Spanish Journal of Agricultural Research
18 (3), e0109, 16 pages (2020)
eISSN: 2171-9292
https://doi.org/10.5424/sjar/2020183-16254
Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA)

RESEARCH ARTICLE

OPEN ACCESS

# Operating leverage and the cost of debt in European agri-food firms

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## Abstract

*Aim of study:* To analyse the effect that operating leverage exerts on the cost of debt of agri-food firms in Europe, both in isolation and indirectly through its other risk factors.

*Area of study:* We used panel data made up of 18,360 European firms from 2009 to 2016 (146,880 observations).

*Material and methods:* The data were extracted from the ORBIS database and EUROSTAT. The econometric approach was estimated by the Generalized Method of Moments.

*Main results:* The results obtained confirm that operating leverage or cost structure, in addition to affecting the cost of debt, also affects the relationship between that cost and other sources of risk. More specifically, indebtedness, size, specificity and age all affect the cost of debt to a greater or lesser extent, depending on the level of operating leverage of the company.

*Research highlights:* The main contribution was the study of the cost of external financing as a function of the cost structure, because this directly influences the competitiveness of companies in a key sector of the European economy. We also demonstrated the country effect, taking into account the different policies and practices regarding the assumption of risk by firms. The agri-food sector has been subject to special aid programs of research & development distributed unevenly across countries. If we add to this the national subsidy programs, the level of indebtedness is not a clear determinant of the cost of debt. The main determinant of that cost is the operating leverage.

**Additional key words:** operational risk; European countries; cost structure; research & development.

**Abbreviations used:** DOL (degree operating leverage); EU (European Union); GDP (gross domestic product); GMM (generalized method of moments); OLM (operating leverage measure); R&D (research & development); SME (small and medium-sized enterprises); VIF (variance inflation factor)

**Authors' contributions:** Both co-authors participated in all stages of the work, including the conception and design of the research, the creation of the database from the information source, interpretation of the data and statistical analysis, revision of the intellectual content and drafting of the paper.

**Citation:** Grau, A; Reig, A (2020). Operating leverage and the cost of debt in European agri-food firms. Spanish Journal of Agricultural Research, Volume 18, Issue 3, e0109. https://doi.org/10.5424/sjar/2020183-16254

**Received:** 18 Dec 2019. **Accepted:** 07 August 2020



**Funding:** The authors received no specific funding for this work.

**Competing interests:** The authors have declared that no competing interests exist.

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# Introduction

The risk assumed by the creditors of a firm depends on the internal characteristics of the firm, the sector of activity and the legal and economic environment of the country in which it operates. The firm characteristics that affect risk are determined by decisions about the financial structure and the asset structure. Decisions about the financial structure generate financial risk and decisions about assets generate operational risk. There is abundant literature that studies the effect of financial risk on the cost of debt and the profitability of the firm. However, the effect of operational risk and operating leverage has received little attention. Moreover, most of the research carried out to date on the effect of operating leverage on the risk and profitability of the firm has focused on firms listed on financial markets and has studied the effect on the betas and the expected returns of the firm's shares (Lev, 1974; Mandelker & Rhee, 1984; Zahng, 2005; García-Feijóo & Jorgensen, 2010; Houmes *et al.*, 2012; Cao, 2015; Novy-Marx, 2011).

This industry is characterised by being very competitive, with many small and young companies competing against larger and more mature firms. Other authors have also analysed the effect of operating leverage on this industry, but have focused on the profitability of Small and medium-sized enterprises (SMEs) (Grau & Reig, 2020). Given the importance of this industry in the European economy and the major drive towards innovation by its companies and governments, we consider it worthwhile to analyse whether the sector (including large companies and SMEs) has an adequate operating cost structure, or if, on the contrary, it generates too much operational risk, leading to higher financial costs, which in turn would negatively affect the sector's competitiveness in the global market.

The operational risk depends on the type of assets used by the firm in its production process, since these determine the cost structure or the operating leverage. Numerous papers use the ratio of fixed assets to total assets as a proxy for cost structure and operating leverage, arguing that high levels of fixed assets generate high fixed costs (O´Brien & Vanderheiden, 1987; Houmes *et al.*, 2012; Harjoto, 2017).

Operational risk also depends on the characteristics of the sector of activity, such as the concentration of the sector or the elasticity of demand. Therefore, if companies from different industries are analysed, operating leverage could not be used as the only variable indicating operational risk. However, if all companies belong to the same sector and share the same risk characteristics of the sector, operating leverage will be a good indicator of operational risk. Novy-Marx (2011) showed that the effect of operating leverage on the risk of the company is determinant within an industry, while no clear relationship is found when analysing it between industries. In short, we can affirm that within an industry, those companies that operate with a greater weight of fixed costs over variable costs will be riskier.

We directed our study towards only one sector, the agri-food industry, made up of companies dedicated to the second link in the agri-food value chain, that is, manufacturing firms involved in the transformation of raw materials into semi-processed or processed products. In addition, the importance of this sector can be seen from the reports provided by the *AgFunder* platform[1] (https://agfunder.com), which show that the agri-food industry attracts many private and institutional investors (venture capital). Given the innovation and the technological development that is transforming and modernising the sector, the emerging needs of the population are being addressed (AgFunder, 2014).

Finally, it is worth highlighting the consideration of the country effect, in which we first carried out the study for a sample of European companies, and then separate the countries with different practices and with different legal and economic environments with respect to the assumption of risks. To do this, we choose the countries with the highest average gross domestic product (GDP) in Europe in the period considered and with the greatest weight in the European agri-food industry[2].

Our goal is to analyse the importance of operational risk in determining the cost of debt in European agri-food firms, first in isolation and then indirectly through other risk factors such as indebtedness, size, specificity or age of the company. Regarding the relationship between operating leverage and the cost of debt, the results of the few investigations carried out show that it is positive, that is, the higher the operating leverage, the greater the cost that firms bear when financing themselves with external resources. An important factor that will determine whether this relationship is significant or not is the firm's institutional and legal environment. Greater protection of the investor will lead to more discipline on the part of the managers of the firm. Cleassens *et al.* (2000) demonstrate empirically that the legal, economic and institutional characteristics of a country affect the risk that firms are willing to assume and, therefore, the cost of debt. In countries where laws protect shareholders and investors to a greater extent (common law jurisdictions), firms assume lower risks, both financial and operational. These authors consider that the effect will be different depending on the sector and the type of assets and products, but, in general, they go so far as to conclude that the greater the protection of investor rights, the lower the level of optimal leverage.

La Porta *et al.* (1997) argued that countries with a "common law" origin are more efficient in the development of contracts and offer greater protection to external investors, both shareholders and creditors. These countries react more quickly to new situations and transmit much less uncertainty regarding the outcome of the resolution of a legal dispute. Other studies that examine the relationship between the legal environment and risk are those made by Simintzi *et al.* (2014) and Serfling (2016), who observed that rigid labour laws will lead to greater operational risk, decreasing the optimum level of indebtedness in order to offset one type of risk with another. Legislation is also important in terms of transparency and the requirement for the disclosure of information by firms. Francis *et al.* (2005) showed that firms that need more external financing must maintain more transparent accounts, which reduces asymmetric information and leads to cheaper financing.

Cleassens *et al.* (2000) also pointed to the question of whether the financial system is based on banking or on the markets as being determinative in the relationship

[1] It is a Venture Capital platform for Agri-Food Technologies that helps accredited and institutional investors to invest in the development of technologies that will transform the food and agricultural industries.

[2] Afonso (2003) showed that economic development and GDP per capita are the most relevant factors in determining country risk.

between risk and the cost of debt. These authors showed that in banking-oriented countries, firms assume greater risk as they are less controlled by the markets. Allard & Blavy (2011) concluded that economies based on financial markets recover faster from recessions than banking-oriented ones, so there is less risk involved when investing in firms in these countries. Depending on the development of the financial markets and the weight of the bank debt in the total debt of firms, countries are classified into one of two systems (Demerguc-Kunt & Levine, 1999; Allard & Blavy, 2011).

In this paper we carried out separate analyses for different European countries, since mixing together firms that operate in different legal and institutional environments can distort the results. In effect, the country will be decisive in terms of the impact that operating leverage has on the cost of debt in an isolated way, and also indirectly through other risk factors such as indebtedness, size, specificity and age. These four factors affect risk, since financial risk is greater if the level of indebtedness is higher, the creditor has less information when the firm is small and young, and the creditor has fewer guarantees if the specificity is greater. We consider these four risk variables to be crucial in an industry characterised by high levels of innovation and major investment in research & development (R&D) being made by a large number of small and young companies.

Regarding the relationship between debt level and operating leverage, it is expected that, in general terms, the most indebted firms will be those with the lowest operating leverage in order to offset the two types of risk: financial and operational. According to Kahl *et al.* (2014), firms with high levels of fixed operating costs are more conservative in their capital structure strategy, maintaining more liquidity and lower levels of indebtedness. However, firms use debt to increase fixed assets, which leads to higher fixed costs, such that greater indebtedness can be accompanied by greater operational risk (Harjoto, 2017).

Most of the studies that compare operating and financial leverage with the risk of firms do so with listed firms and take the beta as an indicator of systematic risk. Houmes *et al.* (2012) note a positive relationship between operating leverage and the beta of firms in the transport sector, reaching the conclusion that operating leverage is more important in the definition of systematic risk than financial risk. In fact, the level of indebtedness does not turn out to be significant to explain the beta.

Based on the foregoing, we considered that, in general, the level of indebtedness increases the cost of debt, but to a lesser extent if the firm assumes greater operational risk.

***Hypothesis 1:*** *The higher the operating leverage, the lower the positive relationship between the level of indebtedness and the cost of debt of agri-food firms.*

In terms of size, there is evidence that it affects the cost of debt (Harjoto, 2017). Francis *et al.* (2005) observed a negative relationship between the two variables. When the size increases, the risk, and therefore the cost of debt, decreases (Sengupta, 1998; Houmes *et al.*, 2012; Ylhäinen, 2017).

Indeed, smaller firms support higher debt costs because they have less bargaining power and more information asymmetry, but that relationship can be diminished if they have low operating leverage. In the same way, the greater the size, the greater the bargaining power, the greater the prestige and the less the asymmetric information, all of which will allow firms to finance themselves at a lower cost. That ratio will be lower if the operating leverage is higher, as the risk is greater.

Therefore, among large companies, those with greater operational risk will have a higher cost of debt. In short, we consider that, the larger the size, the lower the cost of debt, but the negative effect is diluted with the highest operating leverage.

***Hypothesis 2:*** *The higher the operating leverage, the lower the negative relationship between size and the cost of debt of agri-food firms.*

Third, we consider the specificity of the firm's assets. The weight of intangible assets, such as advertising or R&D, in fixed assets is an indicator of the degree of innovation and specificity of the company. Intangible assets include investments in R&D, industrial property, computer applications and goodwill. Other intangibles that do not appear in intangible assets are human, customer and organisation capital, and know-how. This type of investment is not easily observable or measurable for a large sample size of companies. To overcome this limitation, as noted by Dass *et al.* (2014), the empirical literature generally uses investment in intangible assets as a proxy for investment in specific assets and innovation[3]. Van Binsbergen *et al.* (2010) noted that the cost of debt is lower in firms with greater weight of tangible assets because, having more collateral, the creditor assumes less risk.

On the other hand, Hyytinen & Pajarinen (2007) found no relationship between specificity and cost of debt when carrying out the study with Scottish firms. They concluded that as they are governed by the "common law", they are less prone to take risks, and if they have a greater weight of intangible assets, that makes them riskier, which they will compensate for by having less debt.

[3] Other works published in prestigious journals that use this approach are Fee *et al.* (2006) and Kale & Shahrur (2007).

According to AgFunder (2016), given that it is the key to future growth, the need for technological innovation in this sector is now greater than ever. This reports for Agri-Food Technology indicate that the volume of financing granted through the Venture Capital Market platform between 2009 and 2013 remained constant at moderate levels. Starting in 2014, there was a turning point and it began to grow significantly (AgFunder, 2014), placing it well above other sectors of the economy, according to MatterMark (2014).

It can be seen that, by 2015, the figures were almost double those of the previous year, but at the end of the year the global investment in Agri-Food Technology went down. This contraction is explained by the fact that a lot of financing was obtained through venture-backed companies with the consequent risk of exposure to IPOs (Initial Public Offerings) (KPMG, 2015). From 2016 onwards, and in the face of political uncertainty, the venture capital market has fallen further, with funding for these companies dropping by 30%, although remaining above 2014 levels (KPMG, 2016). The forecasts point to a bright future for venture-backed companies given the growing interest of private and institutional investors in supporting the future of food and agriculture.

The agri-food industry is constantly innovating. As the agri-food sector has a major share of the European economy and is tremendously innovative, companies that innovate and invest in intangible assets usually receive some subsidy at the European and/or domestic level, which reduces the cost of financing (Grau & Reig, 2020).

Therefore, although in general terms it is expected that specificity increases the risk and the cost, this effect can be cancelled out or reversed depending on the institutional and legal environment of the country. Greater protections for the investor will lead to more discipline on the part of the managers of the company, lowering the level of optimal leverage, such that some risks will be offset against others. On the other hand, in countries that allocate greater subsidies to innovative companies, increased investment in R&D may be accompanied by cheaper financing.

Furthermore, greater innovation can generate higher operating leverage, since it involves investment in fixed assets. In this way, the cross effect is expected to decrease the direct effect between specificity and cost. In general terms, we state the third hypothesis in the following way:

> ***Hypothesis 3:*** *The higher the operating leverage, the weaker the relationship between the degree of specificity of the assets and the cost of debt of agri-food firms.*

Finally, we introduced age as another risk factor. More mature firms have a lower average cost of debt, which some authors explain as being due to their less asymmetric information (Berger *et al.*, 2001; Hernández-Cánovas & Martínez-Solano, 2010). In contrast, young firms have less negotiating power and the level of ignorance about them on the part of creditors is higher, which can cause greater difficulty in obtaining good financing conditions.

Indeed, age has been used in several corporate finance studies as an approximation of asymmetric information (Beck & Demirguc-Kunt, 2006; Ylhäinen, 2017). These studies concluded that the older the firm is, the lower its cost of debt. However, we consider that age will have a greater or lesser effect depending on the operating leverage that the firm is supporting, since mature firms with high leverage can see this negative age/cost of debt effect reduced due to the greater risk they take on.

> ***Hypothesis 4:*** *The higher the operating leverage, the lower the negative relationship between age and the cost of debt of agri-food firms.*

The objective of this work was to analyse the effect that operating leverage has on the cost of debt of agri-food industry firms and on other risk factors that normally determine this cost, such as size, financial leverage, specificity and age. These four factors affect risk, since financial risk is greater if the level of indebtedness is higher, the creditor has less information when the firm is small and young, and the creditor has fewer guarantees if the specificity is greater. One of the novelties of this work is the consideration of the cross-effects between operating leverage and other risk indicator variables.

# Material and methods

## The agri-food industry: Sample and variables

### *Sample*

The agri-food sector is one of the most important sectors of the European economy according to *FoodDrinkEurope*[4] (www.fooddrinkeurope.eu). For the year 2016, the sales volume of the European food industry represented 15.6% of the food and drink turnover in manufacturing. In addition, the EU continued to lead the world as the largest exporter of food and beverages. Furthermore, innovation and technological development in the sector is becoming very significant, and it has to face major financial challenges that are not seen in other sectors (AgFunder, 2015).

[4] See the complete report at: https://www.fooddrinkeurope.eu/publication/fooddrinkeurope-annual-report-2016

The sample was made up of firms from the agri-food sector (*European Classification of Economic Activities*, NACE Rev. 2: codes[5] 10 and 11) of European countries that were active during the 2009-2016 period. The countries with the highest average GDP in the analysed period were selected, that is, France, Italy, Poland, Spain, Sweden and the UK.[6] In Table 1 (Panel A), the evolution of the GDP of these countries is presented.

The differences in macroeconomic conditions in the euro-zone countries become apparent when they are analysed in depth (Fig. 1). By analysing their financial structure through the level of debt[7] over GDP of European companies, these differences between countries can be seen. Indeed, the highest level on average is attributable to Sweden (192.38) and the most moderate to Poland (74.76). The evolution of these levels also shows a heterogeneous behaviour among these countries, although within each country a fairly stable growth is observed throughout the period (Grau & Reig, 2015).[8] In particular, in France and Poland the level of debt has been increasing, with the particularity that Poland is starting from very low levels of debt. On the other hand, Spain and the UK are making an effort to deleverage. On average, the debt level in the whole sample has fallen over the course of the analysed period.

The data used in this study have been obtained from several sources. First, the economic-financial data for each country have been extracted from the ORBIS database of *Bureau van Dijk*. Secondly, the GDP series for each country has been obtained from EUROSTAT.

Furthermore, the series of variables used have been filtered to eliminate, firstly, the observations with errors in the financial statements, and secondly, the extreme observations that exceeded 95% or those that were below 5% in all the distributions. This double filtering process, depending on the country, has meant the loss of approximately between 12.8% and 19.3% of the original sample. Finally, the panel data consists of 18,360 European firms with a total of 146,880 observations.

## *Cost of debt* vs. *operating leverage in agri-food European firms*

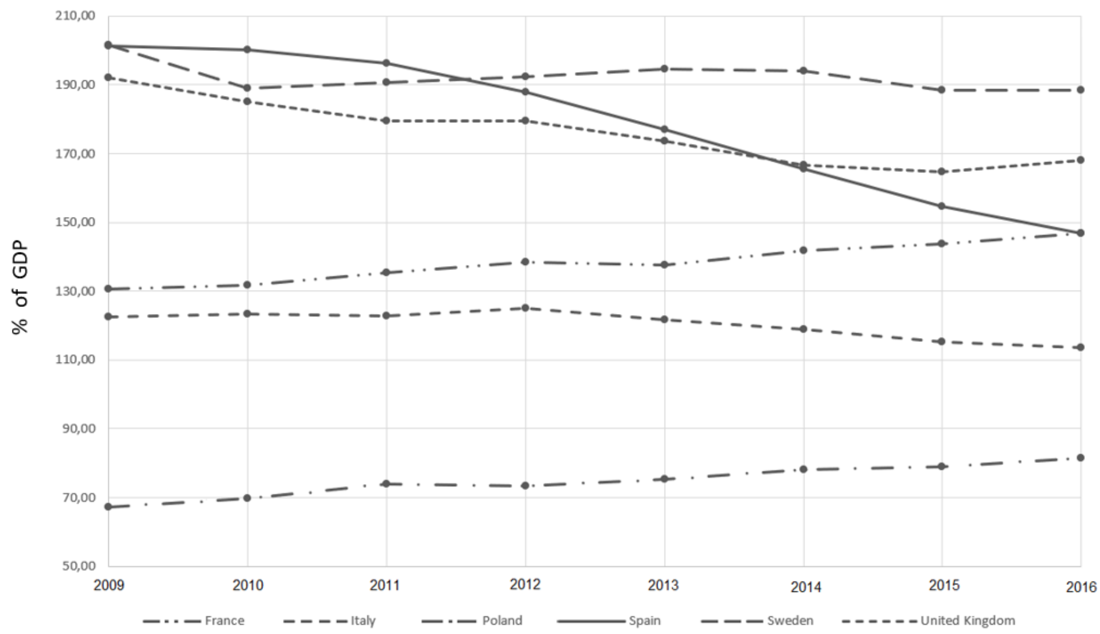
The cost of debt is the variable that we intend to explain (dependent), and since it is not directly observable, we had to estimate it. In the same way that various earlier works such as Francis *et al.* (2005), Hyytinen & Pajarinen (2007) and Ylhäinen (2017) have done so, we estimate the cost of debt by dividing the interest paid for the debt incurred by the average of the debt with the cost at the beginning and at the end of the period.

In Table 1 (Panel B), we provided the evolution of the cost of debt of the different countries considered

**Table 1.** Panel A: GDP growth (base year 2010; Source EUROSTAT). Panel B: Cost of debt by country

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|---|---|---|
| **Panel A** | | | | | | | | | | |
| France | 98.1 | 100 | 102.1 | 102.3 | 102.9 | 103.8 | 104.9 | 106.2 | | |
| Italy | 98.3 | 100 | 100.6 | 97.7 | 96.1 | 96.2 | 97.1 | 97.9 | | |
| Poland | 96.5 | 100 | 105 | 106.7 | 108.2 | 111.7 | 116 | 119.4 | | |
| Spain | 100 | 100 | 99 | 96.1 | 94.5 | 95.8 | 99.1 | 102.3 | | |
| Sweden | 94.3 | 100 | 102.7 | 102.4 | 103.6 | 106.3 | 111.1 | 114.7 | | |
| UK | 98.3 | 100 | 101.5 | 103 | 105.1 | 108.3 | 110.8 | 113 | | |
| **Panel B** | | | | | | | | | | |
| EUROPE | 0.0240 | 0.0206 | 0.0221 | 0.0225 | 0.0211 | 0.0204 | 0.0183 | 0.0164 | 0.0207 | 0.0024 |
| France | 0.0209 | 0.0191 | 0.0201 | 0.0174 | 0.0160 | 0.0151 | 0.0139 | 0.0133 | 0.0170 | 0.0029 |
| Italy | 0.0221 | 0.0184 | 0.0204 | 0.0222 | 0.0218 | 0.0215 | 0.0207 | 0.0186 | 0.0206 | 0.0015 |
| Poland | 0.0300 | 0.0245 | 0.0243 | 0.0300 | 0.0232 | 0.0239 | 0.0163 | 0.0095 | 0.0227 | 0.0068 |
| Spain | 0.0263 | 0.0220 | 0.0233 | 0.0239 | 0.0225 | 0.0216 | 0.0185 | 0.0164 | 0.0218 | 0.0031 |
| Sweden | 0.0345 | 0.0347 | 0.0400 | 0.0426 | 0.0366 | 0.0322 | 0.0291 | 0.0256 | 0.0344 | 0.0055 |
| UK | 0.0242 | 0.0235 | 0.0225 | 0.0240 | 0.0205 | 0.0215 | 0.0174 | 0.0154 | 0.0211 | 0.0032 |

[5] Manufacture of food products and manufacture of beverages, respectively. These are the companies in the second link of the value chain that transform raw materials into processed and semi-processed products.
[6] Germany has been excluded, given that, during the study period, most of the German firms were not required to present annual accounts.
[7] This information is produced regularly by the European Commission and published through EUROSTAT.
[8] These authors point out that the less indebted, non-vertically integrated agri-food companies have not seen their profitability decrease in times of crisis.




| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| Mean EU6 | 152,50 | 149,88 | 149,75 | 149,45 | 146,63 | 144,20 | 140,93 | 140,90 |
| Mean EU28 | 155,78 | 153,09 | 151,80 | 152,31 | 149,64 | 148,74 | 147,92 | 145,67 |

| | France | Italy | Poland | Spain | Sweden | UK | EU6 | EU28 |
|---|---|---|---|---|---|---|---|---|
| Mean by Country | 138,29 | 120,39 | 74,763 | 178,68 | 192,38 | 176,20 | 146,78 | 150,62 |

**Figure 1.** Private sector debt (% of GDP). *Source*: EUROSTAT

throughout the analysis period. These table indicates that the pattern of behaviour of the cost of debt has not been homogeneous among the different countries of Europe. The recent crisis has had effects on these very different economies, and each country has adopted its own economic and monetary policies to mitigate these effects. On the other hand, many firms have embraced the EU's rural development policies[9] that grant subsidies to those that process and market agricultural products, and which aim to improve the competitiveness of agri-food sector. It is notable that among the countries under study, the country that receives the least European subsidies is Sweden, which could explain, at least in part, the higher costs that Swedish companies have borne.

In addition to these subsidies at the European level, agri-food firms have received other subsidies linked to the country where they carry out their activity. This could have caused a lessening, in average terms, of the cost of debt of the firms from countries with high subsidies. It is worth mentioning the existence of the OSEO[10] platform in France, which is a public company with no equivalent in the rest of Europe, whose mission is to finance innovation and the growth of companies. In 2009 alone, OSEO made more than 100,000 interventions that allowed innovative SMEs to obtain some 25 million euros of financing. In addition, among the sectors that receive the most aid and subsidies is the agri-food sector, which is mostly made up of SMEs. French agri-food companies have borne the lowest cost of debt (Table 1, Panel B) and, as we will see in the next section, they are the ones that have made the largest investment in R&D over the study period.

For all this, the cost of external financing that European agri-food firms have shouldered has behaved in an uneven manner in the different countries considered. These differences are what lead us to study the determinants of the cost of debt separately, *i.e.* country by country.

### *Explanatory variables*

In Table 2 we provide the set of variables that we have used in our study and in Table 3 their descriptive statistics.

[9] See the complete report European Court of Auditors, Special Report No1, 2013, at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013SA0001&from=ES
[10] See the report on the financing of innovation in France at: https://es.ambafrance.org/

The main variable that we considered to explain the cost of external financing is operating leverage, since it is one of the main sources of risk borne by the creditors of companies and has had little attention in the literature. To measure it, we used the relationship between net fixed assets and total assets (OLM).

Measuring the operating leverage of a firm is not easy because operating accounts do not distinguish between the different costs that the activity of the firm generates and, therefore, data on fixed and variable costs are not available. Numerous authoritative works have used the relationship between net fixed assets and total assets as a proxy for the cost structure and the operating leverage, arguing that high levels of fixed assets generate high fixed costs (O'Brien & Vanderheiden, 1987; Houmes *et al.*, 2012; Cao, 2015; Harjoto, 2017).

The other measure most used in the financial literature is the degree of operating leverage (DOL), which is calculated by dividing the variation in Earnings Before Interest and Taxes (EBIT) by the variation in sales[11] (Houmes *et al.*, 2012; Harjoto, 2017). Houmes *et al.* (2012) studied the impact of operating leverage on systematic risk in listed firms with the two measures mentioned. They compared the results obtained by using the degree of operating leverage with those obtained by using the ratio between net fixed assets and total assets. They concluded that the weight of net fixed assets over total assets determines the beta of the assets more significantly.

The other main variables are found in Table 2. We use the variable LEV as an indicator of financial leverage, and the logarithm of the total assets as an indicator of size, LTOTASS. We used the variable INTANG as a measure of the specificity of the assets and the innovation, since a greater proportion of investment in intangible assets means more investment in R&D and in more specific assets. The justification for the use of INTANG as a measure of innovation and specificity has been developed in the section on the theoretical framework. Next, we used AGE as the number of years that firms have been carrying out their activity. Finally, we considered the economic growth of each country through the variable GPDGRW, which shows the variation that its GDP experiences each year. This variable, in addition to making it possible to know the importance of the economic situation, can also be used as an indicator of the country effect, since the order of countries based on this macroeconomic data did not vary throughout the period considered (see Table 1, Panel A).

Finally, we introduced control variables that have shown a high degree of explanatory power for the cost of debt: interest coverage (INTCOV), liquidity (LIQUID) and cash flow (CASH).

The use of these explanatory variables in the regression process could cause problems of multicollinearity given the high degree of interrelation that can be established between them. To detect these problems and to take

**Table 2.** Description of the explanatory variables

| Parameters | Description |
|---|---|
| **Dependent variable** | |
| COD | Cost of debt: Interest expenset / average of the beginning and end total debtt |
| **Main explanatory variables** | |
| OLM | Operating Leverage Measure: Net Fixed Assets / Assets. |
| LEV | Leverage: (Net Liabilities + Fixed Liabilities) / (Total Liabilities + Equity). |
| LTOTASS | Total Assets: Logarithm of the Assets. |
| INTANG | Intangible: Intangible Assets / Assets. |
| AGE | Age: Number of active years. |
| GDPGRW | GDP Growth: $(GDP_t - GDP_{2010}) / GDP_{2010}$. |
| **Control variables** | |
| INTCOV | Interest Coverage: EBIT / Interest expense. |
| LIQUID | Liquidity: (Current Assets- Stocks) / Current Liabilities. |
| CASH | Flow Available: Cash Flow / Operating Income. |

[11] Kahl *et al.* (2014) criticized this measure as an indicator of risk because managers can influence depreciation, which can be manipulated and which depends on past investments, and thus does not represent current costs.

**Table 3.** Statistical descriptive for variables

| | COD | OLM | LEV | TOTASS | INTANG | AGE | GDPGRW | INTCOV | LIQUID | CASH |
|---|---|---|---|---|---|---|---|---|---|---|
| **EUROPE** (N=18360) | | | | | | | | | | |
| Mean | 0.02066 | 0.42497 | 0.60216 | 19,987.71 | 0.05318 | 23.50006 | 0.00019 | 210.6346 | 1.32630 | 5.57824 |
| Std. Dev. | 0.02917 | 0.24096 | 0.29708 | 424,207.4 | 0.14316 | 16.97458 | 0.02338 | 7,873.23 | 2.21052 | 10.0479 |
| Jarque-Bera | 2.57E+10** | 5.84E+03** | 3.38E+06** | 1.16E+11** | 1.38E+06** | 4.34E+05** | 5.93E+03** | 2.02E+12** | 1.65E+08** | 2.52E+06** |
| VIF (mean: 1.1425) | --- | 1.1886 | 1.2545 | 1.1881 | 1.1617 | 1.1799 | 1.0128 | 1.0025 | 1.1957 | 1.0992 |

| | COD | OLM | LEV | TOTASS | INTANG | AGE | INTCOV | LIQUID | CASH |
|---|---|---|---|---|---|---|---|---|---|
| **France** (N=4244) | | | | | | | | | |
| Mean | 0.01696 | 0.44133 | 0.57477 | 28,532.46 | 0.16150 | 25.06456 | 117.1385 | 1.18555 | 6.14339 |
| Std. Dev. | 0.02712 | 0.24646 | 0.25941 | 655,192.4 | 0.24301 | 18.616 | 1,915.256 | 1.28073 | 6.12276 |
| Jarque-Bera | 1.19E+11** | 1.89E+03** | 4.37E+05** | 7.11E+09** | 1.13E+04** | 4.51E+04** | 1.64E+10** | 1.66E+07** | 1.11E+05** |
| VIF (mean: 1.4690) | --- | 2.2355 | 1.324 | 1.264 | 2.194 | 1.217 | 1.0044 | 1.344 | 1.1693 |
| **Italy** (N=5691) | | | | | | | | | |
| Mean | 0.02074 | 0.37043 | 0.61017 | 9,390.646 | 0.03376 | 24.91047 | 221.2604 | 1.20676 | 5.70227 |
| Std. Dev. | 0.03459 | 0.23146 | 0.24044 | 72,727.86 | 0.07588 | 17.38196 | 4,067.937 | 1.74017 | 10.3127 |
| Jarque-Bera | 5.55E+08** | 2.00E+03** | 5.51E+02** | 2.12E+10** | 1.66E+06** | 2.40E+04** | 4.57E+10** | 9.30E+07** | 7.48E+05** |
| VIF (mean: 1.1760) | --- | 1.1792 | 1.4125 | 1.1421 | 1.0728 | 1.1572 | 1.0092 | 1.322 | 1.1131 |
| **Poland** (N=428) | | | | | | | | | |
| Mean | 0.02269 | 0.51961 | 0.51941 | 17,672.18 | 0.00870 | 23.9602 | 58.8288 | 0.93825 | 6.16884 |
| Std. Dev. | 0.06290 | 0.19079 | 0.20464 | 51,800 | 0.03945 | 24.0563 | 351.000 | 0.79984 | 5.90301 |
| Jarque-Bera | 7.26E+06** | 4.64E+01** | 2.44E+01** | 1.26E+06** | 1.25E+06** | 3.15E+04** | 6.21E+06** | 1.11E+05** | 2.76E+03** |
| VIF (mean: 1.3294) | --- | 1.3778 | 1.7909 | 1.2124 | 1.0663 | 1.0633 | 1.063 | 1.7143 | 1.3476 |
| **Spain** (N=7100) | | | | | | | | | |
| Mean | 0.02181 | 0.45320 | 0.61711 | 6,513.755 | 0.00854 | 20.43638 | 290.9819 | 1.56145 | 5.06966 |
| Std. Dev. | 0.02037 | 0.24158 | 0.36014 | 49,391.71 | 0.04208 | 12.34017 | 12,205.26 | 3.03079 | 12.0182 |
| Jarque-Bera | 1.26E+06** | 1.99E+03** | 1.42E+06** | 1.38E+10** | 5.38E+07** | 2.85E+05** | 1.59E+11** | 2.24E+07** | 5.68E+05** |
| VIF (mean: 1.1244) | --- | 1.0742 | 1.2685 | 1.1984 | 1.0192 | 1.1692 | 1.0021 | 1.1645 | 1.0991 |
| **Sweden** (N=470) | | | | | | | | | |
| Mean | 0.03439 | 0.44990 | 0.63705 | 17,094.92 | 0.01100 | 24.12979 | 10.31303 | 1.13278 | 5.05398 |
| Std. Dev. | 0.02901 | 0.23374 | 0.27571 | 95,761.78 | 0.07169 | 19.63037 | 46.96227 | 0.98720 | 9.24506 |
| Jarque-Bera | 2.50E+05** | 9.40E+01** | 1.16E+04** | 2.40E+06** | 1.41E+06** | 1.17E+04** | 1.50E+06** | 8.44E+04** | 4.85E+04** |
| VIF (mean: 1.2712) | --- | 1.2000 | 1.4833 | 1.4097 | 1.0213 | 1.2855 | 1.0987 | 1.5024 | 1.1691 |
| **United Kingdom** (N=427) | | | | | | | | | |
| Mean | 0.02112 | 0.42025 | 0.57537 | 295,081.7 | 0.03311 | 36.49297 | 99.18306 | 1.19824 | 6.34362 |
| Std. Dev. | 0.02895 | 0.21788 | 0.29260 | 1,767,904 | 0.09179 | 30.08333 | 650.1150 | 0.97801 | 6.81544 |
| Jarque-Bera | 2.27E+06** | 1.05E+02** | 3.12E+04** | 4.86E+06** | 5.83E+04** | 2.91E+03** | 4.71E+07** | 6.04E+04** | 7.99E+04** |
| VIF (mean: 1.2915) | --- | 1.3187 | 1.4283 | 1.3724 | 1.2011 | 1.2646 | 1.0257 | 1.4406 | 1.2808 |

This table presents the typical descriptive statistics for the variables defined in panel data of 2009-2016, the Jarque-Bera test for contrasting normality, and the variance inflation factor (VIF) to diagnose the presence/absence of multicollinearity. $^{**}p<0.01$, $^{*}p<0.05$, $^{\wedge}p<0.1$.

the appropriate measures, we applied the variance inflation factor (VIF).

## Empirical analysis

Taking the empirical evidence consulted as a reference, we analysed the determinants of the cost of debt of European agri-food firms by means of static panel data. This allowed us to control for the existence of unobservable heterogeneity that is greater with cross-sectional data (Baltagi, 2001; Wooldridge, 2002).

We modelled the cost of debt (COD) for the European countries considered through the following theoretical model:

$$COD_{jt} = \varphi + \sum_{\pi=1} \gamma_{\pi} \cdot X_{\pi jt} + \varepsilon_{jt} \quad (1)$$

where X  is a vector of the π explanatory variables $\gamma_{\pi}$ are the unknown estimated parameters, and $\varepsilon_{jt}$ the random perturbation.

We present our econometric approach for the theoretical model described in Eq. (1), which integrates the specific explanatory variables, the cross-effects of these with the operating leverage and the control variables. The estimation and contrast of this model adopts the following structure:

$$\begin{aligned} COD_{jt} = {} & \delta_0 + \delta_1 OLM_{jt} + \delta_2 LEV_{jt} + \delta_3 LTOTASS_{jt} + \delta_4 INTANG_{jt} \\ & + \delta_5 AGE_{jt} + \delta_6 GDPGRW_{jt} + (\delta_7 LEV_{jt} + \delta_8 LTOTASS_{jt} \\ & + \delta_9 INTANG_{jt} + \delta_{10} AGE_{jt}) * OLM_{jt} + \delta_{11} INTCOV_{jt} \\ & + \delta_{12} LIQUID_{jt} \delta_{13} CASH_{jt} + \eta_j + \lambda_t + \varepsilon_{jt} \end{aligned} \quad (2)$$

where CODjt represents the cost of debt for firm j (j=1, …, J) in time period t (t=1, ..., T), calculated as the quotient between the interest paid for the incurred debt and the average of the debt with the cost at the beginning and the end of the period in which the interest has accumulated; $\delta_0$ represents the intercept (constant term) of the regression; $\delta_j$ represents the estimated values of the cross-section regression coefficients with the following breakdown: the main variables ∀j=OLM, LEV, LTOTASS, INTANG, AGE and GDPGRW; the variables crossed with OLM: ∀j=(LEV*OLM), (LTOTASS*OLM), (INTANG*OLM) and (AGE*OLM); and the control variables ∀j=INTCOV, LIQUID and CASH. $\eta_j$ is the unobservable heterogeneity that arises from the existence of a series of unobservable individual effects. It attempts to encapsulate the specific unique qualities of each company, which may include the characteristics of its sector, although there may be variance among them, but it is assumed that they are constant (the attributes of managers: management capacity, personal skills, etc.); and the specific effects of the industry (entry barriers or market conditions). The main drawback comes from the impossibility of approximating them to some measure, as they are unobservable. $\lambda_t$ are temporary dummy variables that change over time but are the same for all the companies in each of the periods considered. In this way, the aim is to capture the economic variables (interest rates, prices, etc.) that cannot be controlled by companies, but which can affect their financial decisions. Finally, $\varepsilon_{jt}$ are the random perturbations.

Regarding the coefficient of each crossed variable, if it is of the same sign as that of the main variable, the effect of said variable on the cost of debt is increased the greater the operating leverage. On the other hand, if the coefficient of the crossed variable is opposite to that of the main variable, the effect of that variable is reduced as the operating leverage increases.

To deepen our study, we proposed some econometric variants, so we estimated and contrasted three models. In this way we studied the effect of operating leverage on cost, both in isolation, and indirectly through the other risk factors proposed. These models were regressed firstly for panel data that integrates all the countries in the sample (Europe), and then regressed individually for each of the countries considered (France, Italy, Poland, Spain, Sweden and the UK).

Thus, Model 1 only included the control variables (INTCOV, LIQUID and CASH) and OLM, which allows us to know their explanatory capacity. Model 2 includes all the main variables (OLM, LEV, LTOTASS, INTANG, AGE and GDPGRW) along with the control variables. We intended to ascertain the explanatory increase that these risk indicator variables have over our key variable OLM. Finally, Model 3 is the most complete model since it encompasses all the variables enunciated in Eq. (2), that is, the control variables, the main variables (except OLM) and the cross-effect variables (LEV*OLM, LTOTASS*OLM, INTANG*OLM and AGE*OLM). This last model allows us to analyse whether the effect that the main risk variables have on cost of debt depends on whether the firm has high or low operating leverage. In this way, we will learn the degree of compliance with the hypotheses previously raised.

The parameters have been estimated, incorporating instrumental variables by the *Generalized Method of Moments* (GMM)[12] to the equation in first differences. This methodology controls unobservable heterogenei-

[12] This procedure was developed by Arellano & Bond (1991) and presents two levels of application depending on the nature of the random disturbance. If the residuals are homocedastic, the GMM estimate in one stage would be the most appropriate. If, on the other hand, there is heterocedasticity, the estimator of the instrumental variables in one stage will remain consistent, but the estimation in two stages increases the efficiency..

ty and also prevents possible endogeneity problems (through the use of instrumental variables) that could arise, since the random perturbations that affect the decisions on the levels of profitability can also affect other characteristics of the companies (Baños-Caballero *et al.*, 2012, 2013; Martínez-Sola *et al.*, 2013). However, although this procedure by definition could correct these problems, there are reasons why some variables could be subject to endogeneity.

A robust study was carried out to detect the presence of endogeneity by way of the Hausman test (1978), which corrects the model by taking the first differences and comparing the estimation coefficients by instrumental variables and by OLS (under the null hypothesis of the existence of exogeneity in the explanatory variables). The Hausman (1978) tests of the different estimations show there are no endogeneity problems and that the within–group estimator was consistent (Table 4).

As measures of the goodness of fit, we proposed the adjusted $R^2$, the Wald test set of coefficients equal to each other and equal to zero (under the null hypothesis that $\delta_1 = \delta_2 = ... = \delta_6 = 0$), the estimation error calculated from the sum of the mean of the square of the errors (errors due to the bias of the estimator) plus the variance, and the significance of the total set of the mean of the error equal to zero on the residuals (under the null hypothesis that $E(\varepsilon)=0$). Additionally, to test the consistency of the estimates, the second-order serial correlation absence test (m2 test) also proposed by Arellano & Bond (1991) was used. In turn, we used the test of Sargan (1958) on the over-identification of restrictions (under the null hypothesis that the instruments used are valid) to verify the absence of correlation between the instruments and the error term.

# Results

Once the data and the variables were analysed, we observed that Wald's contrast justified the joint explanatory power of the parameters, and the contrast of mean equal to zero allows us to accept the hypothesis of unbiasedness of the errors (see the lower part of Tables 4 and 5). On the other hand, the results of the m2 test indicate the absence of second-order serial correlation since the instruments used in the GMM estimates are not correlated with the error term, both for the complete European sample and for the countries separately. Furthermore, the Sargan test cannot be rejected and, consequently, the instruments incorporated in the GMM regression are valid.

Table 4 presents the results of the estimation of the three models for the complete European sample, and in Table 5 for each country separately. The results from all the analyses carried out showed us that a positive relationship exists between operating leverage and the cost of debt (Models 1 and 2). Therefore, the cost structure, measured with OLM, was shown to be a significant source of risk and is a fundamental determinant of the cost of debt in all countries, indicating that the higher the operating leverage, the higher the financing cost borne by European agri-food companies.

GDP growth (GDPGRW) was statistically significant with a negative sign in the three models (Table 4), which shows that if the country is growing, the cost of debt decreases. This variable, in addition to making it possible to know the importance of the economic situation, can also be used as an indicator of the country effect, since the order of countries based on this macroeconomic data did not vary throughout the period considered (see Table 1, Panel A).

The difference between Model 1 and Model 2 was that the first includes only the control variables and OLM, while in the second the other main variables are added, all indicating some type of risk. The goodness of fit (measured by $R^2$) and the statistical significance of the results increased only slightly when introducing these variables, which indicated that operating leverage is the main determinant of the cost of debt. It was observed that the different risk factors did not affect the cost in the same way in all the countries studied. For example, the result from Poland stands out (Table 5, Model 2), since OLM was the only statistically significant variable. It was also noteworthy that the goodness of fit and the significance of the analyses was greatest for British companies.

Model 3, by introducing the cross-effects of OLM with the main variables, allowed us to know the relationship that operating leverage had with the other sources of risk and to explain to what extent the hypotheses proposed in this work were supported. It is the model that offers the highest $R^2$ and with the lowest measurement error for all countries. Likewise, we ascertained (through Wald's contrast) that, in general, the variables jointly and actively contributed to explaining the cost of debt.

Although the agri-food sector is characterised by having little demand elasticity, it is a very competitive sector. This leads us to predict that operating leverage can affect the cost of debt to a greater extent than in other industries.

We observed a positive effect between the level of indebtedness (LEV) and the cost of debt in the complete sample (Table 4, Model 3) and the variable crossed with OLM of the opposite sign. This result confirmed the acceptance of *Hypothesis 1*, that is, the higher the operating leverage, the lower the positive relationship between indebtedness (LEV) and the cost of debt. When analysing this variable by country, it is worth noting that the results in France were opposite and, on the other hand, in Poland

**Table 4.** Determinants of cost of debt in Europe

| | EUROPE | | |
|---|---|---|---|
| | **Model 1** | **Model 2** | **Model 3** |
| **Main variables** | | | |
| c | 0.0151**<br>(72.69636) | 0.0190**<br>(34.5030) | 0.0244**<br>(46.8796) |
| OLM | 0.0132**<br>(34.1129) | 0.0139**<br>(33.7654) | |
| LEV | | -0.0001<br>(-0.347182) | 0.0072**<br>(11.4476) |
| LTOTASS | | -0.0011**<br>(-9.2078) | -0.0039**<br>(-22.0689) |
| INTANG | | -0.0058**<br>(-8.7514) | -0.0055^<br>(-1.8599) |
| AGE | | -1.06E-05*<br>(-1.9865) | -0.0001**<br>(-5.4505) |
| GDPGRW | -0.1222**<br>(-9.3948) | -0.1058**<br>(-7.9501) | -0.1050**<br>(-7.9011) |
| **Cross effects** | | | |
| LEV*OLM | | | -0.0148**<br>(-13.7926) |
| LTOTASS*OLM | | | 0.0063**<br>(21.0274) |
| INTANG*OLM | | | 0.0017<br>(0.4486) |
| AGE*OLM | | | 0.0001**<br>(5.2582) |
| **Control variables** | | | |
| INTCOV | -1.14E-07**<br>(-4.4569) | -4.12E-07**<br>(-4.4349) | -3.90E-07**<br>(-4.2039) |
| LIQUID | 0.0006**<br>(11.8359) | 0.0006**<br>(9.7349) | 0.0007**<br>(11.4905) |
| CASH | -0.00012**<br>(-7.91839) | -0.0001**<br>(-7.0050) | -0.0001**<br>(-7.0476) |
| *$R^2$ adjusted* | 0.2251 | 0.2349 | 0.2645 |
| *Wald (δ1= ... =δ6=0)* | 34,564.12** | 64,891.44** | 66,841.62** |
| *E(ε)=0* | 364.9684** | 609.1847** | 645.3674** |
| *Estimation error* | 1.4157 | 1.2188 | 1.2036 |
| *m2 test* | 0.79 | 0.67 | 0.63 |
| *Sargan test* | 81.05(73) | 85.42(79) | 88.36(79) |
| *p–Hausman* | 0.3458 | 0.3347 | 0.5214 |

The data in this table correspond to two-step regression results from the GMM model in first differences, described in the Eq. (2), where the dependent variable is the cost of debt (COD) of the European firms. The main variables are: OLM (Net Fixed Assets / Total Assets), LEV (Total Debts / Total Assets), LTOTASS (logarithm of the Total Assets), INTANG (Intangible Assets / Total Assets), AGE (number of active years), and GDPGRW (GDP increase). The cross effects correspond to the main variables multiplied by the operating leverage measure. The control variables are: INTCOV (EBIT/Interest expense), LIQUID (Current Assets-Stocks/Current Liabilities) and CASH (Cash Flow/Operating Income). t-Statistic in brackets. As measures of the goodness of fit, we propose the adjusted R2, the Wald test set of coefficients equal to each other and equal to zero (under the null hypothesis that δ1=δ2= ... =δ6=0, the estimation error calculated from the sum of the mean of the square of the errors (errors due to the bias of the estimator) plus the variance, and the significance of the total set of the mean of the error equal to zero on the residuals (under the null hypothesis that E(ε)=0). In addition, m2 is a test for second-order serial autocorrelation in residuals in first differences, distributed asymptotically as N(0,1) under the null hypothesis of no serial correlation. The Sargan Test is a test of over-identifying restrictions distributed asymptotically under the null hypothesis of validity of instruments as Chi-squared: degrees of freedom in brackets. p–Hausman is the p–value in Hausman's (1978) test. In this case, the estimations for instrumental variables and OLS are compared. Acceptance of the null hypotheses implies no endogeneity problems. **$p$<0.01, *$p$<0.05, ^$p$<0.1.

**Table 5.** Determinants of the cost of debt by country

| | France | | | Italy | | | Poland | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Model 1** | **Model 2** | **Model 3** | **Model 1** | **Model 2** | **Model 3** | **Model 1** | **Model 2** | **Model 3** |
| **Main variables** | | | | | | | | | |
| c | 0.0065** | 0.0066** | 0.0190** | 0.0143** | 0.0197** | 0.0243** | 0.0124** | 0.0116 | 0.0273* |
| | (13.1107) | (4.8314) | (14.2512) | (36.6627) | (14.7265) | (19.2377) | (2.5742) | (0.8383) | (2.2537) |
| OLM | 0.0197** | 0.0297** | | 0.0169** | 0.0176** | | 0.0264** | 0.0262** | |
| | (24.1696) | (25.3192) | | (20.3289) | (19.7224) | | (3.1927) | (3.0463) | |
| LEV | | -4.25E-05 | -0.0055** | | 0.0051** | 0.0124** | | 0.0020 | -0.0053 |
| | | (-0.0464) | (-3.5089) | | (4.8463) | (7.9557) | | (0.2005) | (-0.3038) |
| LTOTASS | | -0.0004^ | -0.0032** | | -0.0028** | -0.0055** | | 0.0002 | -0.0035 |
| | | (-1.7379) | (-8.6713) | | (-10.6832) | (-15.0816) | | (0.0766) | (-1.0194) |
| INTANG | | -0.0146** | -0.0147** | | 0.0173** | 0.0614** | | 0.0221 | 0.1759 |
| | | (-12.8276) | (-3.7778) | | (6.8279) | (7.5390) | | (0.6360) | (0.5484) |
| AGE | | -1.43E-05 | 3.09E-05 | | -1.97E-05* | -5.35E-05** | | -5.54E-05 | 5.83E-05 |
| | | (-1.4823) | (1.4928) | | (-1.9074) | (-2.7562) | | (-1.0602) | 0.423758 |
| **Cross effects** | | | | | | | | | |
| LEV*OLM | | | 0.0121** | | | -0.0187** | | | 0.0122 |
| | | | (4.5599) | | | (-6.4266) | | | (0.4221) |
| LTOTASS*OLM | | | 0.0069** | | | 0.0079** | | | 0.0066 |
| | | | (10.1463) | | | (11.5968) | | | (1.2831) |
| INTANG*OLM | | | 0.0046 | | | -0.0725** | | | -0.2349 |
| | | | (0.9788) | | | (-5.3366) | | | (-0.4819) |
| AGE*OLM | | | -0.0001** | | | 0.0001** | | | -0.0002 |
| | | | (-2.5863) | | | (2.4071) | | | (-0.8884) |
| **Control variables** | | | | | | | | | |
| INTCOV | -9.44E-07** | -9.24E-07** | -9.47E-07** | -8.95E-07** | -8.57E-07** | -8.28E-07** | -1.24E-05 | -1.25E-05 | -1.25E-04 |
| | (-5.7959) | (-5.6762) | (-5.8117) | (-9.1999) | (-8.8208) | (-8.5077) | (-1.4906) | (-1.4414) | -1.438988 |
| LIQUID | 0.0007** | 0.0007** | 0.0004 | 0.0010** | 0.0013** | 0.0014** | -0.0016 | -0.0013 | -0.0018 |
| | (3.3434) | (2.7728) | (1.5516) | (6.7619) | (7.1490) | (7.4714) | (-0.8033) | (-0.5357) | (-0.7336) |
| CASH | 0.0001^ | 2.98E-05 | 4.36E-05 | -0.0002** | -0.0002** | -0.0002** | -0.0003 | -0.0003 | -0.0003 |
| | (1.7916) | (0.6494) | (0.9445) | (-6.3253) | (-5.7388) | (-5.2964) | (-1.0592) | (-0.9533) | (-0.9161) |
| *$R^2$ adjusted* | 0.2549 | 0.2493 | 0.2864 | 0.2496 | 0.2599 | 0.2732 | 0.2503 | 0.2593 | 0.2766 |
| *Wald ($\delta 1 = \ldots = \delta 6 = 0$)* | 12,574.66** | 12,612.36** | 11,512.61** | 34,564.12** | 64,891.44** | 66,841.62** | 4,564.12* | 4,891.44* | 5,841.62* |
| *$E(\varepsilon)=0$* | 147.3264** | 204.6974** | 198.6451** | 452.6647** | 561.3674** | 463.6647** | 34.0368* | 36.6457* | 31.6974* |
| *Estimation error* | 1.1641 | 1.1552 | 0.9644 | 2.3641 | 1.6587 | 1.6077 | 2.6974 | 1.8744 | 1.0587 |
| *m2 test* | 0.97 | 0.8 | 0.65 | 0.85 | 0.7 | 0.68 | 0.96 | 0.91 | 0.90 |
| *Sargan test* | 63.37(68) | 79.29(72) | 90.31(72) | 77.18(49) | 91.29(49) | 92.91(50) | 61.25(50) | 66.75(50) | 67.88(51) |
| *p–Hausman* | 0.4574 | 0.4522 | 0.4867 | 0.7557 | 0.7474 | 0.7928 | 0.1547 | 0.1674 | 0.1698 |

the level of indebtedness was not a determinant of the cost of debt (Table 5, Model 3).

The behaviour of the level of indebtedness was the opposite only in France. In a previous section, we mentioned France's support of innovation by subsidising innovative companies through cheaper financing.[13]

The ratio between the size of the asset (LTOTASS) and the cost of debt was negative in the whole European sample, but this effect was lower if the operating leverage

[13] See the report on the financing of innovation in France: https://santandertrade.com/en/portal

**Table 5.** Continued

| | Spain | | | Sweden | | | United Kingdom | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 1 | Model 2 | Model 3 | Model 1 | Model 2 | Model 3 |
| **Main variables** | | | | | | | | | |
| c | 0.0193** | 0.0219** | 0.0234** | 0.0251** | 0.0583** | 0.0675** | 0.0028^ | -0.0220** | -0.0063 |
| | (81.7823) | (37.5696) | (43.0611) | (14.5386) | (13.2946) | (17.0999) | (1.6829) | (-5.0353) | (-1.5838) |
| OLM | 0.0036** | 0.0036** | | 0.0226** | 0.0202** | | 0.0337** | 0.0318** | |
| | (8.2249) | (7.9961) | | (7.3203) | (6.5549) | | (11.3648) | (10.4044) | |
| LEV | | -0.0014** | 0.0050** | | -0.0129** | 0.0029 | | 0.0131** | 0.0258** |
| | | (-4.1589) | (8.2354) | | (-4.1891) | (0.6851) | | (5.3931) | (5.3311) |
| LTOTASS | | -0.0004** | -0.0025** | | -0.0073** | -0.0148** | | 0.0026** | -0.0022^ |
| | | (-3.0729) | (-11.2296) | | (-9.9421) | (-11.6328) | | (3.0314) | (-1.8696) |
| INTANG | | 0.0052* | 0.0214* | | 0.0285** | 0.0152 | | 0.0014 | -0.0355 |
| | | (2.0003) | (2.0907) | | (3.0103) | (0.2667) | | (0.2064) | (-1.2138) |
| AGE | | -1.05E-05 | 1.14E-05 | | -5.40E-06 | 5.41E-05 | | 0.0001** | 9.67E-05* |
| | | -1.266727 | (0.6144) | | (-0.1830) | 0.710701 | | (7.0148) | (2.0721) |
| **Cross effects** | | | | | | | | | |
| LEV*OLM | | | -0.0128** | | | -0.0354** | | | -0.0299** |
| | | | (-12.6689) | | | (-4.9867) | | | (-3.0969) |
| LTOTASS*OLM | | | 0.0043** | | | 0.0166** | | | 0.0102** |
| | | | (12.0440) | | | (7.12563) | | | (5.8320) |
| INTANG*OLM | | | -0.0266^ | | | 0.0162 | | | 0.0568 |
| | | | (-1.8401) | | | (0.2160) | | | (1.2061) |
| AGE*OLM | | | -3.03E-05 | | | -0.0002 | | | 4.83E-05 |
| | | | (-0.8758) | | | (-0.9633) | | | (0.5705) |
| **Control variables** | | | | | | | | | |
| INTCOV | -3.26E-07** | -3.24E-07** | -3.03E-07** | -0.0002** | -0.0002** | -0.0002** | -8.36E-06** | -7.64E-06** | -7.47E-06** |
| | (-3.8960) | (-3.8717) | (-3.6261) | (-6.5153) | (-5.9546) | (-5.3957) | (5.0938) | (-4.6971) | (-4.6033) |
| LIQUID | 0.0004** | 0.0004** | 0.0005** | 0.0026** | -9.40E-05** | 6.61E-05 | 0.0031** | 0.0046** | 0.0049** |
| | -10.1356 | (8.0082) | (9.8517) | (3.2395) | (-0.0986) | (0.0388) | (4.3689) | (5.9212) | (6.2314) |
| CASH | -8.86E-05** | -9.76E-05** | -0.0001** | -0.0003* | -0.0002 | -0.0002 | 0.0001 | 6.79E-05 | 5.42E-05 |
| | (-6.2573) | (-6.4979) | (-6.7436) | (-2.2009) | (-1.3457) | (-1.4402) | (1.0701) | (0.4707) | (0.3778) |
| *$R^2$ adjusted* | 0.2065 | 0.2102 | 0.2466 | 0.2344 | 0.2903 | 0.3312 | 0.2849 | 0.3009 | 0.3521 |
| *Wald ($\delta 1= \ldots =\delta 6=0$)* | 28,641.33** | 31,546.69** | 30,264.48** | 11,564.55** | 15,687.54** | 16,764.22** | 896.31** | 1,012.54** | 1,066.88** |
| *$E(\varepsilon)=0$* | 649.784** | 596.3147** | 555.3672** | 108.6314** | 99.6415** | 113.1547** | 235.6533** | 315.6314** | 208.6541** |
| *Estimation error* | 1.6651 | 1.5367 | 1.5057 | 9.6451 | 9.2974 | 7.1103 | 1.3387 | 1.3315 | 1.3174 |
| *m2 test* | 0.90 | 0.82 | 0.79 | 0.96 | 0.95 | 0.90 | 0.98 | 0.95 | 0.94 |
| *Sargan test* | 73.54(68) | 79.72(72) | 81.02(72) | 59.62(49) | 60.74(49) | 61.88(50) | 58.19(47) | 66.74(58) | 70.41(67) |
| *p–Hausman* | 0.4867 | 0.4154 | 0.5007 | 0.6674 | 0.5977 | 0.6661 | 0.5874 | 0.5687 | 0.5964 |

was greater, since the sign was the opposite when the two variables were crossed, which supports Hypothesis 2. The same result was obtained in all countries except Poland, where, as we already indicated, only OLM was statistically significant.

The relationship between the specificity and innovation variable (INTANG) and the cost of debt was negative in the whole European sample (Table 4, Models 2 and 3). The results obtained with this variable we are very different in the analysis by country (see Table 5). This is owing to the fact that incentive policies were very different in each country and the results obtained with this variable were very different in the analysis by country. In Spain and Italy, the increase in specificity increased the cost, although this relationship decreased if the operating leverage increased. However, in France, whose companies obtained the largest subsidies and made the greatest investment in R&D (FIAB, 2016)[14], the relationship between specificity and cost of debt was negative, such that the companies with the highest specific investments were those that bear less cost. On the other hand, in the UK there was no relationship between these variables. Thus, *Hypothesis 3* was supported in Spain and Italy, but not in France. On the other hand, in the UK there was no relationship between these variables.

The Age (AGE) had a negative effect on the cost of debt in the European sample, so that, as expected, younger firms bear higher costs when financing their productive activity with debt. However, the cross effect was of the opposite sign (Table 4, Model 3). Consequently, we can affirm, as stated in *Hypothesis 4*, that the greater the operating leverage, the lower the negative relationship between age and the cost of debt. In the analyses of Model 3 by country (Table 5), *Hypothesis 4* was only supported in Italy. In the majority of the countries, age was not statistically significant, which can be explained because within each country age is a fairly homogeneous variable and it ceases to be determinative.

In general, the results obtained allow us to affirm that the explanatory capacity of the proposed variables was much greater for the British firms, demonstrating that those British firms that assume more risks are the most penalised with the requirement of a higher risk premium. Indeed, the goodness of fit and significance of the analyses was greatest for British companies. In contrast, in countries that share the fact of being governed by civil law and being more oriented towards banking, the effect of risk on the cost of debt was less significant, as in the case of Spain and Italy.

Poland's result also stands out since the operating leverage was the only statistically significant variable. Poland was the country that experienced the highest growth in the period under consideration, including the crisis years, and many Polish agri-food companies made many investments in fixed assets, increasing their operating leverage. Indeed, agri-food firms in general had, on average, greater operating leverage than other European firms and lower levels of indebtedness. Therefore, the higher operational risk has been offset by lower financial risk.

# Discussion

Given the importance of the agri-food industry in the European economy and the major drive for innovation made by its companies and governments, it has been worthwhile to analyse whether the sector has an adequate operating cost structure, and whether this structure affects the financial cost, given that this directly affects the competitiveness of companies. However, those studies that analyse operating leverage have examined its effect on operating profitability, a variable that does not consider debt (*e.g.* Grau & Reig, 2020).

The results of this research clearly show the importance of operating leverage as a determinant of the cost of debt, tallying with other authors who have addressed the relationship between these variables (O'Brien & Vanderheiden, 1987; Houmes *et al.*, 2012; Cao, 2015; Harjoto, 2017).

To obtain this result, it has been crucial to consider only one sector of activity, the agri-food sector. By not mixing companies from different sectors in the same study, our results offer much clearer evidence, given that operational risk is highly determinant of risk if we are within the same industry (Novy-Marx, 2011). In this paper, clear evidence is provided, unlike other studies that mix several sectors (*e.g.* Hyytinen & Pajarinen, 2007; Van Binsbergen *et al.*, 2010) without reaching such conclusive results.

Furthermore, the results of this work demonstrate the importance that the legal and institutional environment has in determining the cost of debt. As indicated in the text, countries that are governed by "common law" and have a market-oriented economy, generate more information and have systems that protect investors more, hence companies are less likely to take risks. These arguments are corroborated by the empirical findings of other research (La Porta *et al.*, 1997; Cleassens *et al.*, 2000), which shows that the legal, economic and institutional characteristics of a country affect the risk that companies are willing to assume and, therefore, the cost of debt.

When studying the effect that operating leverage has on other risk factors, the result obtained with the level of indebtedness is interesting: the higher the operating leverage, the lower the positive effect that indebtedness or financial leverage has on the cost of debt. The explanation for this result is that companies offset both economic and financial risks. The extreme case is found in Poland, where the level of debt is not a determinant of the cost. The results are in line with those obtained in other studies in which it is concluded that operating leverage can determine the firm's risk to a greater extent, decreasing and even nullifying the effect of financial risk (Houmes *et al.*, 2012).

In general, the effect of operating leverage on indebted European agribusinesses allows them to reduce their financial burdens, agreeing with the results of Kahl *et al.* (2014) and Harjoto (2017). As indicated by these authors, companies with higher fixed costs follow a more conser-

[14] See the full report of FIAB (Spanish Federation of Food and Beverage Industries) of 2015 at: http://fiab.es/wp-content/uploads/2017/12/Informe-Económico-2015.pdf

vative financial policy by having lower debt rates. Our study has shown that both types of leverage (financial and operating) can be offset by agribusinesses to reduce overall risk and financing costs.

This risk compensation is also supported by the fact that "common law" countries are less risk-averse, and if they have a higher weight of intangible assets, making them riskier, they will offset this with less debt.

It is also worth highlighting the result obtained with the size and age variables. This industry is characterised by being very competitive with many small and young companies competing with larger and more mature firms. We have included in this study both SMEs and large agri-food companies, unlike those papers which only analyse quoted companies (García-Feijóo & Jorgensen, 2010; Houmes *et al.*, 2012; Cao, 2015) or only include SMEs (Grau & Reig, 2020). Size, measured by the volume of assets of the firm, was decisive in all the analyses carried out, indicating that small firms are riskier and they are required to pay more interest on their debts, although this effect is mitigated if the firms do not have a very leveraged cost structure. In the same way, and as expected, age had a negative effect on the cost of debt. Thus, younger companies bear a higher cost when financing their productive activity with debt.

The agri-food sector, being a key sector in the European economy, has been subject to special aid programs distributed in volume unevenly across countries. If we add to this the national subsidy programs, the level of indebtedness is not a clear determinant of the cost of debt in European agri-food firms, since some subsidised companies become more indebted with cheaper loans.

The results obtained in this research have important implications for the managers of companies and for those responsible for agri-food industrial policy, both in Europe and at the local level of each country. Not mixing firms from different sectors allows conclusions to be drawn that can help stakeholders in the sector and policymakers to make decisions that improve the results of these firms and, therefore, boost the economic growth of the countries.

We believe that our research could be expanded by incorporating a greater number of countries into the mix and grouping them according to the origins of their legal systems and by whether they are oriented towards banking or the market. In this way, we can compare the cost strategies that companies follow and their effects, depending on the institutional and legal environment.

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