importers (Eskesen *et al.*, 2014). This sector has proven to be a driving force in the European economy, considering both the level of employment and performance (Tanda, 2018; Food Drink Europe, 2020). Furthermore, this sector has always had an anti-cyclical trend, even in the most uncertain times (Carraresi and Banterle, 2015; Fan *et al.*, 2020), demonstrating great resilience (Mazzoleni and Pollonini, 2021; Paoloni *et al.*, 2021). Whilst in the financial crisis (2007–2008), it played a role in maintaining performance in the face of a general decline in both demand and supply, in the health crisis (2020), the sector was forced to face a demand crisis, due to the lockdown and closure of part of its outlet markets (International Fund for Agricultural Development, 2015; Paoloni *et al.*, 2021). In this circumstance, however, the sectors renewed themselves and assumed a relevant social role. The same reason can be made when looking at the national context: in fact, Italian AFS is the most relevant in Europe (ISTAT, 2019) and has maintained a stable performance even in a period of crisis such as Coronavirus, showing great resilience (ISTAT, 2020b).

One common characteristic in the agri-food supply chain is that small firms make up most of the sector, especially through family businesses (Mazzoleni and Pollonini, 2021). The MSMEs are identified by the European Commission, considering two characteristics: size and access to resources (European Commission, 2015).

When talking about MSMEs, certain natural attributes distinguish this type of firm, such as short-term liquidity problems, insufficient working capital, insufficient start-up capital and poor financial management (Birley and Niktari, 1995), which affect their ability to obtain finance to innovate themselves (Larsen and Lewis, 2007; Baldwin and Gellatly, 2003). In addition, MSMEs usually suffer from a lack of managerial expertise (Birley and Niktari, 1995), which causes inefficiency in choosing adequate data to monitor the firm's performance (Woodcock *et al.*, 2000). For all these aforementioned reasons, MSMEs may have some barriers to innovation (Larsen and Lewis, 2007). Data confirmed what the above said: only 49.5% of MSMEs undertook an innovation activity from 2014–2016 (European Commission, 2019a). Therefore, it is considered necessary to understand how they can overcome these financial barriers. This is more relevant when MSMEs belonging to AFS are considered. First of all, they are crucial in meeting the growing demand for food in the coming years, but, at the same, they are often seen as unattractive clients by financial institutions (International Fund for Agricultural Development, 2015). In this context, small enterprises often represent the cutting edge of new technology, create new jobs and wealth and contribute significantly to exports (Capitanio *et al.*, 2010). Secondly, MSMEs in the AFS are often family businesses whose activities are mainly run by family members (Scorza *et al.*, 2020). This often makes it difficult, and therefore more interesting, to understand how these realities can overcome the negative aspects of small size and enhance their positive role (Scorza *et al.*, 2020).

Focussing more closely on the financial structure of the MSMEs belonging to AFS, previous studies have shown that these companies are undercapitalised, probably because of the MSMEs' poor managerialization (Myers and Majluf, 1984; Rossi *et al.*, 2012) and this affects their investment policies, undermining their competitiveness (Rossi *et al.*, 2012, 2015) and limiting their process of innovation (Larsen and Lewis, 2007). Traditionally, debt finance, including bank loans, overdrafts, credit lines and credit cards, is the most common source of external finance for many MSMEs and entrepreneurs. However, nowadays, debt financing presents some difficulties for MSMEs because lenders cannot always judge, assess and monitor them (OECD, 2015). Consequently, they are not always capable of funding them. MSMEs are heavily reliant on traditional bank sources. However, because of the widespread bank deleveraging, banks are now reducing credit volumes and limiting their loans (Nassr and Wehinger, 2015), so MSMEs now need new funding sources that could easily meet their needs. In this context, alternative financial sources, e.g. mini-bonds, subordinated debt, convertible debt, bonds with warrants and mezzanine finance and crowdfunding, could be the solution (e.g. Nassr and Wehinger, 2015; Paoloni *et al.*, 2019; Paoloni *et al.*, 2020). However, alternative sources are not yet spread in the Italian context (European Commission, 2019b). Specifically, Italian MSMEs have, on average, less opportunity to be funded by venture capitalists and business angels than other European MSMEs. At the same time, in Italy, banks rejected loan applications by MSMEs more than the average in Europe (European Commission, 2019a). Nevertheless, the situation has slightly improved since more alternative resources (e.g. peer-to-peer lending, direct lending funds, invoice trading and mini-bonds) have been available for new and growing firms than in the previous period (European Commission, 2019b). Amongst these sources, equity-like sources (e.g. crowdfunding, shares and venture/angel capitalists) are getting more space (Klerx, 2015). This type of source, by the way, is also the most suitable for financing innovation (Cillo *et al.*, 2019), which is demanded by the sector. Indeed, despite the typical difficulties of MSMEs, this sector drives the national economy's growth (Della Corte *et al.*, 2018; Garzia, 2019). Therefore, considering the banks' financing constraints and the contextual necessity for other sources to innovate, it is possible to formulate a hypothesis as follows.

HP1. In the MSMEs belonging to AFS equity ratio is increasing in the period analysed

2.2 Innovation and financial structure in the AFS

As already asserted, innovation is the fundamental base on which it is possible to build sustainable development (Bai *et al.*, 2020). However, it is a very broad concept that can be interpreted differently and assumes specific characteristics within the AFS sector. Firstly, innovation may be described as the complex process in which enterprises reconstruct, combine and create new things from existing elements (Zaltman *et al.*, 1973). This process could occur in different ways, considering the object of the innovation itself. In literature, innovation is divided into four different types: product innovation is the creation of new technology that can provide consumers with new products or services (Gao *et al.*, 2022). Secondly, process innovation refers to adjusting and improving an existing production process (Blumentritt, 2004). Finally, it is possible also to mention organisational innovation, namely the creation or adoption of a new idea or behaviour in the organisation (Damanpour, 1996) and marketing innovation, which involves the implementation of new marketing methods (OECD and Eurostat, 2005).

When looking at innovation in AFS, literature is growing on this topic as the importance of technological innovation in this area is emerging on various levels (Spanaki *et al.*, 2022; Rialti *et al.*, 2022). Firstly, innovation is necessary to enable the sector to improve its performance, ensuring greater stability and food security, even in times of crisis (International Fund for Agricultural Development, 2015). Secondly, the sector's innovation is seen as a driver for sustainability, as AFS plays a key role in achieving several SDGs, amongst which SDG 2 stands out (Bogers *et al.*, 2020).

In AFS, innovation has mainly consisted of technology acquisition through the purchase of tangible and intangible assets, particularly equipment and machinery (Martinez and Briz, 2000). Historically, the AFS firms do not directly develop the innovation, but it is usually obtained by other entities, such as other firms or research institutes (Petruzzella and Di Mambro, 2017). For this reason, it has always been defined as a "low research-intensive industry" and is characterised by one of the lowest levels of R&D-to-sales ratios of any other sector (Sandven and Smith, 1993; Santoro *et al.*, 2017). However, although this industry is traditionally a low research-intensive sector, it is clear that innovation is crucial for its development (Capitanio *et al.*, 2009; Baregheh *et al.*, 2012; Kafetzopoulos *et al.*, 2020). For this reason, in the last years, this trend has partially changed, increasing and transforming the innovation process into "open innovation", in which the relationship with external actors, creating collaborations and partnerships, becomes fundamental (Ferraris *et al.*, 2021). Considering the various typology of innovation, the AFS is characterised by a greater relevance to the process innovation (Martinez and Briz, 2000; Capitanio *et al.*, 2010; Triguero *et al.*, 2013). This means that the innovation activities must be supported by purchasing fixed and intangible assets, which are useful to improve the efficiency of the processes (OECD and Eurostat, 2005; Skuras *et al.*, 2008). In this view, it is possible to expect the MSMEs that are going through an innovative process to improve their fixed assets, which represent the necessary means for this innovative path (OECD and Eurostat, 2005; Skuras *et al.*, 2008). Therefore, the following hypothesis can be made.

HP2. MSMEs belonging to AFS are improving their fixed assets to go through an innovative process.

Analysing the main trend of innovation in these industries, significant attention is given to technologies that may enhance sustainability and help reach SDGs goals (Bresciani, 2017; Bogers *et al.*, 2020). Generally, using a combination of informatics technologies and other communication technologies could support this growing process (El Bilali and Allahyari, 2018). Furthermore, digitalisation and new technologies are essential to create value and obtain competitive advantages (Cosentino *et al.*, 2020), becoming a driver for firm performance (Kühne *et al.*, 2010). Nowadays, the agri-food industries have started implementing 4.0

technologies, creating a new type of agri-food business (i.e. agritech businesses (Spanaki *et al.*, 2022)). These types of technologies help analyse data, achieve information and could improve knowledge management which supports the business decision, allowing companies in these sectors to achieve a higher level of financial and operational performance (Branco *et al.*, 2015). Therefore, given the increase in competitive capacity, financial performance is assumed to be unaffected by the innovation process. It is assumed that the profitability of the company is not negatively affected (maintaining ROI stable), that ROI is always higher than the ROD (a symptom of a profitable company) and that the ROD is even decreasing, given the preference for other types of sources (equity or equity-like) to innovate (Acharya and Xu, 2017). This idea is articulated in three different hypotheses.

HP3.1. In MSMEs belonging to AFS, ROI is stable in the period analysed.

HP3.2. MSMEs belonging to AFS are decreasing ROD in the period analysed.

HP3.3. On average, MSMEs belonging to AFS have a higher ROI than the ROD in the period analysed.

Considering the composition of the AFS, which mainly includes MSMEs, and the characteristics of these types of firms, understanding how MSMEs belonging to AFS becomes relevant. As a preamble to further reasoning, it must be remembered that, although MSMEs have inherited a fragile structure and lack of money, innovation has the potential to bring as many benefits as larger companies (Maheshwari *et al.*, 2021; Kumar *et al.*, 2022). Certainly, innovation requires resources to be invested, but it is not simple for firms (especially MSMEs, as mentioned before) to find new funds to innovate since innovation suffers from risks (Skuras *et al.*, 2008). A clear example is that banks are hesitant to grant loans for uncertain innovative processes because innovation is associated with higher perceived risks (Kim *et al.*, 2016). In this light, equity financing is inherently more tolerant of technological innovation failure, thus incentivising innovation (Ferreira *et al.*, 2014). For this reason, internal financing, specifically new equity from the firms' owners, is the main funding source for most innovation projects. Looking at external sources, equity sources are the most feasible for innovation as they may positively affect the rate and quality of innovation (Acharya and Xu, 2017). In addition, it is also possible to consider other sources that are comparable to equity, such as crowdfunding, private equity and venture capital (Knezevic *et al.*, 2021). However, it cannot be asserted that banking resources are unsuitable for financing innovation. Especially in bank-centric systems, like the Italian one, the importance of bank resources has been demonstrated (Benfratello *et al.*, 2008). This is especially true when innovation is represented by fixed assets that can serve as collateral for bank lending (Benfratello *et al.*, 2008). In this light, it is possible to hypothesise that MSMEs that are going through an innovative process prefer equity sources without neglecting banking ones, which still represent a relevant source for Italian MSMEs belonging to AFS. Therefore, the fourth hypothesis can be formulated as follows.

HP4. In MSMEs belonging to AFS, the fixed assets are more correlated to equity than debt.

Another element that could be a determinant of the innovation process is the dimension. Historically, large companies are considered the main drivers of any innovative process (Schumpeter, 1934). However, this idea has been widely criticised and partly overcome during the past year. Furthermore, it has been demonstrated that the Schumpeter affirmation is not absolute but may depend primarily on the type of sector being considered. Therefore, MSMEs are a catalyst for innovation in some (non-capital-intensive) sectors (Acs and Audretsch, 1987). In this light, the impact of dimension on the innovative process may be considered uncertain. Therefore, the element "size" will be used in the analysis to make some considerations.

Before going into details with the analysis, it is possible to figure out all the hypotheses in Figure 1.

3. Research design

3.1 Research contextualisation

The Italian AFS is fundamental for the national economy because it still is one of the main industries for added value and employment (The European House – Ambrosetti, 2019). It is largely made up of MSMEs, which inherently have a fragile financial structure, and it consists of different phases: the production and transformation phase and the distribution and commercialisation phase. The first comprises the agriculture, fisheries, forestry and transformation industries, whereas the second includes the distribution and catering industries (The European House – Ambrosetti, 2019). Although some negative performance occurred in isolated cases during the last decades, this sector has not been negatively affected by the broader decrease in competitiveness in the Italian industry. In fact, in a period characterised by a relevant economic stagnation, the performance of the AFS has been able to maintain a positive trend, thanks to protected designation of origin (PDO) and protected geographical indication (PGI) products that drove the Italian economy and exportation (ISMEA, 2018). These anti-cyclical performances are explainable by the regular growth in food consumption (Carraresi and Banterle, 2015; European Parliament, 2019) and the constant increase in exportation, which makes this sector one of the Italian excellences in the Made in Italy. Going into details of the agri-food supply chain, it is interesting to highlight some performance numbers and essential characteristics.

In detail:

(1) Production phase (agriculture, fisheries and forestry) is relevant in terms of employment and added value and 9,2 million people are involved in the activities related to this phase in Europe. In Italy, this industry is characterised by the presence of a considerable number of MSMEs, and in 2019, it was the first European country for the added value with 31,8 billion (ISTAT, 2020a);

(2) Transformation phase consists of the manufacture of food products and beverages. They are mainly composed of MSMEs and have a turnover that has been constantly growing in the last years (ISTAT, 2020a);

(3) Distribution phase recorded a moderate growth of the volume of the large distribution (+1.1%) (ISTAT, 2019b);

(4) Catering industry has increased its added value since 2015, reaching the amount ante crisis (FIPE, 2019).

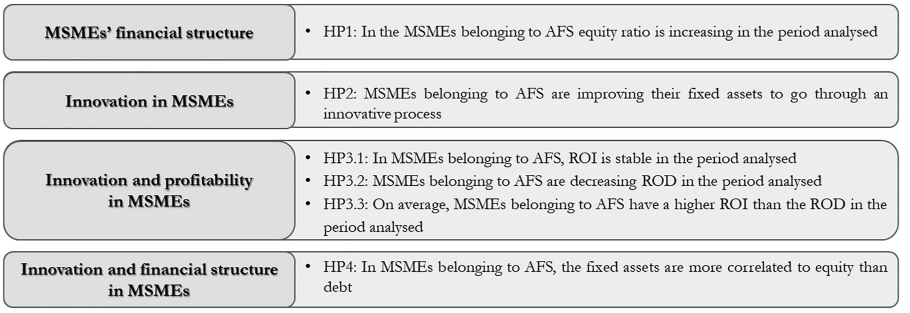

Figure 1.
Summary of the hypotheses

Indeed, these results were undermined by the Coronavirus pandemic impact (ISTAT, 2020b). Anyway, the most significant parts of the entire value chain are the production and transformation phases (The European House – Ambrosetti, 2019), which the authors have considered.

Focussing on the investments of these two sub-sectors, it is possible to observe that firms invest many resources in machinery and equipment, above 70% in both cases, according to a report of the International Fund for Agricultural Development (2015). As seen in the literature (Martinez and Briz, 2000), these types of investments are often equated with innovation processes.

3.2 Sample selection

Aiming to evaluate how Italian MSMEs AFS decide to finance the innovation process, this study considers the data extracted by AIDA [1] on 25 March 2021. In particular, in line with the previous data exposed, the analysis is focused on the firms belonging to the following ATECO code categories that the ISTAT (Italian national statistical office) uses to identify the economic activities corresponding to the production and transformation industries of the agri-food supply chain.

(1) 01 - Crop and animal production, hunting and related service activities (Agriculture)

(2) 02 - Forestry and logging

(3) 03 - Fishing and Aquaculture

(4) 10 - Manufacture of food products

(5) 11 - Manufacture of beverages

After this boundary, the analysed sample counted 18,267 firms. Then, to consider only the MSMEs belonging to these industries, the authors imposed that the companies had to meet the European MSMEs criteria: a number of employees less than 250 and an annual turnover of less than EUR 50 million or a total balance sheet of less than EUR 43 million (European Commission, 2015). The limitation imposed for the first criterion, the number of employees, reduced the sample to 8,032. Furthermore, the sample was restricted to the firms whose financial statements were available for seven years (2013, 2014, 2015, 2016, 2017, 2018 and 2019), limiting the analysis to 8,020. Afterwards, to analyse the evolution of the financial structure, the authors considered only the MSMEs *in bonis*. Therefore, companies belonging to the sample which present a critical financial situation in the chosen period (2013–2019) have been eliminated to avoid distortion, reducing the sample to 7,008.

In addition, the authors deleted the firms with missing data and with at least one of the financial sources' values (total equity or total liabilities) outliers at least once during the analysed period. The term "outliers" means a value > 99th or <1st percentile (Giuliani and Poli, 2021). Therefore, the final number of MSMEs analysed in this study is 4,815.

Considering the differences between production and transformation phases, which imply different economic and financial characteristics, the authors defined two different sub-samples. The production sample includes 1,681 firms, whereas the Transformation sample consists of 3,134 firms.

Another element that should be considered in sampling is the dimension. In fact, MSMEs could be highly different from each other. To define what medium, small and micro are, the authors adopted the MSMEs criteria of the European Union (European Commission, 2015).

The details of the sample's selection and composition are presented in Table 1. It shows that most of the sample (3,134 out of 4,815, 65% of the entire sample) is composed of firms belonging to transformation industries. Out of a total 3,134, 646 are micro-enterprises, 1,552

are small enterprises and 936 are medium enterprises. On the other hand, the production industry comprises 1,681 firms (35% of the entire sample), of which 299 are micro-sized, 959 are small-sized and 423 are medium-sized enterprises.

3.3 Methodology

To test the hypotheses and, then, answer the RQ1, a quantitative approach is used, performing a ratio-analysis of the main financial indicators (Beaver, 1966; Koutsou and Sergaki, 2019). This technique involves the use of several ratios. It could be used for several purposes, such as the prediction of failure or, more generally, the observation of the health status of the firms (Beaver, 1966) and in different contexts, such as the AFS (Koutsou and Sergaki, 2019). The financial ratio analysis, in this study, is used to empirically investigate a sample of Italian companies over a 7-year period (2013–2019), realising a longitudinal study (Needles *et al.*, 2010).

3.3.1 Variables. The first ratio considered is:

$$Equity\ Ratio = \frac{Total\ Equity}{Total\ Liabilities + Total\ Equity}$$

Equity Ratio (ER) is the percentage of equity firms use to finance their own activities.

Other ratios have been analysed to verify if there has been a relevant change in the investments' structure and the firms' performance. The indicators analysed are described in the following lines.

(1) *ROI* (*returns on investments*) is fundamental to be analysed to understand if the change in the financial structure has negatively affected the economic performance of the firms. If it does not happen, it is positive for firms since they can improve their financial structure and, consequently, their financial performance;

(2) *ROD* (*returns on debt*) must be compared with the ROI to have a positive leverage effect, which is necessary for firms to be profitable in the long term (Simone *et al.*, 2017).

Regarding innovation, total fixed assets (AF) have already been used as a proxy to represent the investment in innovation, also in the AFS (Martinez and Briz, 2000). The choice of this variable depends on the fact that innovation is not exclusively manifested in R&D expenditures, which is the primary indicator used to assess innovation (Kleinknecht, 2000). It has been demonstrated that the most substantial part of innovation often depends on investments in strategic assets. In addition, in the present case, R&D expenditures would not have been available for two reasons; firstly, since from the literature, AFS is a low-intensive research industry and, therefore, the amount of R&D expenses are not relevant (Sandven and Smith, 1993; Santoro *et al.*, 2017). Secondly, the detail related to the R&D expenses is not present in most MSMEs' annual reports since MSMEs used to draw up abbreviated financial statements.

3.3.2 Analysis. This study is conducted using a longitudinal approach, including a descriptive analysis of the above-mentioned ratios and some quantitative statistical tests

		Type of industries		
		Production industries	Transformation industries	Total
Firms dimension	Micro enterprises	299	646	945
	Small enterprises	959	1,552	2,511
	Medium enterprises	423	936	1,359
	Total	1,681	3,134	4,815

Table 1.
Sample composition

(*t*-test and Mann–Whitney *U* test). These tests have been largely used to compare financial and economic data in different contexts, e.g. impact of innovation on performances (Bockova and Zizlavsky, 2016). In addition, they were applied also relating to agri-food industries (e.g. Shiu *et al.*, 2004). The two samples analysed were the data related to the first year of observation (2013) and the last (2019), focussing on the variation amongst these two time points. Each analysis is performed on both the production and transformation groups of firms.

Finally, after these statistical tests, linear regression is carried out. The statistical analysis considers the sample composition obtained from the cleaning activity, divided by production and transformation businesses.

Going into detail, the HP1 is addressed by the boxplot analysis to investigate the ER trend of the two sub-samples during the analysis period. It is helpful since it allows showing the summary statistic for the data, capturing how the distribution is structured and how it has changed in the period analysed, avoiding the effects of the outliers (Smith, 1999). In addition, a paired *t*-test is done to confirm the result. Specifically, the null hypothesis (H0) is that ER (2019)'s means is not greater than ER (2013)'s means, whereas the alternative hypothesis (H1) is the opposite.

Regarding HP2, the authors represent the innovation change using the paired *t*-test between Fixed assets in 2013 and 2019, considering a 95% confidence interval. Specifically, it is hypothesised that most firms are increasing their Fixed assets in the period analysed. A paired *t*-test is used to investigate whether the mean difference between pairs of measurements is zero. In particular, the null hypothesis (H0) is that the total fixed assets (2019)'s means is not greater than the total fixed assets (2013)'s, whereas the alternative hypothesis (H1) is the opposite.

For what concerns HP3, two different analyses are performed. Firstly, to investigate the change in ROI and ROD, a paired *t*-test between ROI (2019) and ROI (2013) and between ROD (2019) and ROD (2013) has been performed. In HP3.1, the null hypothesis (H0) consists of the equivalence of the ROI (2019)'s means and ROI (2013)'s means, whereas the alternative hypothesis (H1) is their diversity. In HP3.2, the null hypothesis (H0) is that ROD (2019)'s means is major (or, at least, equal) than ROD (2013)'s means, whereas the alternative hypothesis (H1) is the opposite. In both cases, it was considered a 95% confidence interval. Secondly, to test HP3.3, Mann–Whitney *U* test is performed, taking into account a 95% confidence interval. It is a non-parametric used to compare two independent samples and identify the mean differences. The null hypothesis (H0) represents that ROI's means is not higher than the ROD's means in the period analysed, whereas the alternative hypothesis (H1) consists of the opposite.

Finally, to test HP4, a regression analysis is performed. Data are organised as panel data, which can be seen as a combination of cross-sectional and time-series data. Panel data is a two-dimensional concept where the same individuals are repeatedly observed over different periods. Specifically, a Fixed-Effects Model has been created for the panel. It is helpful to determine individual effects of unobserved, independent variables as constant over time. This type of analysis has been chosen, considering the result of the Hausman Test, which produces a $p < 0.05$.

Specifically, in the model, total fixed assets (AF) is the target variable, whereas debt (D) and equity (E) are the predictors. In addition, some control variables that previous research had linked to the dependent variable have been introduced. Firstly, a profitability index has been taken into account, specifically ROE. As previously demonstrated, profitability is positively linked to innovation (O'brien, 2003). Secondly, ROS, calculated as operating income on sales, represents the firm's efficiency. Finally, a dimension index, called Size: ROS, has been created to capture the size's effects. For each firm, this variable is calculated by summing the total operating income of all firms of a particular dimension (micro, small and

medium), excluding the focal firm and dividing by the total sales for all those firms included in the numerator, according to their dimension. This index capturing the size effect was added, as the literature suggests different results (Schumpeter, 1934; O'brien, 2003).

4. Findings

The first part of the analysis consists of the ER boxplot analysis. The first boxplot (Figure 2) directly compares the ER distributions related to the seven years analysed for the two sub-samples. Considering the observable variability amongst different firms' dimensions, the same analysis was performed on a dimension basis to understand if this behaviour affected all the companies in the production and transformation industries (Figure 3).

As it is possible to observe from Figure 2, the ER trend generally has grown during the period, with a median having passed from nearly 28% to 32% for transformation industries, whereas the median of the production industries has passed from 25% to 30%. Looking at Figure 3, the same trend has been found in all the dimension typologies: micro, small and medium. It is interesting to observe that the boxplot representation suggests the presence of a higher percentage of equity as the size increases.

Before going into detail with the statistical tests, some descriptive data are presented in Table 2, focussing on the mean and median of all the firms in the period analysed.

As shown, the growing trend of ER is confirmed by median and mean in both the sub-samples. The ROI has been characterised by a parabolic tendency, with a relevant increase in the first years and a slight decrease in the more recent ones. It is also possible to observe a difference between firms belonging to the production sector and firms belonging to the transformation sector, with the former having a lower ROI, close to half that of firms belonging to the transformation sector. Remarkably, the ROD index has decreased during the period, as is confirmed by both mean (production: 1.67%–1.09%; transformation: 1.78%–1.09%) and median (production: 1.41%–0.90%; transformation: 1.54%–0.82%).

To statistically test HP1, HP2 and all the HP3, *t*-tests and Mann–Whitney *U*-tests are performed. The results are shown in Tables 3 and 4.

Findings in Table 3 highlight that, considering the ER, the *p*-value of the *t*-test is lower than 0,05; therefore, it is possible to accept the alternative hypothesis (H1) and affirm that the ER in 2019 is significantly higher than the same ratio in 2013. Regarding AF, the *p*-value of the *t*-test is lower than 0.05, demonstrating that H0 must be rejected; therefore, AF in 2019 is significantly higher than in 2013. Considering the ROD, the difference between 2013 and 2019 is significant (*p*-value <0.05), meaning that ROD in 2019 is significantly lower than ROD in 2013. These two results are common to both industries (transformation and production),

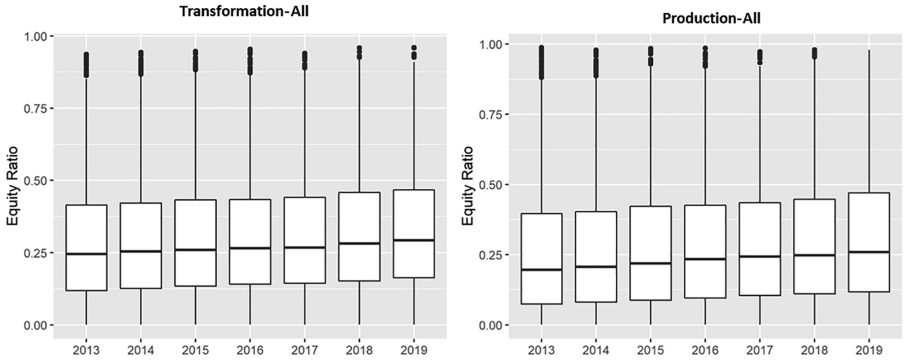

Figure 2.
Equity ratio boxplot chart - production and transformation samples (2013–2019)

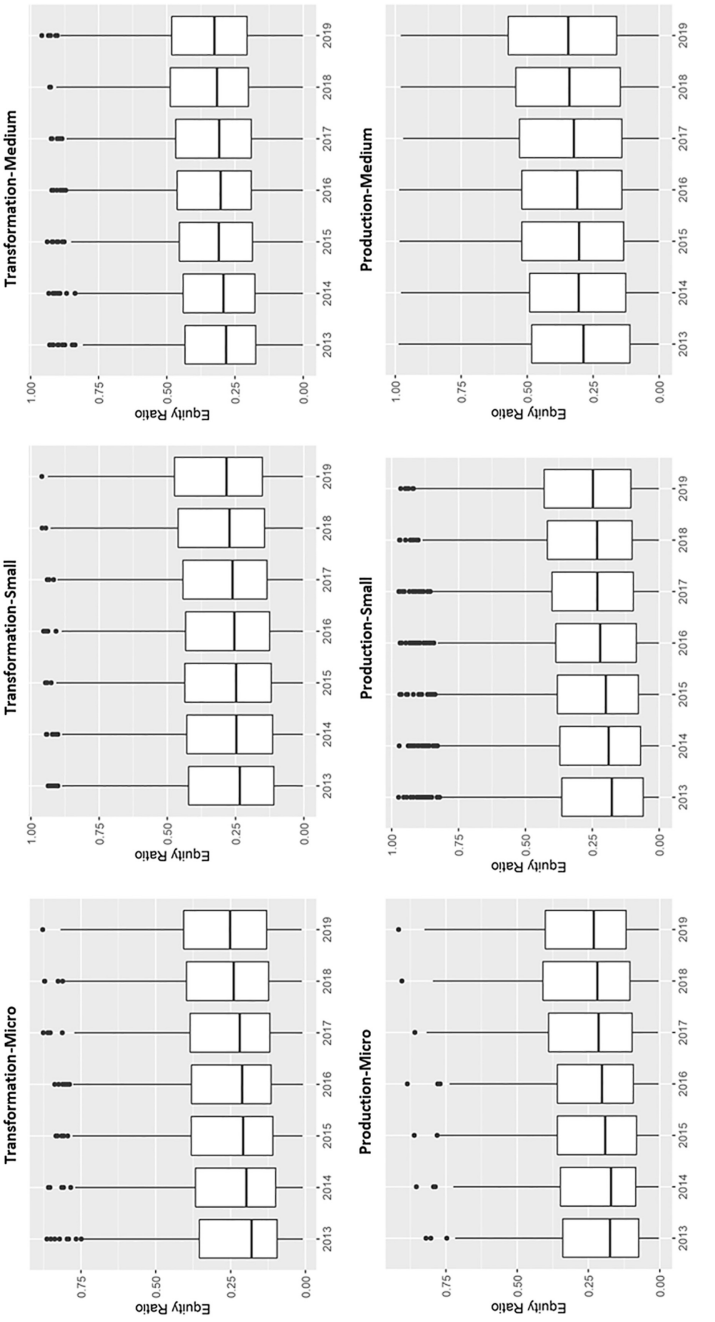

Figure 3.
Equity ratio boxplot chart – firms divided by dimension (2013–2019)

	Transformation industries: all MSMEs			Production industries: all MSMEs		
	Mean			Mean		
	ER %	ROD %	ROI %	ER %	ROD %	ROI %
2013	28.55	1.78	4.46	25.90	1.67	2.30
2014	29.23	1.74	4.85	26.60	1.71	2.62
2015	30.21	1.55	5.12	27.48	1.58	2.73
2016	30.53	1.30	5.19	28.24	1.39	2.87
2017	30.96	1.13	4.84	29.04	1.22	2.79
2018	32.08	1.09	4.61	30.03	1.14	2.91
2019	32.84	1.09	4.34	30.97	1.09	2.85
	Median			Median		
	ER %	ROD %	ROI %	ER %	ROD %	ROI %
2013	24.47	1.54	3.31	19.66	1.41	1.74
2014	25.37	1.54	3.56	20.67	1.46	1.89
2015	25.99	1.31	3.65	21.94	1.33	1.76
2016	26.46	1.03	3.64	23.41	1.12	1.69
2017	26.70	0.87	3.35	24.30	0.93	1.59
2018	28.24	0.83	3.27	24.75	0.90	1.48
2019	29.32	0.82	3.06	25.92	0.90	1.50

Table 2.
Ratio descriptive analysis per year

HP1: In the MSMEs belonging to AFS Equity ratio is increasing in the period analysed			***HP2: MSMEs belonging to AFS are improving their fixed assets to go through an innovative process***		
t-test on ER (2019) and ER (2013) - p-value			*t-test on AF (2019) and AF (2013) - p-value*		
	Production	Transformation		Production	Transformation
Micro	0.000	0.000	Micro	0.000	0.000
Small	0.000	0.000	Small	0.043	0.000
Medium	0.000	0.000	Medium	0.001	0.000
All	0.000	0.000	All	0.000	0.000
HP3.1: In MSMEs belonging to AFS. ROI is stable in the period analysed			***HP3.2: MSMEs belonging to AFS are reducing ROD in the period analysed***		
t-test on ROI (2019) and ROI (2013) - p-value			*t-test on ROD (2019) and ROD (2013) - p-value*		
	Production	Transformation		Production	Transformation
Micro	0.004	0.214	Micro	0.000	0.000
Small	0.046	0.921	Small	0.000	0.000
Medium	0.098	0.799	Medium	0.000	0.000
All	0.001	0.835	All	0.000	0.000
The significant results (p-value < 0.05) are highlighted in grey					

Table 3.
t-test *p*-values (Comparison between 2013 and 2019)

regardless of the dimension. On the other hand, what concerns ROI, the results are less concordant and significant differences exist between the two types of industries and the various sizes. Specifically, looking at the transformation phase, there is not a significant difference comparing their amount in 2013 and 2019, as the p-value suggests (p-value <0.05, thus accept H0). On the contrary, there was generally a significant increase in ROI in the production sectors.

Looking at Table 4, which compares ROI and ROD in each year of observation through the Mann–Whitney U test, it is possible to observe that the p-value is mostly lower than 0.05. Therefore, ROI is significantly higher than ROD in both industries (transformation and

Table 4.
Mann–Whitney *U* test *p*-values (Comparison between ROI and ROD)

	Transformation industries				Production industries			
	Micro	*Small*	*Medium*	*all*	*Micro*	*Small*	*Medium*	*all*
2013	0.000	0.000	0.000	0.000	0.000	0.000	0.980	0.000
2014	0.000	0.000	0.000	0.000	0.000	0.000	0.900	0.000
2015	0.000	0.000	0.000	0.000	0.000	0.000	0.666	0.000
2016	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.000
2017	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
2018	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000
2019	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.000

The significant results (p-value < 0.05) are highlighted in grey

production) for the entire observed period. The only exception the data shows is for medium-sized companies in the production sector, limited to the first years of observation.

Finally, to test HP4, the FE model is tested and the results are shown in Table 5. They illustrate that both equity and debt positively affect the total fixed assets, as the p-value suggests. The model was repeated for both industries (production and transformation). The level of R^2 and adjusted R^2 suggest that the total fixed assets trend is partially explained by equity and debt movements (approximately 36% for transformation and approximately 34% for production).

Considering the coefficient of each variable, it is possible to make two different considerations: firstly, all the predictors' coefficients are significant, as the p-value suggests (p-value <0.05). This is confirmed by the low standard error (SE) level for both the variable and their related high value of the t statistic, especially for transformation. Secondly, in all the years analysed, the coefficients related to E are higher than those related to D, suggesting that the impact of E on the AF is normally higher than that of D.

Variables	Coefficients	Std. Error	*t*-value	Pr(>|t|)
Production: All				
E	0.499729	0.007027	71.1153	<2.2e−16***
D	0.366303	0.004697	77.9862	<2.2e−16***
ROS	−7.406302	3.359554	−2.2045	0.027505*
ROE	−2.964211	1.433936	−2.0672	0.038739*
Size:ROS	0.314999	0.104366	3.0182	0.002548*
R-Squared: 0.45082				
Adj. *R*-Squared: 0.34325				
F-statistic: 1911.9 on 5 and 11,645 DF, *p*-value: <2.22e−16				
Transformation: All				
E	4.0909e−01	5.9652e−03	68.5786	<2.2e−16***
D	3.6874e−01	3.4512e−03	106.8426	<2.2e−16***
ROS	−594.56	8.0938e+01	−7.3458	2.118E−13***
ROE	−2.9579	9.3532e+00	−0.3162	0.7518
Size: ROS	−5.9585	5.6262e−01	−10.5907	<2.2e−16***
R-Squared: 0.46603				
Adj. *R*-Squared: 0.36264				
F-statistic: 3744.56 on 5 and 21,452 DF, *p*-value: <2.22e−16				

Note(s): Signif. Codes: 0 '***', 0.001 '**', 0.01 '*'

Table 5.
Regression results

Looking at the control variables, as the literature suggests (Schumpeter, 1934; O'brien, 2003), the dimension has contradictory effects. In fact, size seems to be negatively correlated for the more industrial sectors (transformation), whilst for the production sectors, it is positively correlated. Furthermore, contrary to what has been seen in the literature (O'brien, 2003), profitability does not seem to have a strong correlation with innovation, being insignificant in transformation and low significant in production.

5. Discussion

The results obtained from the boxplot analysis and the paired *t*-test confirmed HP1 because, in the period analysed, the firms belonging to the sample have changed their financial structure, moving from debt to equity. This could be seen focussing on Figure 2, in which it is possible to see that the entire sample population moved towards increased equity. However, it is possible to highlight that, as the literature suggests (Rossi *et al.*, 2012, 2015), the AFS firms still remain undercapitalised (ER < 50%), even if they are slightly altering this situation. The results illustrated in Figure 3 also show that the undercapitalisation problem decreases as the size increases, as general data suggested (European Commission, 2019a, b). This is also confirmed by Table 3 and is in line with what has been seen in the literature regarding the increased use of equity or innovative equity-like sources (Eskesen *et al.*, 2014; Klerx, 2015; Knezevic *et al.*, 2021). Focussing on the typology of industries, the results became more interesting and allowed some additional considerations. The percentage of equity in transformation is stably higher than in production firms. This could be explained since the agriculture sector suffers from the undercapitalisation problem aforementioned (Rossi *et al.*, 2012, 2015).

Looking at the level of innovation, identified with the amount of the total fixed assets, it is possible to notice a significant increase in the period analysed (Table 3). Therefore, it is possible to confirm HP2. This result would confirm that, in a sector like agri-food, where innovation is often imported, the AF could represent innovation (Sandven and Smith, 1993; Santoro *et al.*, 2017); therefore, Italian companies are growing and innovating.

This innovation process does not seem to be affecting the profitability of companies. In fact, with regards to the ROI (Table 3), it is possible to observe a quite stable trend in the entire analysed period since there is not a significant difference, at least in the transformation industries. Even in the agricultural sector, there has been an increase that can be considered significant in some cases (especially in small firms). This is important, considering that the change of financial structure must be done without undermining the firms' profitability (Paolucci, 2013) and confirms HP3.1. Analysing the ROD, two comments can be made: firstly, if the changes in the financial structure are done in a balanced and measured way, as happened in the sample selected, they can reduce the weight of financial charges on the profit (Teodori, 2017), as it is possible to observe in Table 3 where it is possible to observe a statistically significant reduction in the period analysed, confirming HP3.2. Secondly, the firms are profitable since the ROI is higher than ROD, as the Mann–Whitney *U* test in all the years considered in Table 4. Therefore, it is possible to confirm HP3.3, namely that firms have not compromised their profitability in pursuing innovation (Kühne *et al.*, 2010; Cosentino *et al.*, 2020).

Finally, considering that the high risks of innovation prevent the inflow of bank resources into the innovation process (Pogodaeva *et al.*, 2018), the necessity to contemplate other financial resources is still a demand for the future. In fact, as the regression analysis suggests (Table 5), *equity* and *debt* positively impact fixed assets, even if equity sources seem to have a higher impact on fixed assets; therefore, it is possible to highlight the great relevance that an increase in equity sources could have on innovation, even if debt financing has still a significant impact on these assets, as explained in the literature (Benfratello *et al.*, 2008). In this light, improving open innovation through crowdfunding or alternative equity-like financial sources could be a solution (Cillo *et al.*, 2019). This result is also consistent with the Pecking Order Theory (Myers and Majluf, 1984), for which the use of internal sources of

equity is preferred as it is more suitable to finance riskier projects (such as the innovation process), thus reducing transaction costs and, at the same time, maintaining firm's control (Myers and Majluf, 1984). Furthermore, as shown by the result of the control variable incorporating size (Size:ROS), these conclusions can also be extended to larger companies since it has no significance or low significance.

Summarising and systematising the results and answering the RQ1, this study is empirical evidence of the financial structure change happening in the AFS firms and that firms, no matter what industries are considered, are increasing the percentage of equity. At the same time, this process of innovation, demonstrated by the increase of total fixed assets illustrated in Table 3, was partially caused by the increase of the ER, in that Equity has resulted in influencing more strongly fixed assets than Debt (Table 5). In addition, according to the results of the *t*-test (Tables 3 and 4), this change in the financial structure did not compromise the firms' profitability (ROI > ROD). Therefore, the ER trend is expected to continue and companies will increasingly look for alternative ways to bank financing to undertake innovation processes. Therefore, it is necessary to continue this process of capitalisation, which, on the one hand, solves an age-old problem of MSMEs in the AFS (Rossi *et al.*, 2012, 2015), and on the other hand, is proven to help innovation. In this light, it is possible not only to turn to equity, but also to equity-like sources, which are also becoming more widespread in this sector (Cillo *et al.*, 2019).

6. Conclusion

The agri-food supply chain is fundamental for the Italian economy, being one of the leading industries for the national Gross domestic product (ISTAT, 2020a). It is made up of different sectors, amongst which the most profitable for investors is the production phase, composed of Agriculture, Fisheries and Forestry, and the transformation phase, made up of the Food and Beverage industries (The European House – Ambrosetti, 2019).

This sector mainly comprises MSMEs, which drive the Italian and European economies (European Commission, 2019a, b). As was previously illustrated, MSMEs are used to facing some additional challenges related to their insufficient financial structure (Birley and Niktari, 1995), which could be considered barriers to innovation (Larsen and Lewis, 2007). To overcome these challenges related to undercapitalisation (Rossi *et al.*, 2012, 2015), MSMEs in AFS traditionally have used debt finance, including bank loans, overdrafts, credit lines and the use of credit cards. However, when the financial crisis arose, banks reduced their funding for these firms. In fact, especially in the south of Europe, banks' growing difficulties in obtaining funds to invest have immediately caused some credit constraints (Nassr and Wehinger, 2015), with adverse effects on the investment in MSMEs. The necessity to access finance becomes even more relevant if it is taken into account the need for firms to increase their performance and productivity, implementing a process of innovation (Baldwin and Gellatly, 2003; Larsen and Lewis, 2007). The relevance of this work lies in the fact that innovation in the AFS has become crucial for several reasons: first of all, innovation is seen as a key element to improving its performance, thus ensuring greater stability and food security, even in times of crisis (International Fund for Agricultural Development, 2015). In addition, as is evident from SDG no. 2, this sector is called upon to play a key role in sustainability and technological innovation is seen as a driver for this achievement. Therefore, considering an existing literature gap, this work investigates how AFS Italian firms finance innovation, despite this credit crunch. Specifically, to answer RQ1, that is: "*How do AFS Italian MSMEs finance the innovation?*", an empirical analysis has been performed. In particular, according to the existing literature and empirical data, data were analysed through financial ratio analysis, descriptive analysis, *t*-test and Mann–Whitney *U* test and regression analysis.

The results of the analyses confirm the hypotheses based on theory and empirical analyses. In particular, it was seen that fixed assets, used as a proxy for innovation in agri-

food (Kleinknecht, 2000), have increased over the period analysed (HP2 accepted). In addition, a slight change in the structure of the firms in the sector was highlighted, with a statistically significant increase in the ER (HP1 accepted), which is also consistent with the Pecking Order Theory assumptions (Myers and Majluf, 1984). Finally, results demonstrated that equity is more correlated with the increase in fixed assets, as shown by the regression (HP4 accepted). The innovative process, mainly supported by equity, without neglecting debt, is sustainable over time, as it has improved financial performance (HP3.1, HP3.2 and HP3.3 accepted). Therefore, answering the RQ1, the results show a preference for using equity to innovate, even if this source is still underestimated in the MSMEs belonging to AFS (Rossi *et al.*, 2012, 2015). Thus, in this light, the use of new financing equity-like sources such as crowdfunding, shares and venture/angel capitalists could be seen as a solution for MSMEs for two reasons: to continue to fight the reduction of banks and other financial institutions' funding and, at the same time, to provide the necessary financing sources to implement an innovation process, as also literature suggests (Cillo *et al.*, 2019).

7. Theoretical contribution and practical implications

The value of the present research is to deeply analyse the AFS, focussing on the MSMEs' financial structure's choice of using equity and new alternative equity-like sources instead of traditional banks' credit. Specifically, according to Pecking Order Theory assumptions (Myers and Majluf, 1984), this choice is necessary to avoid the high transaction costs required by banks for risky investments and, at the same time, is effective for implementing innovative development.

The paper's main theoretical contribution lies in bringing together two issues of great relevance: financial structure and innovation. Even though many studies have investigated how financial strategies could impact innovation, only some focus on the AFS. In this sector, the financial structure of companies has always been studied, as it is characterised by historical undercapitalisation due to its small size (Rossi *et al.*, 2012, 2015). Similarly, innovation is an issue of growing interest and relevance, considering its impact on sustainability and financial performance (International Fund for Agricultural Development, 2015). This study combines these issues in the AFS, contributing by opening up new debates concerning the role of equity and new equity-like sources in supporting innovation in this sector and sheds some light on how financial choices could impact innovation.

The primary practical implication to MSMEs belonging to AFS is the possibility of considering non-traditional sources of financing for an innovative path. This suggestion is useful for MSMEs, as they are often characterised by poor managerial and financial expertise of their managers, who are unaware of this possibility (Myers and Majluf, 1984). This may be even more relevant for AFS firms, given the undercapitalisation mentioned above that the sector suffers from, which makes the financial structure of the companies fragile (Rossi *et al.*, 2012, 2015). The results of the work confirm that the choice to prefer equity and equity-like sources allows for a more significant impact on innovation, which is nowadays required for the entire sector. This would be helpful, especially in light of the events that are taking place (the Coronavirus pandemic, the energy crisis and the war in Ukraine), since these events will increase uncertainty, leading banks to be even more prudent unless states provide appropriate guarantees. This study, therefore, allows MSMEs in this sector to consider other sources, including innovative ones (equity-like sources), to cope with the likely reduction in banking resources.

8. Limitations and future lines of research

This paper presents some limitations due to the discretional choice of the indicators considered in the analysis. Specifically, the choice of the dependent variable in the regression model, namely the total fixed assets amount, can be considered an imperfect proxy for innovation. However, it

was the only one possible since the MSMEs do not provide the detail of several items in their balance sheet. Future studies could identify more precise variables by requesting information directly from the companies, reducing the sample. In addition, this study is focused only on the Italian context, which could be unique, given the MSMEs' severe difficulties in accessing banking sources and the occasional use of alternative financial sources (European Commission, 2019a).

For this reason, future research may be developed, investigating other scenarios through a comparative case study. Furthermore, future research lines may focus on identifying the specific alternative financing sources that are more suitable for the innovation process that the AFS is living. In this light, it will also be interesting to understand how the present global scenario (COVID-19, energy crisis and the war in Ukraine) will transform the MSMEs' financial structure, always with an expectation of continuing the innovation process.

Note

1. It is an online database produced by Bureau van Dijk, containing financial and commercial information on over 1,000,000 corporations operating in Italy.

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