RESEARCH ARTICLE

Debt *vs.* self-financing innovation projects: An exploratory study of Spanish agri-food SMEs

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Abstract

Aim of study: This paper determines the preferences for debt or equity – common stock and self-financing – that are shown by agri-food companies to finance innovation investment strategies and identify the monitoring role that third-party funding providers can play.

Area of study: A sample of 41,109 Spanish SMEs (364,020 observations).

Material and methods: The information was obtained from the SABI database, using the Generalised Method of Moments (GMM) estimator and a logistic regression like contrast methodologies.

Main results: Spanish agri-food companies undertake innovation projects by financing these investments through owners' resources, mainly from current common stock, as they are independent of these companies' capacity to generate internal funds. This may be conditioned by the problems of severe negative self-financing presented by this sector in Spain which make it difficult to use retained earnings as a source of financing for new investments; 30% of these firms have a negative self-financing level of EUR 100,000 as the losses accumulated by economic activity are higher than the reserves provided.

Research highlights: Agri-food companies prefer to use owners' funds to finance innovation projects which allows them to maintain the concentration of power, a decision that is reinforced by the limitation to credit access due to innovation creates intangible assets that are not usually accepted as collateral by financial institutions. Meanwhile, given the particularities of these companies – instability and liquidity problems due to the need for funds of operations – the recourse to debt is an appropriate control mechanism to prevent overinvestment decisions.

Additional key words: investment, capital structure; equity; common stock; retained earnings; financial structure; liquidity

Abbreviations used: CNAE (Clasificación Nacional de Actividades Económicas); GMM (generalised method of moments); NET (net present value); NOF (need for funds of operations); R&D (Research and Development); ROA (return on assets); SABI (Sistema de Análisis de Balances Ibéricos); SMEs (small and medium-sized enterprises)

Introduction

The agri-food industry accounts for the main activity of the manufacturing sector in several countries (Hirsch & Hartmann, 2014), and the investment strategies of this industry are crucial to increase competitiveness, boost job creation and overcome the social challenges of territories (*i.e.*, FoodDrinkEurope, 2019; MAPAMA, 2019). The issues that justify the need for new investment relate to the barriers that exporting firms operating in this sector sometimes face due to their pollution behaviour (Zhuang & Moore, 2015), the need to comply with the requirements of food security protection laws, the growing competition from emerging market firms that are able to produce agri-food products at more competitive prices, and major changes in lifestyles over recent decades, which have drastically altered consumer behaviour (Costa & Jongen, 2006; Rama, 2008; Alarcón & Arias, 2018; García-Sánchez *et al.*, 2021).

One of the main challenges that affects this sector is the need to adopt new technologies that support innovation in processes and products to increase production and in turn achieve sustainable economic growth (Huang *et al.*, 2010). This is vital to assure the long-term success of firms (Boehlje *et al.*, 2011) and to avoid relying exclusively on public support (Kirchmann & Thorvaldsson, 2000; Esposti, 2011; Malone & Chambers, 2017), although access to public funding is one of the main drivers of innovation efforts (Alarcón & Arias, 2018).

Despite the current importance of biotechnology, the agri-food sector has traditionally been considered to be a non-intensive sector in R&D (Connor & Schiek, 1997; García-Martínez & Briz, 2000) as these companies generally innovate in processes (Archibugi *et al.*, 1991), applying new technologies from other sectors, so innovation usually occurs through investments in capital and equipment. When innovating in products, the changes are usually progressive rather than radical to avoid customer aversion to new agri-food products (Galizzi & Venturini, 2008).

These innovation activities are predominantly found in larger companies, with greater experience in the industry and better access to knowledge (García-Alvarez-Coque *et al.*, 2014). However, other research highlights the innovation capacity of SMEs thanks to their greater flexibility and adaptability to changes (Bayona *et al.*, 2001; Maravelakis *et al.*, 2006; Alarcón & Sánchez, 2013). Nevertheless, there is no empirical evidence regarding the role that the financial and capital structure plays in these business decisions of agri-food companies (Calderón *et al.*, 2007; González-Moralejo, 2008; Gardó *et al.*, 2009; Capitanio *et al.*, 2010; Lin, 2012).

The capital structure is determined by the combination of the different resources used by a company to finance its investments: equity (which includes common stock and self-financing associated with the retained earnings) and indebtedness. For small companies that are normally managed by their owners, according to Hutchinson's (1995) arguments, the adequacy of the financial and capital structure determines their investment policies and business success. Hutchinson argues that these companies show an aversion to increase common stock that may lead to the entry of new owners, as it dilutes the power of the current owners and debt contracting involves the monitoring of the company by financial institutions.

However, the limitations that some companies place on raising common stock from funds provided by the current owners cannot be overlooked and may lead to the self-generation of internal funds to finance policy investment projects becoming more appropriate for their interests. Since the self-financing generated by these companies is often not sufficient to meet the necessary investment needs, it is necessary to resort to financial indebtedness. In addition, these companies use third-party financing to meet the financial needs associated with the operating cycle. All of this means that these companies are often characterised by access to third-party financing with short-term maturity that requires continued renegotiation (Scherr & Hulburt, 2001).

In this regard, our proposal aims to analyse, in relation to innovation strategies, the advantages and disadvantages associated with the capital structure (the preference for the use of equity over external funding) as well as the corrective role that the financial structure can perform, in addition to the traditional prism associated with the type of financing used (the quality of debt associated with maturity) and the need for funds of operations arising from the operating cycle (claimants operating debt). Furthermore, we observe whether these control mechanisms help to mitigate informational asymmetries, making investment in innovation more efficient (Cutillas & Sánchez, 2014). In this sense, while innovation can be seen in times of crisis as a way to survive the market and maintain or improve competitiveness in other scenarios, the OECD (2012) shows that the most innovative companies have been affected by a collapse of the consumption of their 'new' products and must address these uncertainties, perhaps as a result of overinvestment policies.

This research contributes to the existing literature by presenting empirical evidence on the effect of the capital structure and debt on innovation investment in the context of an industry (agri-food) and a country (Spain) where approximately 30% of agri-food companies have a negative self-financing level of EUR 100,000 as the losses accumulated through their economic activity. This situation is particularly serious for 55% of these companies because they are in an unstable situation, presenting negative net worth. Unstable companies are micro-enterprises that have an inadequate capital structure as a result of the reduced common stock, EUR 32,860. The rest of the companies with negative self-financing are in a stable position resulting from the common stock amounting to EUR 375,886.

In addition, 86% of agri-food companies have liquidity problems, having to resort to third-party financing to satisfy the obligations arising from the operating cycle. Accordingly, 58.43% of companies with liquidity problems are over-indebted, with low-quality or short-term debt. On the other hand, 4.46% of companies without liquidity problems experience over-indebtedness to undertake expansion strategies. In addition, agri-food companies have a very low average economic return (1.7%), because the margin on sales is negative (-0.2%) which is indicative of a non-optimal cost structure, and an asset rotation of 2,055.

In this context, agri-food companies prefer to use equity to finance innovation projects, mainly through current common stock, due to the problems of negative self-financing that characterise this industry. This situation is aggravated by liquidity problems due to the need for funds of operations, and all of this leads companies to access

external financing in the short term. This financial structure mitigates overinvestment. In addition, and contrary to the theoretical hypotheses, we contrast the idea that the capital structure is also a useful mechanism to control underinvestment, which is characteristic of SMEs. This effect is also relevant due to the nature of this industry's operations and that it traditionally has little predisposition to be innovative. These results differ according to the business size and the agri-food subsector in which the company operates.

Material and methods

Sample and data resources

The information used was obtained from SABI by downloading the Balance Sheets and the Income Statements as of 31 December in the financial years 2008 to 2017 of companies engaged in the agri-food sector. SABI is a database of Bureau van Dijk that contains the accounting information of all Spanish firms that deposit their annual statement in the registry according several business laws.

We downloaded information from 159 CNAE tree-digit-codes and grouped them into four activities according to ICEX (2017). As can be seen in Fig. 1, the agri-food system comprises the activities of the primary sectors (agriculture and livestock) and processing industry as the first links of the agri-food chain, and there is a strong relationship with suppliers and services. The distribution companies (transport and wholesale) and those responsible for the retail marketing of products and the provision of catering services are the final link in the chain, establishing the direct link with the final consumer.

The time period was selected according to the standard of uniformity of the accounting information contained in the financial statements used in the analysis. Thus, because the current accounting regulations, the PGC (Spanish General Accounting Plan), were implemented in 2008, this date determines the beginning of the study period as the annual accounts of previous years are not homogeneous in terms of masses heritage. The completion year

of 2017 stems from it being the last year with information available as of the date of data download.

The population corresponds to 2,600,000 Spanish companies for which financial data are available in the SABI. In the first phase of selection, the 224,050 companies in the agri-food sector that appeared in the database during the period 2008–2017 were identified. Subsequently, information was downloaded from active agri-food firms, companies that had a total asset and net amount of sales figure different from 0 in 1 of the years analysed. The observations for which some measures had missing values were then deleted, and those with extreme values for the variables of interest (*i.e.*, outliers) were also removed. In addition, companies for which their CNAE code was not available were deleted. After this process, the sample comprised 490,856 observations from 45,196 Spanish companies in the agri-food sector for the period 2008–2017.

The information for each company was required to refer to a minimum of three consecutive years to have a data panel with reduced analysis bias resulting from the business turbulence associated with the onset and extinction of companies in the period under investigation. In addition, the requirement of three years is associated with the need for a minimum period of time to control for unobservable heterogeneity and correct endogeneity problems in the analyses. Thus, the final sample contains 41,109 companies (364,020 observations), forming a panel of companies that is not complete (unbalanced panel) in the sense that the information is not available for all the companies in all the years analysed.

Research hypothesis

Innovation promotes greater productivity and competitiveness, but making such investments requires an adequate financing policy. Previous scholars posit that R&D investment is negatively (positively) associated with leverage (the capital structure) because innovation creates primarily intangible assets that are not good collateral (Simerly & Li, 2000). In the agri-food sector, the effect of the financial structure on innovation is realised by
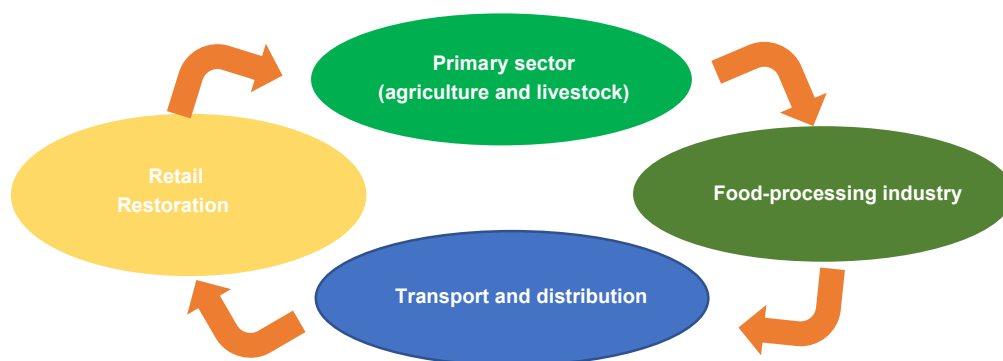

Figure 1. Phases of the agri-food system

taking an indirect approximation of the indebtedness effect associated with business size. Thus, some authors find that the larger the business size, the greater the degree of innovation due to better access to human capital and financial resources (Karantininis *et al.*, 2010; Bayona *et al.*, 2013; Hirch *et al.*, 2013). However, other work highlights the innovation capacity of SMEs thanks to their greater flexibility and adaptability to changes (Bayona *et al.*, 2001; Maravelakis *et al.*, 2006; Alarcón & Sánchez, 2013).

In this sense, our proposal aims to analyse the advantages and disadvantages associated with the financial and capital structure for the innovation strategies of agri-food companies. In this regard, various theories about capital structure are proposed in the literature and numerous studies try to analyse the factors that determine companies' level of indebtedness (Pindado *et al.*, 2011, 2017). However, there is insufficient evidence regarding the effects that indebtedness has on other business dimensions, such as the degree of innovation.

Among the main corporate capital structure theories, the pecking order theory and trade-off theory are the most common. According to the first theory (Myers & Majluf, 1984), companies that need to undertake new investments are turning firstly to self-financing, secondly to debt and thirdly to common stock. Financial preferences have been observed in several papers (*i.e.*, O' Brien, 2003; Capizzi *et al.*, 2011; Bartolini, 2013), although other authors (*i.e.*, Hall, 1992; Vicente-Lorente, 2001; Hsu *et al.*, 2014) evidenced a negative impact of debt in R&D investment given the high risk associated to an intangible project, what causes that creditors apply higher borrowing costs (Capizzi *et al.*, 2011; Bartoloni, 2013).

In addition, the second of the theories indicates that, to understand the capital structure of companies, other issues must be considered. For example, on the one hand, indebtedness has tax advantages in reducing the payment of taxes. On the other hand, a high level of indebtedness can lead to financial insolvency proceedings. For these reasons, the static balancing theory proposes that there is an optimal level of indebtedness to which companies aspire (de Miguel & Pindado, 2001).

For SMEs, which are normally managed by their owners, according to Hutchinson's arguments (1995), the adequacy of the financial and capital structure in relation to investment policies is more complex. On one hand, firms avoid using debt contracting due to this option involving the monitoring of the company by financial institutions. On the other hand, these corporations show an aversion to increasing the current common stock that may lead to the entry of new owners, as it dilutes the power of the current owners. Therefore, taking into account the fact that SMEs could present important limitations on increasing equity from funds provided by the current owners,

they can lead to the self-generation of internal funds becoming the policy for financing investment projects that are more suited to their interests (De Massis *et al.*, 2018).

Empirically, previous papers note that corporate investment in physical capital depends to a large extent on the capacity to generate internal funds or self-financing (Pindado & de la Torre, 2009; Pindado *et al.*, 2011) and the self-financing capacity by SMEs is usually not sufficient to meet the necessary investment funds, so it is fundamental to enjoy a good level of current common stock to undertake innovation projects due to (i) the discretion arising from the use of owners' funds is greater in the face of the reissuing of accounts to lenders and (ii) the intangible nature and high risk of investments in innovation that provoke restrictions in the access to finance. In this regard, we establish the first hypothesis of the paper:

H1: Spanish agri-food companies will use equity – current common stocks and self-financing – to undertake innovation projects.

In addition, following García-Sánchez & García-Meca (2018), it is necessary to take into account the efficiency of innovations investment as less able managers could overinvest (implement projects with a negative NET) or underinvest (reject projects with a positive NET). These decisions, according to agency theory, could be corrected by the presence of debt in the capital structure as banks are specialised institutions in the supervision of borrowers (Petersen & Rajan, 1994). Therefore, debt could be a discipline or control mechanism aimed at a more efficient use of financial resources as a consequence of the effects associated with the risk of bankruptcy in highly leveraged firms and the higher control over the discretionary use of cash flow that guides companies to only finance investment opportunities with positive net present value (Singh & Davidson, 2003).

Spanish businesses[1] are characterised by presenting financial leverage close to 60% (Cutillas & Sánchez, 2014) and 76% of these external funds expire in the short term, so the quality of the indebtedness is quite low (CES-CyL, 2018). However, in line with the previous agency arguments, the shortening of the debt maturity allows for more comprehensive control over management decisions, as it requires continuous renegotiation and may lead to changes in the initial conditions of debt contracts. In other words, short-term debt use will help to control underinvestment and overinvestment, as it allows greater financial flexibility for borrowers and greater control by lenders (Cutillas & Sánchez, 2014). Therefore, we posit our second hypothesis:

H2: Spanish agri-food companies with a financial structure characterised by a larger volume of

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[1] For a more complex financial analysis of Spanish agri-food systems, see García-Sánchez (2021).

short-term debt will undertake more efficient innovation projects.

Moreover, we have mentioned that Spanish businesses present serious liquidity problems arising from the need for funds of operation (NOF) being higher than the working capital (Baños *et al.*, 2016) and resort to the use of short-term debt as a source of current asset financing due to the difficulty in obtaining long-term financing (Peters *et al.*, 2013). This is because the payment terms for suppliers and creditors are longer than the expiration of receivables. These NOFs will adversely affect innovation strategies in the agri-food sector, leading to underinvestment because funds cannot be allocated to profitable projects when used in the financing of current assets. In addition, underinvestment is a severe problem for small companies (MacMahon, 2003) due to the concentration of decision making and monitoring of the owner figure, a duality that makes it difficult to consider different points of view and involves less specialisation (Danielson & Scott, 2007). Therefore, we establish the last hypothesis of the paper:

H3: Spanish agri-food companies with liquidity problems underinvest in innovation.

Models and econometric procedures

To test the proposed hypotheses, the following analysis models were proposed in which the independent variables are 'Leverage' in Model 1 and 'CommonStock', 'Self-financing', 'Debt_Maturity' and 'Liquidity_Problem' in Model 2. Model 1 was designed to evaluate the first hypothesis, H1, concerning the effect of the capital structure on the investment in innovation projects and the investment efficiency. Model 2 aimed to test the validity of H2 and H3, deepening the analysis of H1.

$INV_{i,t+1} = \beta_0 + \beta_1 Leverage_{i,t} + \beta_2 Size_{i,t} +$

$\beta_3 ROA_{i,t} + \beta_4 Growth_{Opportunities_{I,t}} +$ [Model 1]

$\beta_5 Age_{I,t} + \beta_6 Cash_{I,t} + \beta_7 Loss_{I,t} + \beta_8 Inventory_{I,t}$

$+ \beta_9 Subsector_i + \beta_{10} Year_t + \beta_{11} Crisis_t + \eta_i + \mu_{it}$

$INV_{i,t+1} = \beta_0 + \beta_1 CommonStock_{i,t}$

$+ \beta_2 Self\text{-}financing_{i,t} + \beta_3 Debt\_Maturity_{i,t}$

$+ \beta_4 Liquidity\_Problem_{i,t} + \beta_5 Size_{i,t}$

$+ \beta_6 ROA_{i,t} + \beta_7 Growth\_Opportunity_{i,t}$ [Model 2]

$+ \beta_8 Age_{i,t} + \beta_9 Cash_{i,t} + \beta_{10} Loss_{i,t}$

$+ \beta_{11} Inventory_{i,t} + \beta_{12} Subsector_i + \beta_{13} Year_t$

$+ \beta_{14} Crisis_t + \eta_i + \mu_{it}$

where the notational term INV is expressed by two different dependent variables, 'Investment' and 'Optimal_Investment', i identifies company 1 to company 41,109, t takes values for the years 2008 to 2017, β represents the coefficients to estimate, η, represents unobservable heterogeneity, and µ the error term. The definitions of variables are listed in Table S1 [suppl.].

Regression models were proposed to take into account dependency techniques for panel data and methodologies that strengthen the power and explanatory capacity as well as the consistency, which are all associated with the period analysed; to control the specific characteristics of each company that remains unchanged in the period analysed or unobservable heterogeneity; and to facilitate a dynamic study of companies and reduce the aggregation bias that arises when time series analyses are used to characterise the behaviour of individuals. Specifically, for the variable 'Investment', we used the two-stage dynamic estimator proposed by Arellano & Bond (1991), based on the generalised method of moments. For the 'Optimal_Investment' variable, due to its dichotomist nature, we employed a logit regression. In both regressions, we employed two lags for the independent variables to avoid endogeneity problems as previous papers have evidenced in the management and business field. These lags refer to the instrumental variables introduced in the Generalised Method of Moments (GMM) procedure and the inclusion of independent variables in t-2 in logistic regression. To avoid any pattern of multicollinearity, heteroskedasticity and autocorrelation within panel regression models, the robust command is used for the GMM estimator. For logistic regression, we required that the eigenvalues would be close to 0, indicating that the predictors are highly intercorrelated.

The goodness of fit of the logistic regressions was determined by the Log-Likelihood and the Wald test of the joint significance of the coefficients obtained, distributed asymptotically as χ^2 under the null hypothesis of no relation. In addition to the Wald test for GMM, we estimate two serial correlation tests of order i that use first-difference residuals, distributed asymptotically as N (0.1) under the null hypothesis of no serial correlation and the Hansen test of over-identification restrictions, distributed asymptotically as χ^2 under the null hypothesis of no correlation between the instruments and the error term.

The first variable of analysis is 'Investment', which, following Biddle *et al.* (2009), is defined as the sum of investment in innovation in capital goods and other intangible assets minus cash from sales of similar elements, multiplied by 100 and scaled by the total assets. Second, we proposed an abnormal investment proxy, *Optimal_Investment*, which is obtained from the residuals of a firm-specific deviation from optimal investment, calculated by estimating an industry–year model of investments as a function of growth opportunities (as measured by the

percentage change in sales from year t-1 to year t). The model is described as follows:

$$\text{Investment}_{i,t+1} = \beta_1 \text{SalesGrowth}_{i,t} + \mu_{it} \qquad \text{[Model 3]}$$

However, the previous measure could not be considered as a dependent variable due to this residual identifying different deviations (negative and positive) from the optimal investment, so we ranked this measure in quartiles and rescaled the quartile rankings from 0 to 4. Firm–year observations in the middle quartile are considered to be the optimal investment. Firm–year observations in the bottom quartile (*e.g.*, the most negative residuals) are classified as underinvestment. Observations in the top quartile (*i.e.*, the most positive residuals) are classified as overinvestment.

The independent variable 'Leverage' of Model 1 represents the capital structure and is measured using the ratio total debt to total assets. It is recommended that it should be between 0.5 and 0.6, reflecting a balance in the use of equity and liabilities in the financing of the economic structure. The breakdown of this variable in Model 2 entails the incorporation of the independent variable 'Debt_Maturity', determined as the degree of short-term enforceability of the debt and measured using the current to total liabilities ratio. Its value must be between 0 and 0.5, indicating that the maturity of most of the debt is long term, while, if the value is greater than 0.5 and close to 1, all debts are enforceable in less than a year. To represent the volume of equity, we incorporated the variables 'CommonStock' and 'Self-financing', measured as the logarithm of common stock and the accumulated retained earnings, respectively, relativised by the total assets. 'Liquidity_Problem' is a dummy variable that takes the value 1 if the company has liquidity problems, 0 otherwise. It is determined by the negative difference between the working capital (current assets minus current liabilities) and the need for funds of operations or NOF (Stocks + Receivables + Operating Treasury – Spontaneous Liabilities). If the working capital is lower than the NOF, it implies that the company does not have sufficient liquidity to meet its operational needs and has to resort to external financing to meet the payment of obligations for commercial operations. In the other case, the company is meeting its operational needs without resorting to other financing as well as enjoying financing through operating debts that do not usually involve explicit costs.

Finally, a series of control variables were included to avoid biased results based on previous studies (García-Sánchez & García-Meca, 2018): 'Size', the logarithm of total assets; 'ROA' or economic profitability; 'Growth_Opportunities' determined as the year-on-year variation in sales over the period; 'Age', the logarithm of the age of the company; 'Cash', the standard deviation of the cash flows from t-2 to t; 'Loss', a dummy variable that takes the value 1 if the ordinary result before extraordinary income and expenses is negative and 0 otherwise; and 'Inventory', the duration of the operating cycle. In addition, we control the subsectors, the time period and the time of crisis. For the first two variables, we used categorical measures that represent the four activities in the agri-food industry and each year in the period 2008–2017. The crisis variable is a dummy that takes the value of 1 if t=2008 to t=2012, 0 otherwise.

Results

Agri-food systems in numbers: Descriptive statistics

Table 1 shows the descriptive statistics for the variables used in the analysis. The analysis of the capital structure of the companies, Panel A, allowed us to identify 20% of agri-food companies as being in an unstable position, presenting negative net worth as a result of the losses arising from their economic activity. In addition, among the companies with a stable position, 16.26% have a negative self-financing level of approximately EUR 100,000. Looking more closely at Panel B, we can say that the difference between companies with an unstable position and companies with a stable position with negative self-financing is a capital structure problem arising from the reduced common stock.

In Panel C, it can be noted that the annual investment rate relative to the total assets is 3.70%. This investment is optimal for 41.13% of companies in the agri-food sector, while 37.31% of these companies overinvest and 21.56% underinvest. On average, agri-food companies have high financial leverage (0.722). Regarding debt maturity, about 73% of the payable liability expires in the short term, indicating a low debt quality given the proximity of maturity in stable and unstable situations. For a more complex financial analysis of Spanish agri-food systems, see García-Sánchez (2021).

Capital structure and innovation investment

Table 2 presents the results obtained for the proposed Models 1 and 2 to test the research hypotheses. In relation to the variable 'Leverage', it can be observed that it is not significant in the estimated model for innovation investment (coeff. = – 0.00457; p = 0.252), showing a negative significant effect in the level of efficiency of innovation investment (coeff. = – 0.017; p = 0.000). These results indicate that companies with a smaller volume of equity (higher leverage) undertake less optimal innovation projects because they underinvest and do not earmark funds for investments with a positive NET.

Table 1. Descriptive statistics of the Spanish agri-food industry. SD: standard deviation

Panel A. Balance positions

		Frequency	
		2008–2017	**2017**
Stability		**79.96%**	**83.86%**
Maximum stability A = E; L = 0 **Stability** A = E + L	The company´s assets (A) is fully financed with its equity (E); there are no liabilities (L). The company is financed with indebtedness and equity at different levels.		
Instability		**20.041%**	**16.14%**
Equivocal position A = L; E = 0	The company is fully financed by debt.	0.001%	0.00%
Unstable or abnormal position A + E = L	Indebtedness is higher than the assets.	20.04%	16.14%
Maximum instability E = L; A = 0	The company has no assets and is entirely indebted.		

Panel B. Descriptive for current common stock and self-financing according to the balance position

	Stability		Stability with negative self-financing		Instability	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
2008-2017						
CommonStock	184.419	566.056	375.886	822.517	32.680	173.017
Self-financing	321.874	964.849	-94.334	-193.455	-114.470	-170.651
2007						
CommonStock	189.527	575.266	447.327	898.224	32.697	170.208
Self-financing	381.853	1034.013	-111.152	-211.094	-115.969	-177.361

Panel C. Descriptive numerical variables

Magnitudes/rates	Global		Stability		Instability	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Investment	0.370	0.297	0.365	0.294	0.389	0.307
Leverage	0.722	0.359	0.594	0.276	1.231	0.126
Debt_Maturity	0.733	0.294	0.734	0.292	0.727	0.302
CommonStock	-2.802	1.621	-2.784	1.648	-2.873	1.503
Self-Financing	-1.685	1.299	-1.685	1.299	0.000	0.000
NOF	4.250	1.744	4.466	1.694	3.220	1.610
Size	5.640	1.583	5.860	1.556	4.760	1.369
ROA	0.017	0.105	0.028	0.094	-0.026	0.133
Growth_Opportunities	0.033	0.228	0.037	0.225	0.018	0.238
Age	2.318	0.823	2.359	0.818	2.156	0.824
Cash	0.087	0.098	0.088	0.966	0.080	0.101
Inventory	4.656	2.209	4.758	2.200	4.244	2.196

Panel C. Descriptive numerical variables

Magnitudes/rates	**Global frequency**	**Stability frequency**	**Instability frequency**
Optimal_Investment	41.13%	42.16%	36.99%
OverInvestment	37.31%	37.25%	37.56%
Underinvestment	21.56%	20.58%	25.45%
Liquidity_Problem	86.48%	84.18%	95.64%

Table 2. Dependency models for the analysis of the capital structure and innovation in the agri-food sector. Models include the coefficients and standard error in brackets.

	Investment		Optimal_Investment	
	(1)	**(2)**	**(1)**	**(2)**
Leverage	-0.00457		-0.017***	
	(0.00399)		(0.00287)	
CommonStock		0.127***		0.0257***
		(0.0114)		(0.00501)
Self-Financing		0.000519		0.00538
		(0.00156)		(0.00560)
Debt_Maturity		-0.0777***		0.167***
		(0.00634)		(0.0234)
Liquidity_Problem		0.0271***		0.113***
		(0.00209)		(0.0182)
Size	0.0490***	0.192***	0.0942***	0.115***
	(0.00634)	(0.0140)	(0.00454)	(0.00600)
ROA	-0.00271***	-0.000992	0.0122***	0.0223**
	(0.000641)	(0.00223)	(0.00299)	(0.00893)
Growth_Opportunities	1.95e-06	1.77e-05	-0.786***	-0.965***
	(1.99e-05)	(1.84e-05)	(0.0122)	(0.0167)
Age	-0.0168***	-0.0266***	0.511***	0.501***
	(0.00281)	(0.00410)	(0.00874)	(0.0109)
Cash	-0.196***	-0.178***	-0.0394***	-0.0797***
	(0.00394)	(0.00472)	(0.0149)	(0.0190)
Loss	-0.0292***	-0.0280***	-0.523***	-0.526***
	(0.00777)	(0.00924)	(0.0109)	(0.0145)
Inventory	-0.0225***	-0.0192***	-0.136***	-0.158***
	(0.00104)	(0.00123)	(0.00298)	(0.00385)
Subsector	0.000	-0.00575***	0.284***	0.0414***
	(0.000)	(0.000418)	(0.00559)	(0.00426)
Year	-0.0042***	0.000	0.0361***	0.294***
	(0.000344)	(0.000)	(0.00348)	(0.00681)
Crisis	-0.000379	-0.00159**	0.0886***	0.117***
	(0.000646)	(0.000761)	(0.0175)	(0.0217)
Constant	0.000	0.000	-74.52***	-85.19***
	(0.000)	(0.000)	(-7.005)	(8.573)
Log-Likelihood			-177886.0	-119490.67
Wald-test (Logistic)			14526.52***	10056.34***
Wald-test (GMM)	4059.31***	2510.04***		
m_1	-3.21	-2.30		
m_2	-5.68	-5.29		
Hansen	1375.14	753.74		

m_1 is the first-order serial correlation test in the difference residual, distributed asymptotically as N (0.1) under the null hypothesis of no serial correlation; m_2 is the second-order serial correlation test in the difference residual, distributed asymptotically as N (0.1) under the null hypothesis of no serial correlation; *Hansen* is a test of over-identification restrictions, distributed asymptotically as χ^2 under the null hypothesis of no correlation between the instruments and the error term. * $p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

To deepen the analysis of the capital structure with which companies in the agri-food industry prefer to undertake innovation projects, in Model 2 we can see that a greater volume of companies' common stock leads to higher investment rates in innovation projects ('CommonStock' in 'Investment': coeff. = 0.127; $p = 0.000$) and selecting these projects efficiently ('CommonStock' in 'Optimal_Investment': coeff = 0.0257; p = 0.000). However, the accumulated retained earnings by the company, the variable 'Self-financing', are not significant in any of the estimated models ('Investment': coeff. = 0.000519; $p = 0.739$; 'Optimal_Investment': coeff. = 0.00538; $p = 0.337$). The results obtained for the 'Investment' variable confirm the arguments of our first hypothesis, regarding the preference of smaller companies to use their own resources for the financing of innovation projects. However, the provenance of these resources affects the efficiency of the ongoing investment differently. In this sense, the agri-food companies with the largest contributions of funds from their owners undertake more efficient innovation investments, correcting the trend towards underinvestment that characterises smaller companies and that take place for 21.56% of the companies in our sample (MacMahon, 2003). Conversely, the self-financing of innovation projects with accumulated retained earnings has no effect on the level of investment efficiency, perhaps as a result of the accumulated losses in this sector.

With regard to the H2 scenario, concerning the monitoring role that the maturity of the financing from others may play in underinvestment and overinvestment decisions, it can be observed in this regard that, although it reduces the monetary amount earmarked for innovation (coeff. = – 0.0777; $p = 0.000$), it leads to optimal investments (coeff. = 0.167; $p = 0.000$), avoiding overinvestment. These results confirm our H2 scenario regarding the role of monitoring debt maturity in decisions that are made in a concentrated manner in small businesses, concretely, discretionary decisions in projects with a negative NET that affect 37.31% of our sample.

Regarding the H3 scenario, contrary to what was expected, we note that companies with higher needs for funds of operations undertake more efficient investments (coeff. = 0.113; $p = 0.000$), allocating more funds to innovation projects (coeff. = 0.0271; $p = 0.000$). Therefore, we reject the proposed H3 scenario in which we expected liquidity-challenged companies to take underinvestment innovation decisions.

Regarding the control variables, the results show that the largest agri-food companies allocate more funds to innovation projects, selecting them efficiently. The most profitable and older firms show a greater aversion to innovation, without leading them to underinvest. The losses from economic activity and the associated necessary average inventory enhance the underinvestment in innovation in the agri-food sector. This situation is partially extendable to

companies with greater opportunities for growth, which do not undertake the investment in innovation necessary for their growth status. These results partially confirm previous evidence from the studies by Cutillas & Sánchez (2014) and García-Sánchez & García-Meca (2018).

Preferences according to subsector of activity

In this context, and unlike the approach taken in previous studies, this work considers that, in the field of agri-food, it is necessary to differentiate between: (i) agricultural crops and livestock holdings, which fall within the primary sector; (ii) the food-processing industry, which is part of the secondary sector; (iii) the wholesale distribution sector; and (iv) the retail and catering sector, which the tertiary sector encompasses. This differentiation is necessary because the capital structure depends on the purpose and scope of the business. It is also necessary to take into account the power of each agent in the supply chain, especially that of companies in the distribution sector (Trebbin, 2014), as this can influence the most recommended innovation for production units in the other phases of the production process.

By groups of subsectors of activity, as shown in Fig. 2, companies that carry out commercial activities and services and are engaged in the retail trade of agri-food products and catering account for 46.51% of the agri-food system. This is the group of activities that has experienced an initial increase and the largest reduction in the number of companies in the last two years because the majority of companies in this subsector are micro-enterprises. Of the companies analysed, 20.41% carry out primary activities related to agricultural crops and livestock farms, 11.86% are engaged in the agri-food-processing industry or production activities that are part of the secondary sector and 21.23% conduct transport and distribution activities for agri-food products.

Table 3 summarises the results obtained for an analysis of subsamples based on the activity subsector in which the companies that configure the agri-food system operate. In this regard, in Panel A, it can be observed that, in relation to the volume of funds earmarked for innovation projects, the results are common to those obtained in the overall analysis. Meanwhile, it is apparent that, in the case of the tertiary sector – the subsectors of wholesale distribution, retail trade and restoration – self-financing is used to undertake innovation projects. In relation to the results for the investment efficiency, Panel B, these are only maintained for the tertiary sector, lacking significance in the primary and production subsectors. Therefore, the capital structure of the primary, industrial and commercial firms could influence the innovation of this industry, but it is not a guarantee of more efficient innovation investments. Both effects only occur in the tertiary sector.
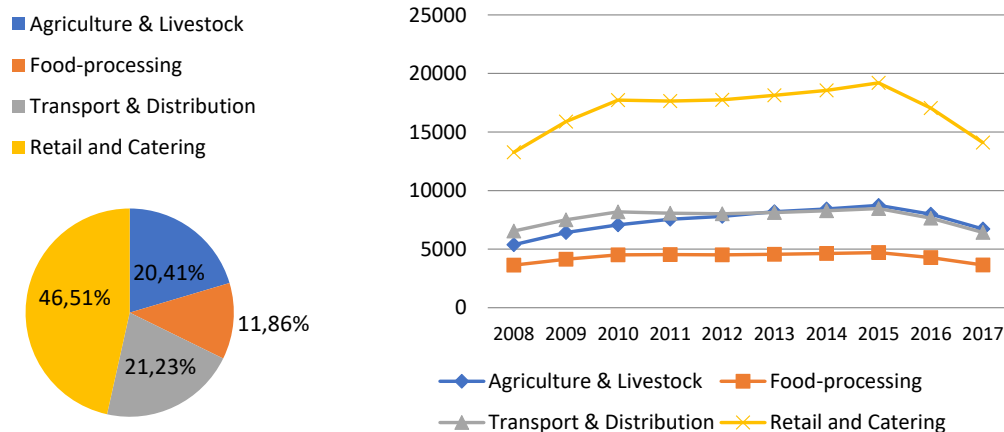
Figure 2. Distribution of observations by subsectors

Preferences according to firms' size

On the other hand, the results obtained for the variable size generate interest in the effect of the financial and capital structure on innovation according to the size of agri-food companies. On average, the economic investment of agri-food companies is around EUR 1 million (EUR 1,048,033) within a range of more than EUR 2.5 million (EUR 2,692,972). We decided to categorise these companies into three sizes. In Fig. 3, it

can be seen that 86.18% of agri-food businesses are micro-enterprises, that is, companies with fewer than 10 workers, total assets less than or equal to EUR 1 million and a total income of less than or equal to EUR 2 million. SMEs – companies with fewer than 50 workers, total asset less than or equal to 4 million and a total income less than or equal to EUR 8 million – account for 12.02% and large companies for 1.80%. The sectoral composition dimension is constant over time for SMEs and large companies. However, although the number of

Table 3. Dependency models for the analysis of the capital structure and innovation in the agri-food sector: Complementary analysis I at the subsector level. Models include the coefficients and standard error in brackets.

	Agriculture & Livestock	Food-processing	Transport & Distribution	Retail and Catering
Panel A. Results para Investment				
CommonStock	0.06259***	0.07194***	0.067484***	0.10356***
	(0.01778)	(0.01850)	(0.01459)	(0.02055)
Self-Financing	0.00353	0.00174	0.00608***	0.003715**
	(0.00258)	(0.00372)	(0.00146)	(0.001826)
Debt_Maturity	-0.0709***	-0.0831***	-0.15285***	-0.05580***
	(0.01100)	(0.01659)	(0.01292)	(0.00909)
Liquidity_Prob.	0.0257***	0.03431***	0.01671***	0.029433***
	(0.00424)	(0.00641)	(0.00345)	(0.003169)
Panel B. Results for Optimal Investment				
CommonStock	-0.00220	0.021654	0.03464***	0.023638***
	(0.00890)	(0.015498)	(0.011148)	(0.007814)
Self-Financing	0.01073	0.024304	0.000344	-0.007932
	(0.01142)	(0.01788)	(0.01264)	(0.007947)
Debt_Maturity	-0.00101	0.10579	0.30945***	0.29301***
	(0.04466)	(0.07480)	(0.05814)	(0.033652)
Liquidity_Prob.	0.06611*	0.03432	0.15989***	0.08892***
	(0.03564)	(0.06015)	(0.03928)	(0.027046)

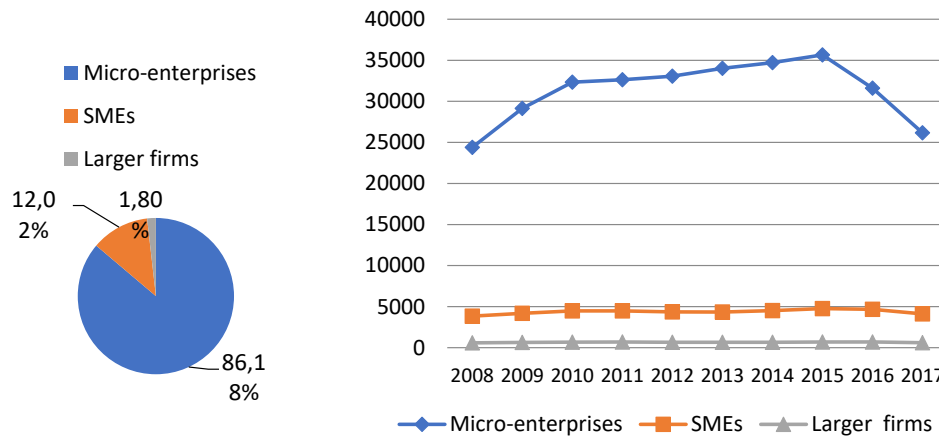* $p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Figure 3. Distribution of observations by size

micro-enterprises is increasing, particularly between 2008 and 2010, in 2016 and 2017 they experienced a significant decline in the number of micro-enterprises to levels close to those in 2008. This decline must be associated with the demise of these companies because it does not translate into increments in other categories of business size.

Table 4 presents the results obtained for the subsamples based on firm size that make up the agri-food system. In this regard, in Panel A, it can be observed that,

in relation to the volume of funds earmarked for innovation projects, the results are similar to those obtained in the global analysis for micro-enterprises and SMEs. It is apparent that, in the case of large companies, the financial and capital structure has no statistically significant effect on the decision to undertake innovation projects. In relation to the results for the investment efficiency, shown in Panel B, these are only maintained for micro-enterprises, presenting divergences in the role of liquidity and self-financing in other companies.

Table 4. Dependency models for the analysis of the capital structure and innovation in the agri-food sector: Complementary analysis II by firms size. Models include the coefficients and standard error in brackets.

	Micro-enterprises	SMEs	Larger firms
Panel A. Results for Investment			
CommonStock	0.15443***	0.03346***	0.00228
	(0.01713)	(0.01183)	(0.1003)
Self-Financing	0.00105	0.005296	0.001536
	(0.001624)	(0.003504)	(0.00366)
Debt_Maturity	-0.08753***	-0.09368***	-0.036155
	(0.00675)	(0.013982)	(0.02898)
Liquidity_Pro.	0.029913***	0.017597***	0.008516
	(0.002467)	(0.003871)	(0.006693)
Panel B. Results for Optimal_Investment			
CommonStock	0.021558***	0.028232***	0.071755*
	(0.005745)	(0.010255)	(0.03878)
Self-Financing	-0.002299	0.042904***	0.17025**
	(0.005947)	(0.015716)	(0.06655)
Debt_Maturity	0.12422***	0.11784*	1.53398***
	(0.02503)	(0.065075)	(0.29854)
Liquidity_Pro.	0.122281***	0.036126	0.07702
	(0.020176)	(0.04431)	(0.17457)

* $p < 0.10$; **p < 0.05; ***p < 0.01.

Discussion

Empirically, we found evidence that the Spanish agri-food system has a structure based on micro-enterprises, companies with fewer than 10 workers, total assets less than or equal to EUR 1 million and total income less than or equal to EUR 2 million, representing 86.18% of agri-food businesses. SMEs, companies that quadruple these numbers and have between 10 and 50 employees, account for 12.02%. Companies that exceed the latter figures, classified as large companies, account for 1.80%. By sector of activity, 46.51% of the agri-food industry is engaged in retail trade of agri-food products and catering, 21.23% in distribution activities of agri-food products, 20.41% in primary activities related to agricultural crops and livestock farms and 11.86% in the agri-food processing industry or production activities that are part of the secondary sector.

Spanish agri-food companies undertake innovation projects by financing these investments through their own resources, mainly from common stock from the owners, independent of these companies' capacity to generate internal funds. This may be conditioned by the problems of severe negative self-financing presented by this sector in Spain – 30% of agri-food companies have a negative self-financing level of EUR 100,000 due to the losses accumulated by economic activity – making it difficult to use accumulated retained earnings as a source of financing for new investments. However, this financial situation leads to common stock determining the level of efficiency of investments in innovation.

In addition, the previous situation causes these companies to resort to third-party financing, conditioning access to debt with short-term maturity that requires continued renegotiation. The financing characteristics of others lead to the investment in innovation undertaken by agri-food companies being more efficient, correcting overinvestment decisions. In addition, liquidity problems in meeting their operational needs characterise 86% of the agri-food companies that make up our sample, reinforcing the disciplinary role of financing from others.

From a theoretical point of view, this paper confirms that agri-food companies have implemented innovation investment strategies to increase the quality of their products and the efficiency of their production processes, benefiting from the flexibility and adaptability to changes that small companies possess (*i.e.*, Bayona *et al.*, 2001; Maravelakis *et al.*, 2006; Alarcón & Sánchez, 2013). Although in line with papers such as those by García-Alvarez-Coque *et al.* (2014), these innovation projects are more significant as the size of companies increases. In addition, this research expands the empirical evidence contrasting the effect that the capital and financial structure has on these business decisions, contributing to the previous literature focusing on larger companies operating in other sectors of activity with a greater focus on innovation (Martinez & Briz, 2000; Calderón *et al.*, 2007; González-Moralejo, 2008; Gardó *et al.*, 2009; Karantininis *et al.*, 2010; Capitanio *et al.*, 2010; Lin, 2012; Hirch *et al.*, 2013; Bayona *et al.*, 2013).

In this sense, in accordance with Hutchinson's (1995) theoretical approaches, we confirm that Spanish agri-food companies, characterised by a small size, undertake innovation projects through financing mainly from current common stock, which allow them to maintain the concentration of power with the insiders of the companies, a situation that is reinforced by the limitation to credit access due to innovation creates intangible assets that are not usually accepted as collateral by financial institutions (Simerly & Li, 2000).

Unlike the results obtained by Pindado & de la Torre (2009) and Pindado *et al.* (2011) for physical capital investments, innovation does not depend on the ability to generate internal funds or self-financing. This may be conditioned by the problems of severe negative self-financing presented in this sector in Spain – 36.26% of agri-food companies have a negative self-financing level of EUR 100,000 as the accumulated losses due to economic activity are higher than the reserves provided, making it difficult to use accumulated retained earnings as a source of financing for new investments. This means that common stock determines the level of investment efficiency, correcting the usual trend of small enterprises underinvesting (MacMahon, 2003).

The previous situation causes these companies to resort to third-party financing, conditioning access to debt with short-term maturity that requires continued renegotiation (Scherr & Hulburt, 2001; Peters *et al.*, 2013) and more comprehensive control over managers in that they can lead to changes in the initial terms of debt contracts. These financing characteristics of others lead to the investment in innovation undertaken by agri-food companies being more efficient, a result that is in line with the findings obtained by studies carried out in other contexts and for other typologies (*i.e.*, Cutillas & Sánchez, 2014). Specifically, we note that it avoids the overinvestment that mainly occurs in the design of 'new' products due to the firms focus on new variants of agri-food products that are already being consumed by a saturated market that does not require any more input (OECD, 2012).

In addition, liquidity problems in meeting their operational needs characterise 86% of the agri-food companies that make up our sample, problems that Baños *et al.* (2016) reveal for other sectors of activity, reinforcing the disciplinary role of common stock farmers.

Our results contribute to the previous literature by confirming the arguments of the static equilibrium theory that suggests the need for an optimal level of indebtedness. In this regard, we found that the advantages associated with the use of third-party financing as a management

monitoring mechanism are effective in controlling behaviours in small undertakings with a concentration of power, correcting overinvestment trends. However, more efficient investments that alleviate underinvestment require a capital structure based on contributions from the owners of these companies, especially for projects associated with intangible assets that are not admitted as an endorsement by external funding providers.

From a practical point of view, the results obtained show the advantages of short-term debt maturity for SMEs as a mechanism that (i) allows the financing of funds of operations without harming the necessary investment to be undertaken and (ii) corrects over-dimension deviations as a result of the surveillance that financial institutions exercise over the firms in the annual debt renegotiation.

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