LIVING WITH ZOMBIES COMPANIES: DO WE KNOW WHERE THE THREAT LIES?

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ABSTRACT

This paper shows the existence of extreme types of zombie firm, i.e. companies with negative equity that continue to do business despite having lost their entire equity. We explain how these firms are measured and how the riskier ones are defined with different determinants. Using a Spanish sample from 2010 to 2014 an index called the EZIndex is developed that includes four dimensions of the extreme zombie problem: extension, contagion, recovery signs and immediacy. The paper contributes to zombie theory on the one hand by developing a method for ranking zombie firms based on risks and changes over time, and on the other hand by using a log-linear model to detect the riskiest corporate profiles out of all these risky firms. It demonstrates significant implications that need to be considered by the competent authorities not only in terms of their impact as a whole but also in regard to the particular profile of extreme zombie firms: they are less regulated, large and located in regions with large business fabrics.

JEL: M10; G30; G31.

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1. INTRODUCTION

The world's leading economies are striving to become more competitive in order to follow the path of sustainable growth and move into a new economic cycle (IMF, 2015). A competitive economy needs a competitive business fabric, and it is precisely here that the main weakness of many countries may lie. There is a type of uncompetitive, largely unviable company that is referred to as a "zombie firm". Such firms pose a potentially very high threat to the economy as a whole, not only because of their own looming bankruptcy, but also due to the risk they transfer to other companies, undermining their level of competitiveness and their capacity for value creation (Ahearne and Shinada, 2005; Caballero et al., 2008).

The subject of this research is the most extreme type of zombie firm, in which the protection does not come only from banks, as stated in previous literature on zombie firms, but also from creditors as a whole. They are negative equity companies that continue to trade despite having lost all their equity (see Mohrman and Stuerke, 2014 for an example). Zombie firms are analysed here using the Japanese case where banks continued to keep alive highly inefficient, debt-ridden firms, causing significant negative consequences for economic growth. However, the zombie firms theory can also be applied to other countries, at least in the sense that such firms are alive only because of the protection of creditors; otherwise, they would be dead. Along these lines, our aim is to highlight the existence of such firms in the Spanish economy, given that it is often the case that no one is aware of their presence or at least not of the seriousness of the problem. This requires measuring the level of risk that they are generating, and identifying where the greatest threat lies (industry, region and firm size). In order to assess the intensity of a firm's zombie nature, one needs to consider not only the gap between its debts and the value of its assets but also such matters as how long this situation has lasted, the knock-on effect it could have on other firms, the extent to which a possible recovery may be envisaged and the urgency of the problem. This paper therefore pursues two goals: the first is instrumental, taking the form of the construction of a composite indicator to record the seriousness of the problem caused by a zombie firm, bearing in mind the nuances already mentioned (Extreme Zombies Index, EZIndex). The second goal is to analyse the presence of zombie firms in the Spanish economy by applying that index and identifying the sources of greatest risk. Negative equity companies are part of the domestic scene not only in Spain but also throughout Europe but scholars of international finance have paid scant attention to them (Luo et al., 2015; Retolaza et al., 2016), although there is some research that addresses other scenarios, such as Japan.

This paper contributes in two different ways to the literature on the zombie economy. First of all, the presence of companies of this nature is measured through a multidimensional index that caters for the different nuances and the aggravating and mitigating circumstances of the threat that they may pose. It is thus possible to describe the scope of the problem as a whole. The methodology used for constructing this index can be transferred to other geographical contexts and indeed to highly indebted firms (though the specific ratios used would need to be adapted). Secondly, zombie firms and the threat that they pose to the economy have been identified in Japan and to a lesser extent in the United Kingdom, i.e. in two major economies, but for the time being this analysis has not been extended to other countries. That makes this a pioneering study in the case of Spain and indeed most of Europe. The sources of the greatest

threat to the Spanish economy are identified according to industry, region (autonomous community) and firm size. The results obtained may have potentially important implications in calling on the competent authorities to consider and appraise the impact that firms of this nature could have on the economy as a whole, and to make appropriate decisions accordingly.

This paper is organised as follows. Section 2 considers the potential economic impact of negative equity firms, i.e. those belonging to the group of so-called zombies. Section 3 tackles the first of our two goals, i.e. the construction of the index. Section 4 sets out the hypotheses concerning the second goal and establishes its theoretical grounding. Section 5 explains the method used in the empirical study conducted, defining the sample population and its framework, the metrics and the procedures used. Section 6 presents and discusses our main findings, including a multivariate analysis. The paper ends with an outline of our main conclusions, limitations and future research.

2. LIVING WITH ZOMBIE FIRMS

Zombie firms are highly inefficient, debt-ridden companies with very low or even negative productivity which may seriously compromise the economy and restrict a country's economic growth (Caballero et al., 2008). These authors first addressed this issue in the case of Japan, which has been striving to reactivate its economy for a quarter of a century, with no satisfactory results. However, there are recent reports on the possibility of zombie lending practices in other countries such as Spain (Prada, 2010), Ireland (Bloomberg, 2010), the UK (Papworth, 2013; Bingham, 2014) and China (Tan et al., 2016). On the one hand, such firms cause atrophy in economic development, because they prevent the market entry and consolidation of potentially efficient companies (Ahearne and Shinada, 2005), and on the other hand job creation is very low in areas with a significant proportion of zombie firms, with greater job destruction and lower productivity levels. Moreover, an increase in the number of zombie firms depresses investment and restricts job growth in non-zombie firms, and widens the productivity gap between these two types of company. According to Caballero et al. (2008), the congestion created by zombie firms reduces profits at healthy companies, thereby discouraging entrepreneurship and new investments.

Although there is no specific definition of the term "zombie firm", and much less any precise delimitation of the concept (Papworth, 2013), the relevant literature has so far used measures based on bank protection to identify such firms (Ahearne and Shinada, 2005; Hoshi, 2006; Caballero et al., 2008; Fukuda and Nakamura, 2011; Asanuma, 2015; Imai, 2016). Caballero et al. (2005) argue that zombies receive financial help from their banks through low interest rate loans, so they identify zombies based on the difference between the actual interest paid by a company and hypothetical risk-free interest payments (this minimum is estimated from the interest rates that the most creditworthy borrower pays). If the figure is negative they consider the firm as a zombie because interest payments are lower than those of healthy firms. Subsequently, Fukuda and Nakamura (2011) point out two limitations of this measure: on the one hand, there could be healthy firms whose interest rates are lower than the prime lending rates taken as a reference (in fact they identify some for the case of Caballero et al., 2008), in which case excellent firms would be mixed with zombie firms; on the other hand, it is possible that not all zombies can be identified in this way, because some may use evergreen lending to survive rather than interest rate reductions. Therefore, they propose that a "profitability criterion" be included to avoid both errors. However, Imai (2016) states that the method of Fukuda and Nakamura (2011) "is also inadequate" because temporary decreases in profits could be interpreted as a signal of zombiness. They therefore advocate using a

dynamic approach to compliance of conditions rather than a static one as an identifier of zombie firms.

So far, then, zombie firms have been identified based on bank protection. However Imai (2016), although he himself also maintains bank protection as a fundamental feature for identifying them, acknowledges that "it is important to identify zombie firms directly utilizing their financial statements". Indeed, authors such as Hoshi (2006), Tan et al. (2016) and Imai (2016) himself use various ratios from financial statements (mainly based on profitability and borrowing levels) in cataloguing firms as zombies or non zombies, and they find that their behaviour is significantly different. This paper seeks to advance the understanding of zombie firms precisely in this respect, since the criteria used to identify zombies and determine their degree of zombiness are based directly on financial statements. This strategy enables us to evaluate not only the extent, contagion, recovery and immediacy of the effects of extreme zombies on the economy, but also individually to identify the degree of extreme zombie firms.

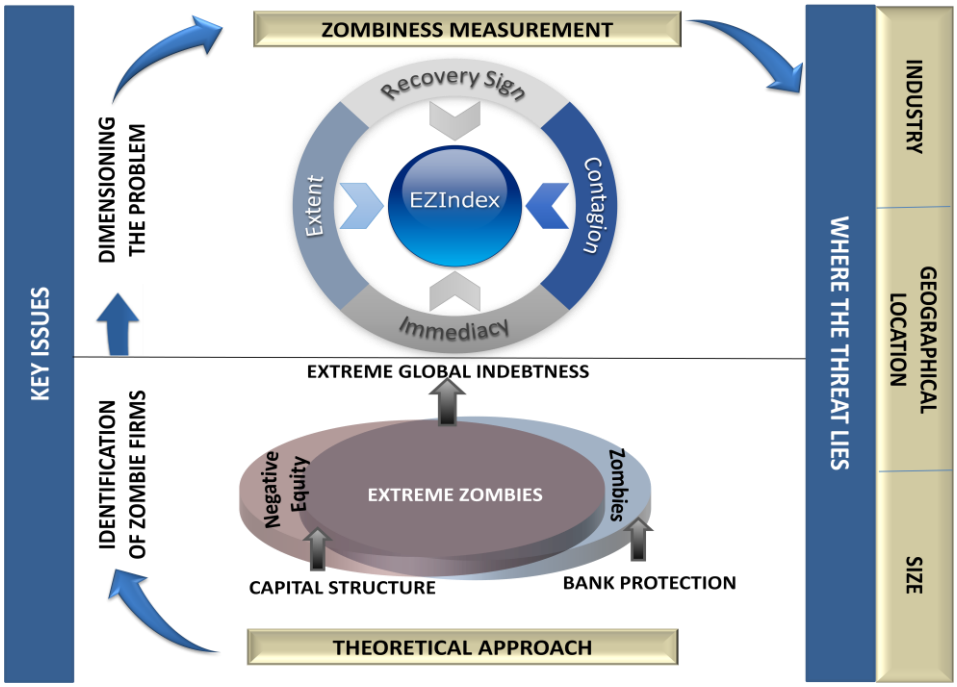
There is a standard feature that appears to be generally accepted: zombie firms are heavily indebted (Ahearne and Shinada, 2005; Hoshi, 2006; Caballero et al., 2008; Papworth, 2013; Tan et al., 2016; Imai, 2016). Therefore, the most extreme type of zombie firm comprises negative equity firms that continue to trade in spite of having lost all their equity (Mohrman and Stuerke, 2014). Firms that incur negative equity have lost their entire net worth after years of financial losses; in theory they should go into liquidation, but instead they continue doing business. Net book value is the difference between total assets and total liabilities, which owners are entitled to recover after the liquidation of the company once all its assets have been sold and all debts paid. One might assume that while negative equity firms manage to keep trading and dodge bankruptcy they do not pose any risk to the economy, but the truth is that in a stagnant situation a company of this nature would be unable to honour its commitments. In general most negative equity companies arebe "companies that are insolvent and should exit the market but are kept alive by help from creditors" (Hoshi, 2006: 32). In the case of Spain, over 80% of negative equity companies can be considered as zombies in the original sense of firms with serious liquidity problems, which is a sign of protection by creditors.

Zombie theory focuses not on individual zombie firms but rather on the problem as a whole and its potential impact on the economy. Zombie firms hurt healthy, non-zombie firms and in extreme cases turn them into zombies too, "just as zombies do in horror movies" (Hoshi, 2016, p. 32). The extent of the problem in the economy and the extent of "contagion" of other companies have been taken as the main dimensions by almost all the literature on zombies (Hoshi, 2006; Caballero et al., 2008; Imai, 2016; Tan et al., 2016). The third main dimension, concerned with the possible "recovery" of zombie firms, was first introduced by Fukuda and Nakamura (2011) with the "profitability criterion", and subsequently given a dynamic approach by Imai (2016). Zombie firms are capable of surviving a severe recession, and even of re-emerging once the economy has begun to show signs of recovery (Fukuda and Nakamura, 2011). Nevertheless, during this state of "dormancy" the risk of insolvency they face is not covered by their equity, so it is borne by other companies. In this paper we take "immediacy" as a fourth main dimension, as it is directly associated with the liquidity problems of firms and their difficulties in overcoming their dormancy. Starting from the original concept of zombie firms, based on bank protection, liquidity problems are an implicit part of the problem. However when the initial definition of zombiness is based on accounting statements, as it is here, they need to be included explicitly. The original measure for identifying zombie firms is based on their ability to meet interest payments. However that information may not be readily available in most databases, so instead we consider their

ability to meet their immediate payment requirements or short-term debts, as this is a variable that is directly observable on corporate balance sheets and is therefore easy to compare and replicate in different geographical contexts.

Our approach is set out in Figure 1:

Figure 1. Conceptual framework: EZIndex Approach based on Zombie Theory



The presence of firms with negative equity, filtered for the four dimensions recognised by the literature on zombie firms, provides a clear signal of the danger that they may pose for the economy as a whole. The transfer of risk may erode more competitive economies if it takes place in a covert fashion, because its impact on the economy is not known until the risks actually materialise. This is an even more serious problem when one considers that when shareholders have nothing to lose, as their investment has become negative, they are motivated to adopt much riskier positions and opportunistic behaviour that may increase the negative impact on the economy. Theoretically, a company that has lost all its net worth due to continued operating losses is in technical bankruptcy and should be liquidated (Correa et al., 2003), since it no longer has any resources to cover its liabilities[1]. However, there are companies that do not go into bankruptcy under these circumstances and continue trading. In Spain alone, in 2014 there were 111,259 firms with negative equity, accounting for 17.54% of the business fabric and amounting to 56.23 billion euros, which in turn accounts for 5.6% of GDP. It is therefore vital to shed light on this reality, identify the sources of greatest threat, assess their possible impact on the economy and make appropriate decisions before the risks materialise.

[1] The book value of assets does not correspond to their market value in many cases, and may be significantly higher due mainly to the value of intangibles. Nevertheless, the value of intangibles is not strippable, and it is usually attached to the rest of the company, i.e. their value is conditional on the continuation of the business. If a company were to go into liquidation, the value of these assets could depreciate by between 50% and 70% (Kaplan 1989; Holland, 1990; Shleifer and Vishny, 1992; Recio, 2011). Thus, we consider book value as the correct proxy measure here.

Yet this is not a problem that is restricted to Spain: it is a general concern throughout Europe: nearly 20% of companies have negative equity, handling over one billion euros (European sense), i.e. nearly 10% of Europe's GDP (Urionabarrenetxea et al., 2016).

3. BUILDING A MULTIDIMENSIONAL INDEX OF EXTREME ZOMBIE FIRMS: EZINDEX

Extreme zombie firms, i.e. those whose debts exceed the total sum of assets, can be readily identified using a single index. Nevertheless, if the aim is to assess the risk that firms of this nature may pose for the economy as a whole, then the four dimensions highlighted in the previous section need to be taken into account, i.e. the following additional circumstances need to be factored in:

- Has the situation of negative equity persisted over time?
- What is the contagion effect on other firms?
- Will these firms be able to reverse this situation in the medium term?
- What is the value of the short-term debt that needs to be resolved urgently?

We therefore set out here to construct a composite indicator that allows a complex dataset to be compressed into just one index. A single index is easier to interpret than many separate ones because it facilitates communication, especially with policymakers and the general public. Second, a composite indicator enables different groups to be compared (e.g. different firm sizes, regions and industries) (Freudenberg, 2003).

A typical composite indicator takes the form:

$$CI_i = \sum_{j=1}^{J} w_j \cdot I_{ji}^h$$

where:

CI_i is the composite indicator for firm i.

I_{ji}^h is the normalised simple index for factor j of firm i.

w_j is the weight of the normalised simple index I_{ij}^h such that

$$\sum_{j=1}^{J} w_j = 1 \quad y \quad 0 \leq w_j \leq 1$$

Here we follow the general assumption that there are a number of steps that need to be followed in constructing composite indicators (Nardo et al., 2005). These steps can be summed up as follows:

- Developing a theoretical framework, and identifying and measuring relevant variables.
- Multivariate analysis.
- Standardising variables and weighting variables.

Developing a theoretical framework, identifying and measuring relevant variables

When constructing an index of this kind, the first step necessarily involves establishing the scope of the problem to be addressed, with the subsequent definition of specific indicators for each one.

As already noted, the purpose of this index is to shed light on a "latent" issue, namely the existence of firms that in the event of total bankruptcy would be unable to fulfil their obligations to their creditors according to the book value of their assets, with the risk that this entails for them accordingly. We therefore posit, according to the literature, that the following dimensions need to be considered:

- Extent of the problem. The aim here is to quantify the contribution that a given company makes to the problem. Indicators are required to value the losses that it would cause to the economy.
- Contagion effect. The impact that the firm's insolvency would have on other companies as creditors needs to be assessed. This dimension seeks to reflect the level of risk assumed by creditors.
- Recovery signs. The situation the firm has reached may be more or less serious depending on its reversibility; in other words whether its continued trading can generate a positive return in terms of equity and this problematic state of affairs will therefore disappear.
- Immediacy of the problem. The severity of the problem will increase as the due date of debts grows closer, as there is less time available to reverse the situation.

All four of these dimensions are required to understand the problem as a whole.

A holistic view of the problem needs to be provided, so the EZIndex needs to adopt a two-fold perspective that is both static and dynamic. Furthermore, we believe that the variables should be expressed as ratios, i.e. relative measurements, so that comparisons can be drawn between firms and it can be ensured that firm size does not distort the conclusions reached.

Finally, in order to facilitate their interpretation, the different indicators are all defined in the same direction, with higher levels denoting more problematic situations.

In keeping with these dimensions and by adopting the above criteria, the following indicators have been defined[2]:

Table 1. Simple indicators quantifying the level of negative equity

Dimensions		Indicators	
		Static	Dynamic
Amount	Extent of the problem	$\frac{\text{Neg. Equity}_i}{\sum_{i=1}^{N}\text{Total Neg. Equity}_i}$	$\frac{\Delta\text{Neg. Equity}_i}{\sum_{i=1}^{N}\text{Total Neg. Equity}_i}$
	Contagion effect	$-\frac{\text{Neg. Equity}_i}{\text{Assets}_i}$	
		$1-\frac{\text{Assets}_i}{\text{Debt}_i}$	
Temporality	Recovery signs	$1-\frac{\text{CF}_i}{\text{Debt}_i}$	$-\frac{\Delta\text{Neg. Equity}_i}{\text{Debt}_i}$

[2] This method can be used for firms of all kinds, but the specific indicators are adapted for firms with negative equity.

		$1 - \frac{\text{EBIT}_i}{\text{Assets}_i}$	
	Immediacy of the problem	$1 - \frac{\text{Assets}_i}{\text{S/T Debt}_i}$	

As can be seen, different accounting variables are used to reflect the same phenomenon. We consider that the combination of variables will help to show more accurately the different dimensions of the problem to be measured.

Multivariate analysis

First, a Principal Components Analysis (PCA) was performed to group factors together and thus reduce the size of the dataset. The principal goal of the multivariate analysis technique is to reveal how variables are associated: it groups together collinear indicators to form a composite indicator that captures as much common information between indicators as possible.

After the explanatory factors were analysed a confirmatory analysis was run to check the reliability and validity of the scales of measurement used (Hurley et al., 1997). The results are shown in Table 2[3]. These results were obtained by using the mean values of the simple indicators for the time frame considered. It should be noted that similar results are obtained for each of the years in this period, which reinforces the validity of the indicator proposed.

Table 2. Factor loadings and descriptive statistics

	Standardised weights	Mean (%)	Std. dev. (%)		Standardised weights	Mean (%)	Std. dev. (%)
Extent of the problem							
$\frac{Neg.Equity_i}{\sum_{i=1}^{N} Total\ Neg.Equity_i}$	0.907	0.0445	0.216	$\frac{\Delta Neg.Equity_i}{\sum_{i=1}^{N} Total\ Neg.Equity_i}$	0.905	0.0055	0.053
Contagion effect							
$-\frac{\text{Neg. Equity}_i}{\text{Assets}_i}$	0.883	115.27	248.24				
$1\text{-}\frac{Assets_i}{Debt_i}$	0.872	35.09	21.62				
Recovery signs							
$1 - \frac{\text{CF}_i}{\text{Debt}_i}$	0.946	101.88	11.50	$-\frac{\Delta Neg.Equity_i}{\text{Debt}_i}$	0.726	5.677	11.60
$1 - \frac{\text{EBIT}_i}{\text{Assets}_i}$	0.949	101.03	12.24				
Immediacy of the problem							

[3] The Kaiser-Meyer-Olkin Measure of sampling adequacy is 0.63.

$1-\frac{\text{Assets}_i}{\text{S/T Debt}_i}$	0.992	113.05	639.36				

The internal consistency of the indicators is assessed using composite reliability (ρ) and Split half method[4]. The average variance obtained is also calculated (Table 3). With regard to convergent validity, composite reliability and Split half method should be greater than 0.70 and the variance extracted and the factor loadings greater than 0.5. These requirements are met for all points.

Table 3. Internal validity measures

	Explained variance	Average variance extracted	ρ (composite reliability)	Spearman-Brown Coefficient (equal length)
Extent of the problem (X)	82.478%	0.821	0.902	0.940
Contagion effect (Y)	81.395%	0.770	0.870	0.772
Recovery sign (W)	80.158%	0.774	0.910	0.931
Immediacy of the problem (Z)	-	–	–	–

Standardising variables and weighting variables

Standardisation is required prior to any data aggregation, as the indicators in a dataset often have different units of measurement. The standardisation proposed for the simple indicators is:

$$I_{ji}^{h}=\frac{I_{ji}-\min(I_{ji})}{\max(I_{ji})-\min(I_{ji})}$$

This brings the various indicators together on a single scale (0 to 1), thus enabling them to be integrated into a higher order (composite) indicator in accordance with their relative variance.

Once the standardising variables (I_{ji}^{h}) have been identified, weights must be assigned to each one so that the composite indicator can be calculated. Those weights must reflect the contribution of each indicator to the overall composite. The components are aggregated by

[4] There are several ways of estimating the degree of confidence for internal consistency. The two most widely used are Cronbach's Alpha and the Split Half Method. Both have their critics. Cronbach's alpha is affected not only by the correlation between responses but also by the number of items that make up the scale (Tavakol and Dennick, 2011). In our case there are few items so it is reasonable to expect low values for Cronbach's alpha, which do not necessarily signal a low level of correlation between items. As an alternative the Split Half Method (Flynn et al., 1990) can be used. The main criticism levelled at this method is that there can be many different splits into two halves, which may give different results for the reliability coefficient. However in this case the factors are made up of only two (or three) items, so this criticism is rendered meaningless.

weighting each composite using the proportion of the variance explained in the dataset (OECD, 2008).

This means that the EZIndex for a firm "i" is calculated via the weighting of the various constructs as follows:

$$Index_i = k_1(X_i)+k_2(Y_i)+k_3(Z_i) + k_4(W_i)$$

Where k_j; j= 1,…,4 are calculated in terms of the proportion of variance explained by each factor.

After weight and coefficients were analysed the EZIndex was developed as:

$$EZIndex= 0.433\ X+ 0.251\ Y + 0.177\ Z+ 0.139\ W$$

4. HYPOTHESES AND GROUNDING IN THEORY

When the EZIndex is created it can be used to identify the sources of greatest threat in the Spanish economy, according to the implicit assumption that firms with less equity and their intensity are not uniformly distributed. The three target characteristics of these firms will be analysed: industry, location and size.

As regards industry, it should be noted that studies of capital structure (i.e., Jong et al., 2008; Booth et al., 2011) often employ dummy variables to control for the effect of industry on leverage. There are few studies that use industry as a direct determinant. Kayo and Kimura (2011) analyse firm structure using three-level characteristics: level 1 (time), level 2 (firm characteristics) and level 3 (industry/country interaction). They analyse three major characteristics of industries, i.e. abundance of resources in a given industry or dynamism and the instability or volatility of that industry. They conclude that industry-level characteristics account for nearly 12% of leverage variance. Simerly and Li (2000) also analyse industry dynamism, but only as a moderator variable of leverage on a firm's return-on-assets. Ferri and Jones (1979) assert that companies in the same industry tend to reflect similar patterns of business risk because they produce similar products, have similar costs of skilled labour and raw material and depend on similar technologies. In this sense, just as riskier firms record higher leverage an industry that aggregates these riskier firms may be expected also to have higher leverage, so the specific industry can be expected to be a determinant that sheds light on the similar characteristics expected of companies in it (Hoshi, 2006). Using the analogy of Japanese zombie firms, Caballero et al. (2006) conclude that the presence of zombies in an industry mainly threatens the non-zombies in the same industry. Thus, industry is a determinant from our point of view (MacKay and Phillips, 2005).

Regarding the type of sector, it should be noted that regulation determines the type of industry affected by zombies: a priori highly regulated sectors such as finance, insurance and the public administration itself can be expected to have a residual effect because of the expected low volume of negative equity, while companies in high leverage sectors such as construction, or in lightly regulated sectors, are expected to be more likely to become zombie firms (Hoshi, 2006).

A further factor to be considered in relation to the operating industry is its intensive nature in terms of intangibles. The total value of a firm's resources does not appear on its balance sheet, because accounting standards impose limitations on the inclusion of intangible resources as book assets (IAS 38, 2004; IAS 36, 2004; IFRS, 2004) (García-Meca and Martínez, 2007). Those firms with a greater volume of off-balance-sheet intangibles may survive and obtain

funding over and above the value of their book assets, as they have resources that do not appear on their balance sheet. Furthermore, much of their investment in intangibles (e.g. training and advertising) is recorded as operating costs, which reduce a firm's earnings and, indirectly, its equity. Therefore, firms with a heavy presence of intangibles are more likely to become zombie firms.

The above discussion leads to the following hypothesis (stated in the alternative form):

H_1: The EZIndex differs depending on the industry to which firms belong

$H_{1.1}$: The EZIndex is higher in highly leveraged industries

$H_{1.2}$: The EZIndex is higher in industries with less regulation

$H_{1.3}$: The EZIndex is higher in industries with a heavy presence of intangibles

Another characteristic to be considered is the location of firms, which impacts on organisational culture because a firm's behaviour, management and strategy are affected not only by local culture but also by local resources, infrastructure and government control. Regarding location, there are studies that use the zombie effect as the focus of their analysis to conclude that zombie firms are more likely to be located outside large metropolitan areas (Hoshi, 2006), maybe because of their reduced access to a financial regulation system, lower visibility and reputation and less control from government. In the case of Spain, Carbó et al. (2003) conclude that the degree of development of the regional financial system is not homogeneous, and that this directly affects firms' structure. This extreme financial situation in firms could therefore be affected by localisation: there are at least statistically significant regional differences in the capital structure of Spanish SMEs (Palacín-Sánchez et al., 2013). A comparison of Spain's regional autonomous communities shows that those with the highest debts are Andalusia and Castilla-La Mancha, but there are in fact ten regions with above average debts (Madrid, Murcia, Galicia, Extremadura, Community of Valencia, Castilla-Leon, Cantabria and Asturias (data from SABI[5])). The differences in results for companies in different regions could be due to differences in investment capacities, centralisation levels, regulation levels, control effort and competitive advantage. Localisation-related factors can thus be expected to affect zombie firms, so the following hypothesis is formulated:

H_2: The EZIndex differs depending on firms' geographical location

$H_{2.1}$: The EZIndex is higher in regions with a less extensive business fabric in regard to their populations.

$H_{2.2}$: The EZIndex is higher in those regions with higher levels of debt

The third characteristic to be analysed is firm size, which in general affects the type of management, financial policies and capital structure decisions (Hoshi, 2006, Sánchez-Vidal, 2014; Palacín-Sánchez et al., 2013).

Size is positively related to debt (Ramalhoa and Vidigal da Silvab, 2009): larger firms tend to be more diversified, so their probability of bankruptcy is relatively smaller and they can afford higher levels of borrowing. On the one hand information asymmetries are less severe for larger firms, and many of them have credit ratings which enable them to gain greater access to non-bank funding. Such access is very difficult for smaller firms to obtain (Faulkender and Petersen, 2006). On the other hand, the attitude of banks towards larger firms is different as regards funding: when they make losses and begin to "burn" their equity there is a greater tendency not to permit them to fail. This can lead to levels of financial leveraging that smaller firms are unlikely to be able to match (Hoshi, 2006). Small firms may have fewer

[5] Iberian System for Balance Sheet Analysis.

opportunities to access outside financing, so they may have lower debt ratios (Salas-Fumas, 2015). Furthermore, the higher rate of default that they record (Herce and Hernández, 2014) dissuades financial institutions from granting them credit.

We therefore propose the following:

The size of the negative equity structure assumed by each business unit can be high, and can have a considerable impact on large-size companies. The above discussion leads to the following hypothesis (stated in the alternative form):

H_3: The EZIndex differs depending on firm size

$H_{3.1}$: The EZIndex is higher in large corporations than in medium-sized ones

$H_{3.2}$: The EZIndex is higher in medium-sized firms than in small ones

$H_{3.3}$: The EZIndex is higher in large corporations than in small ones

5. METHOD

Definition of the sample

The data on firms with negative equity was gathered from the SABI database. The analysis involved those firms that recorded negative equity over the five business years from 2010 to 2014 (totalling 1271). The analysis therefore focused on firms that persisted in this situation over time, and thus covered the most extreme cases. This paper does not set out to analyse the crisis, but it has been concluded previously that zombie firms do not exist only at times of crisis (Retolaza et al., 2016), so there is no reason to add more years. We therefore use the most recent period in our analysis The study disregards micro-enterprises with fewer than 10 employees, as in such companies there is frequently no clear line drawn between the owners' personal assets and the firm's equity. The proportion of companies with negative equity in each sector / region / size with respect to the total population is controlled for: there is no representativeness error.

Econometric method

Firstly, in order to determine the extent to which the data matched the relations posited in the hypotheses we conducted a descriptive analysis of the data. Secondly, we tested the hypotheses themselves. A Kolmogorov-Smirnov test indicated that the EZIndex did not fit a normal distribution, so we performed non-parametric tests. Specifically, given that the purpose in all the hypotheses was to compare the behaviour of sub-samples, we used the Mann-Whitney U test. Thirdly, a log-linear analysis was conducted to estimate the quantity and sign of the effects of the size, sector and region variables together on the EZIndex, so as to identify corporate profiles linked to higher values of the index, i.e. to identify those firms at most risk within the group of zombie firms analysed in the study.

Scales of measurement

More/less leveraged industries: This is measured by the aggregate debts in each industry. The median is used for establishing a high leverage level because it eliminates the potential negative effect of skewness.

Regulated/non-regulated industries: Based on the study by Hoshi (2006), finance, insurance and the public administration are considered as regulated industries.

Industries intensive/non-intensive in intangibles: According to OECD criteria (1999), knowledge-intensive industries include highly technological industries, advanced services to

companies and others such as education, health and financial brokerage, plus the so-called "creative industries" (Méndez and Tébar, 2011).

More/less leveraged regions (Spain's autonomous communities): This is measured by the aggregate debts in each region. Andalusia, Castilla-La Mancha, Extremadura, Galicia, Madrid and Murcia are the most highly leveraged autonomous communities.

Regions with a larger/smaller business fabric: Number of firms/head of population (data provided by INE[6]). The autonomous communities are divided into two groups around the median (Madrid, Catalonia, Galicia and Community of Valencia have the largest business fabrics, while Andalusia, Extremadura, Castilla La Mancha and Murcia have the smallest). This measure is based on Hoshi (2006) but includes the number of firms with the aim of eliminating the possible effect of population-employee differences (age pyramid effect). However, the results using just the population and those for the population corrected by firms are similar for Spain; the regions with the largest business fabric are Madrid, Catalonia and Galicia.

Small/medium/large enterprises: Classification according to headcount (small <50, 49<medium<250, large>249 employees) (European Commission Recommendation C (2003) 422 approved on 6 May 2003).

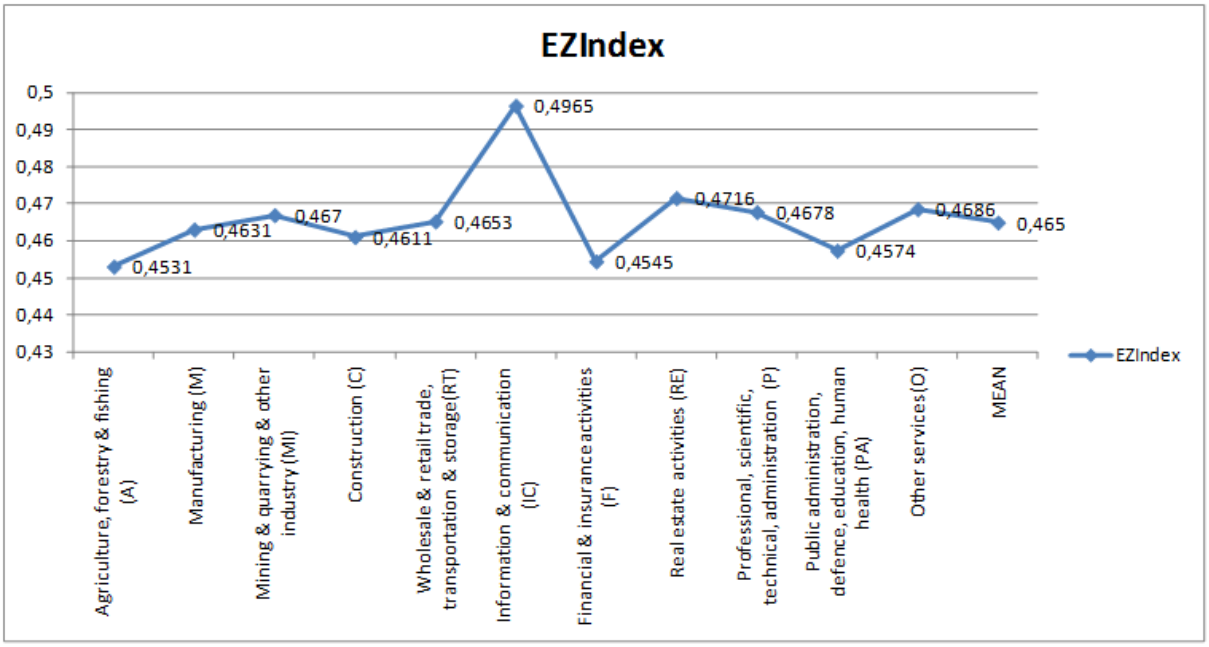
6. RESULTS AND DISCUSSION

As stated above, we analysed industry (in line with criteria of level of leverage, regulation and intensity of intangibles), geographical location (level of leverage and business fabric) and company size as factors that may affect the EZIndex[7]. This section shows the results of the descriptive analysis, the univariate analysis and, finally, the log-linear analysis.

Figure 2 shows the index value of industries: the industry with the highest index is the Information and Communication (C) industry (0.4965 points), followed by Real Estate (0.4716), while others are less affected by this financial situation, such as Agriculture, forestry and fishing (A) (0.4531 index points), Financial and Insurance activities (F) (0.4545) and Public Administration (0.4574 points). The reasons why they are not highly affected by this phenomenon could be their specific characteristics related not only to extent but also to contagion. In the case of small, highly concentrated industries contagion is probably direct, and the economy affects them negatively. The reasons why they are less affected by this phenomenon could be the control established over them by the authorities in this regard: they are highly regulated or are directly attached to the government. The manufacturing sector has been identified in previous studies as being less likely to have zombie firms (Hoshi, 2016), and occupies an intermediate position according to the EZIndex, slightly above the mean and the median.

[6] Spain's Office of Statistics.
[7] The results for the descriptive statistics are shown in Annex I.

Figure 2. EZIndex classified by industry: descriptive.



There are certain common factors that could determine differences across industries: the intensity of intangibles, leverage and regulation (explained in the section on scale). These aspects are therefore analysed in depth to establish whether an industry could characterise this extreme zombie phenomenon and to find what type of determinants affect it. This will enable us to control not only for overall industries but also for some of the differentiations and common factors of different industries. Table 4 presents the analysis, which shows that the second hypotheses ($H_{1.2}$) is accepted and the first and third hypotheses ($H_{1.1}$ and $H_{1.3}$) are rejected. This means that the intensity of intangibles and indebtedness hypothetically affects the zombie effect; however, statistically there are no differentiations, so we cannot use them as determinants of our index. Regulation and the level of indebtedness of each sector are variables that affect the EZIndex significantly. Regulation could be used to control this phenomenon, reducing the effect (a lower index). It is stressed that regulation is an efficient way to control zombie firms.

Table 4. Industry effects in the EZIndex.

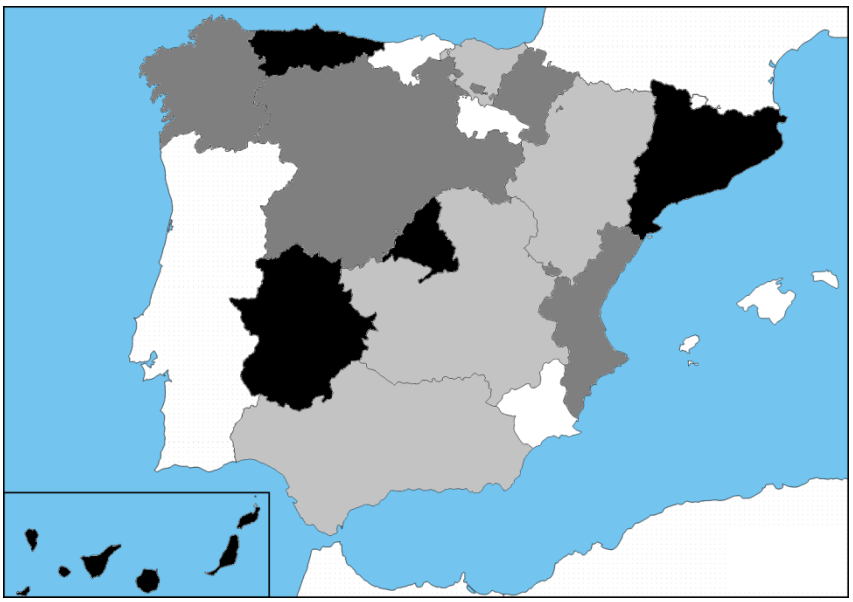
Hypothesis	Industry Type	EZIndex	Z Statistic (α)	Mann-Whitney U	Wilcoxon W
$H_{1.1}$	More leveraged industries	0.46965	0.495	1666060.500	584215.000

	Less leveraged industries	0.46513	(0.621)		
$H_{1.2}$	Less regulated industries	0.46576	2.241	74329.500	744232.500
	Highly regulated industries	0.45733	(0.025)*		
$H_{1.3}$	Intangible-intensive industries	0.46715	-0.013	91187.500	703358.500
	Less intangible-intensive industries	0.46469	(0.990)		

*p-value in parenthesis; *p<.05; **p<.01*

In regard to geographical location, Figure 3 shows the EZIndex level for each of Spain's regions or autonomous communities. The communities belonging to the quartile at the greatest risk are shaded in black, followed in descending order by dark gray, light gray and, finally, white for the quartile where risk is lowest. As can be seen, the potential impact of firms with negative equity on the economy may be significant in Madrid, Catalonia, Extremadura, Asturias and the Canary Islands, whereas their potential repercussions are lowest in Cantabria, La Rioja, Murcia and the Balearic Isles. The communities with the highest risk levels are Extremadura (EZIndex: 0.4777) and Madrid (EZIndex: 0.4727).

Figure 3. EZIndex classified by geographical location: descriptive.



The second hypothesis posits that the EZIndex differs depending on geographical location. In order to identify the factors underlying these common behaviour patterns, we raised two possibilities: first, the level of development of business in the region; and second the aggregate leverage in the region. According to sub-hypothesis $H_{2.1}$, those communities that have developed a larger business fabric in relation to their population size are less at risk from the possible impact of negative equity firms, as such regions offer greater access to outside financing, better technology transfer, greater visibility, improved production structures and

stricter governmental control, all of which improves results and detects any anomalous situations such as the presence of firms with negative equity fairly quickly. Nevertheless, this sub-hypothesis is rejected, and the results indicate that the situation is clearly the other way round. The communities with larger business fabrics, such as Madrid, Catalonia, Baleares, La Rioja, Galicia, Community of Valencia and The Basque Country, have significantly higher EZIndex readings than Andalusia, Extremadura, Castilla La Mancha, Murcia, Cantabria, Asturias, etc., where the business fabric is smaller, while the mean EZIndex is significantly lower. Communities with a more highly developed business fabric can provide clear advantages for business activities, but it is their easier access to outside financing that seems to carry the greatest weight. A moderate level of this facility is positive, but with high levels of leverage it may compromise the economy as a whole. Another argument for this effect is that defended by Hoshi (2006), who predicts that there will be more zombie companies in metropolitan areas where the asset price boom and subsequent collapse were prominent during the crisis years (Hoshi, 2006, expected but not confirmed for the case of Japan). This is confirmed for the case of Spain.

In turn, sub-hypothesis $H_{2.2}$ considers that the most highly leveraged communities at aggregate level pose a greater threat in terms of the intensity of negative equity firms. This hypothesis is rejected because the relationship is not significant. The level of leveraging in these communities seems to be uniformly distributed across all firms, so it does not lead to excess leveraging of just some of them.

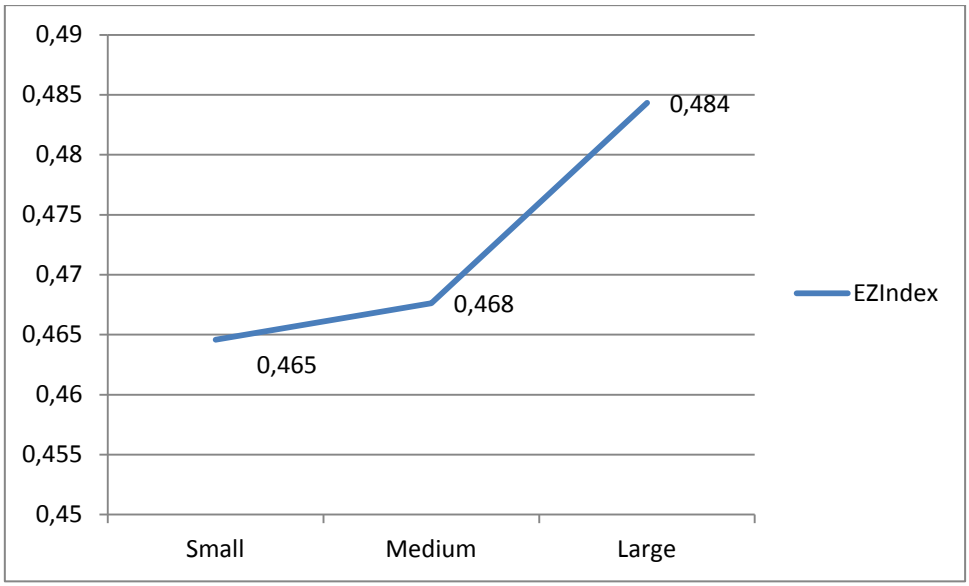
Table 5. Geographical location effects in the EZIndex.

Hypothesis	Type of community	EZIndex	Z Statistic (α)	Mann-Whitney U	Wilcoxon W
$H_{2.1}$	Larger business fabric	0.46679	2.833	193359.000	566175.000
	Smaller business fabric	0.46126	(0.005)**		
$H_{2.2}$	Greater leveraging	0.46500	-0.072	169370.000	564975.000
	Lesser leveraging	0.46507	(0.943)		

*p-value in parenthesis;*p<.05; **p<.01*

Lastly, firm size is a factor that has a significant impact on the behaviour of the EZIndex (Figure 4). By far the greatest risk lies in large corporations, while small firms contribute very little to the problem of negative equity firms. $H_{2.1}$ is accepted and $H_{2.2}$ is rejected.

Figure 4. EZIndex classified by firm size: descriptive.



The last three hypotheses posit that the bigger a firm is, the higher the EZIndex will be. Only the third of these hypotheses ($H_{3.3}$) – which posits that large firms have significantly higher EZIndex levels than small ones – is confirmed. There seem to be two possible reasons for this: on the one hand, large corporations have greater access to borrowing and greater negotiating power if they need to borrow more than would be advisable under a sound financial position; on the other hand, when a large firm becomes a zombie banks protect it and shore it up with more borrowing to stop it failing (Hoshi, 2006). This may become a closed loop from which it is difficult to escape. Small firms have levels of EZIndex that are significantly lower than larger firms, mainly because their access to outside financing is restricted and the credit tap is quickly turned off as soon as there is the slightest hint of default. By contrast, larger corporations are almost never allowed to fail.

Medium-sized firms do not show behaviour that is significantly different from either large or small firms, so hypotheses $H_{3.1}$ and $H_{3.2}$ are rejected. However, the arithmetic mean of the EZIndex does show some correspondence with the ordinal scale of the size variable, i.e. the bigger the firm the greater the zombie firm likelihood. Large firms tend to be backed by governments (because of the negative impact that their failure could have on the economy as a whole) and by society (because it is taken for granted that a company can only grow big by performing well). However, the data reveal a hidden fact: the greatest risk lies precisely in large firms.

Table 6. Firm size effects in the EZIndex.

Hypothesis	Type of community	EZIndex	Z Statistic (α)	Mann-Whitney U	Wilcoxon W
$H_{3.1}$	Large	0.48433	1,762 (0,078)	812.500	903.500
	Medium	0.46761			
$H_{3.2}$	Medium	0.46761	0,608 (0,543)	57854.500	62510.500
	Small	0.46458			
$H_{3.3}$	Large	0.48433	2,082 (0,037)*	10086.000	10177.000
	Small	0.46458			

*p-value in parenthesis; *p<.05; **p<.01*

Univariate analysis enables two variables to be ruled out as determinants for the EZIndex: high intensity of intangibles in sectors and the level of indebtedness of regions. Given that the remaining variables are significantly linked to the index, we seek below to identify the corporate profiles that show high EZIndex values and that should therefore be monitored due to their risk potential. The multivariate statistical analysis technique used is log-linear analysis, which enables categorical variables from a contingency table with more than two variables to be related, considering one in particular as dependent on the rest, through log regression functions (Jobson, 1992).

Partial association tests were applied, and reveal that the model which best represents the behaviour of the EZIndex, and therefore provides the best fit, is the one based on the data in Table 7 ($G^2 = 3.887$; g.l. = 7; overall significance = 0.793)[8].

[8] The fit according to coefficient G^2, which expresses the verisimilitude ratio with the χ^2 distribution, is a reference for checking the predictive capability of the model.

Table 7. Estimated coefficients and frequencies of the log-linear model for the variable "score obtained".

$$\varphi_{ijn}^{Y} = \lambda_{ijn} + \beta^{Y} + \beta_{i}^{YX} + \beta_{j}^{YF} + \beta_{n}^{YZ}$$ [9]

Size	Industry	Location	EZIndex	λ_{jin}	β^{Y}	$\beta^{YX}{}_{i}$	$\beta^{YF}{}_{n}$	$\beta^{YZ}{}_{n}$	Theoretical Frequencies	Real Frequencies
Small	High regulation	Small business fabric	Low	2.183	-1.279*	1.150*	0.253	0.41*	63.0%	58.3%
			High	2.183					37.0%	41.7%
		Large business fabric	Low	3.52	-1.279*	1.150*	0.253		53.1%	52.8%
			High	3.52					46.9%	47.2%
	Low regulation	Small business fabric	Low	5.048	-1.279*	1.150*		0.41*	57.0%	57.20%
			High	5.048					43.0%	42.80%
		Large business fabric	Low	5.926	-1.279*	1.150*			46.8%	46.9%
			High	5.926					53.2%	53.1%
Medium	High regulation	Small business fabric	Low	0.207	-1.279*	0.979	0.253	0.41*	59.0%	66.7%
			High	0.207					41.0%	33.3%
		Large business fabric	Low	1.895	-1.279*	0.979	0.253		48.8%	61.5%
			High	1.895					51.2%	38.5%
	Low regulation	Small business fabric	Low	2.14	-1.279*	0.979		0.41*	52.8%	55.6%
			High	2.14					47.2%	44.4%
		Large business fabric	Low	3.573	-1.279*	0.979			42.6%	38.7%
			High	3.573					57.4%	61.3%
Large	High regulation	Small business fabric	Low	0	-1.279*		0.253	0.41*	-	-
			High	0					-	-
		Large business fabric	Low	0.387	-1.279*		0.253		-	-
			High	0.387					-	-
	Low regulation	Small business fabric	Low	-0.35	-1.279*			0.41*	-	-
			High	-0.35					-	-
		Large business fabric	Low	2.057	-1.279*				21.8%	30.0%
			High	2.057					78.2%	70.0%

The blank spaces in the table are redundant values, and the β show the expected frequency logs.

-: The frequencies are null or practically null. It is logical for some crossovers between different categories to give null observed frequencies, because such situations seldom arise in reality: there are very few large companies that are highly regulated and that are located in regions with a small business fabric. That is why these boxes are blank.

[9] The super-indices indicate the effects of the explanatory variables and the sub-indices show that the effects can have different values. For instance the variable X refers to business size, and the corresponding sub-index i can take three different values (large/medium/small).

In this model the various parameters are defined as follows:

$\varphi_{ijn}^{Y} : \ln(f_{ijn})$

$f_{ijn}(*)$: frequency according to the model posited $\Rightarrow 100 \times \frac{e^{\varphi_{ijn}^{Y}}}{e^{\varphi_{ijn}^{bajo}} + e^{\varphi_{ijn}^{alto}}}$

* Estimates significant for a confidence level of 90%

$\varphi_{ijn}^{Y} = \ln(f_{ijn})$, where f_{ijn} represents the absolute frequencies of the cell *ijn*.

λ_{ijn} : Constant term.

β^{Y} : Baseline.

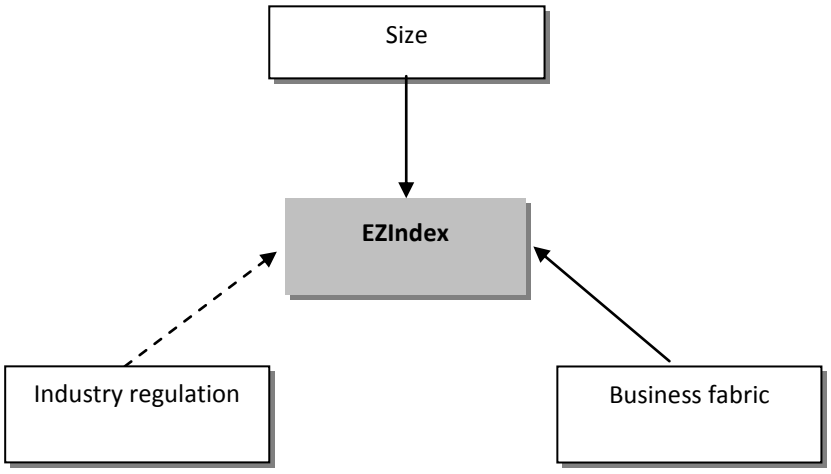
β_{i}^{YX} : Effect in φ_{ijn}^{Y} of business size (X) on the dependent variable (*Y*).

β_{j}^{YF} : Effect in φ_{ijn}^{Y} of whether or not the firm belongs to a regulated sector (F) on the dependent variable (*Y*).

β_{n}^{YZ} : Effect in φ_{ijn}^{Y} of whether or not the firm belongs to a region with a large business fabric (Z) on the dependent variable (*Y*).

Business size and business fabric are significant variables, and in both cases what is posited in the univariate analysis is confirmed: size is positively linked to the index, but in the case of business fabric the effect is the opposite (see Figure 5). As far as size is concerned, larger firms have significantly higher EZIndex levels: according to the model posited small firms are three times more likely to have a low EZIndex than large ones (β^{YX}_{j} for small firms: $e^{1,15}$ =3,1) *ceteris paribus*. Large firms are certainly associated with greater risk than small ones.

Figure 5. Logarithmic model that predicts the EZIndex company profile.



———— Significant links according to linear *logit* analysis

- - - - - - - - - - Non-significant links according to linear *logit* analysis

As far as regions are concerned, contrary to our initial hypothesis but in line with univariate analysis and the first approach Hoshi (2006), firms in regions with a large business fabric have significantly higher EZIndex values. A firm that operates in a region with a small business fabric is 50% more likely to have a low EZIndex level than one from a region with a large business fabric ($\beta^{YZ}_{n} : e^{0,41} = 1.5$).

Whether or not a sector is regulated (a significant variable in univariate analysis) ceases to be significant when it comes into interaction with the two aforesaid variables. However, the logarithmic model posited on the basis of the coming together of all three variables gives a highly reliable explanation of reality, as can be observed in Table 7, and clearly shows the locations of the hotspots where there is most danger among zombie firms (high EZIndex). The highest risk profile is certainly that of large firms with low regulation and a large business fabric: more than 70% of firms with such a profile have a high EZIndex. It would be logical to assume that the "political and social pressure to protect troubled firms and their employment may be stronger in smaller cities" (Hoshi, 2006: 40), and the results in that paper follow precisely that line. However in Spain this effect is not found and the contrary may even occur. Larger companies in locations with large business fabrics may be more protected by the authorities precisely because "almost everywhere in the world, there is pressure to save a troubled company with a large number of employees" (Hoshi, 2006: 31).

The second biggest risk profile is that of medium-sized firms with low regulation and large business fabrics: according to the model posited, over 57% of such firms can be expected to have a high EZIndex. The third riskiest profile is that of small firms with low regulation and large business fabrics, among which the likelihood of a high index level is just over 53%. These results enable us to confirm that both regulation and concentration of businesses are determinant factors of high-risk situations, the former because lack of foresight increases permissibility and the latter because the contagion and herding effects are found more frequently when firms are more highly concentrated. The size effect is scaled: the smaller the size the lower the risk.

Table 8. The three highest-risk corporate profiles according to the EZIndex

Risk level	Size	Sector	Region
1	Large	Low regulation	Large business fabric
2	Medium		
3	Small		

In all three of the high risk profiles detected firms are in regions with large business fabrics and in sectors with low levels of regulation (Table 8). On that basis, risk then increases in parallel to business size. In Spain it seems that the initial argument in the expectations of Hoshi (2006) is consistent with the data, and the effect of a large business fabric in some regions may be influenced by the real estate boom and the collapse in the crisis years.

Regulation, in turn, seems to be effective as a control for extreme zombie firms. Supervision and monitoring of these sectors seems to create an awareness of the problem that helps to reduce its negative effects. Finally, size enables the problem to be scaled: "small firms mean small problems". This leads us to question whether corporate growth is efficient in the long term in all areas, because there comes a point at which firms "are too big to fail". From the viewpoint of this analysis of zombie firms, they should indeed be a limit on corporate growth based on debt.

However, taking into account all the corporate profiles drawn up and not just the three with the highest index levels, it can be observed that business size and business fabric act as risk markers: regardless of whether or not sector is regulated, larger size and location in a region with a large business fabric are associated with higher risk. A great deal of risk is built up in large and medium sized firms in regions such as Madrid, Catalonia and Galicia. This denotes a contagion effect in which more permissive situations may arise. As mentioned above, large firms cannot be allowed to fail, and this enables some large firms to exist as extreme zombie firms (they have greater access to non-bank funding and are treated more permissively by banks). Moreover, the locations most affected are those where the number of firms is highest, because they can reinforce their positions and create a culture, while at the same time exerting joint pressure on authorities and banks.

7. CONCLUSIONS

The existence of zombie companies in a country reflects the level of business competitiveness and also the permissibility of the country in regard to the infecting of other, healthy companies. This phenomenon has been analysed for more than a decade in Japan and to a lesser extent also in the United Kingdom and China. Despite its significance, that concern has not been transferred to other economies that might potentially be exposed to the same problem. The gap in the literature concerns not just the very few geographical areas where the problem of zombie firms has been studied but also the procedure used to identify them and measure the extent of the problem. To date zombie firms have been identified in literature based on a single trait – bank protection – and have been measured solely in terms of bank interest payments.

This paper seeks to tackle these gaps in zombie firm literature. The case of Spain is presented using extreme zombie firms, i.e. companies with negative equity. The crisis is not a contingency that directly affects the creation of zombies, so we decided to choose the latest five years available for analysis; to our knowledge there are no underlying forces that directly affect this phenomenon during those years, so they are good enough to represent the context. In 2014 17.54% of all active companies were doing business with negative equity in Spain, which means 56.23 billion Euros, i.e. 5.6% of GDP. To draw up an in-depth, all-round assessment of the risk of extreme zombie companies, an index called the EZIndex (Extreme Zombie Index) has been developed that includes four dimensions of the problem: extent, contagion, recovery signs and immediacy. The index seeks to explain extreme zombie companies' persistence over time, the effect that they have on other, healthy companies, the possibility of them recovering and the urgency of the problem. By contrast with earlier literature, the indicators needed to construct the EZIndex are drawn from the accounting statements of companies, as advocated by the most recent studies (Imai, 2016, Fukuda and Nakamura, 2011). The negative effect of zombie companies on economies – analysed in

depth in the papers by Hoshi (2006) and Caballero et al. (2008) – is highlighted for Spain too in this paper. But that is not all: certain features characteristic of zombie firms are defined in terms of four dimensions, and the relative importance of the zombie effect is established individually in each of the companies analysed.

Using the EZIndex we have detected some determinants of the situation in Spain that will contribute to zombie theory. With regard to sectors of industry, we analyse not just the behaviour of the different sectors grouped based according to conventional criteria (manufacturing/construction/real estate/retail/wholesale trade) but also as analysed in Hoshi (2006) and Caballero et al. (2008): accordingly, we conduct a study of the different sectors based on characteristics that may have a significant effect on whether or not there are zombie firms. This leads us to conclusions that go beyond those presented in earlier studies. This paper identifies regulation as a variable for discriminating between zombie and non zombie firms: it could be used to control this negative effect in the economy because the most highly regulated sectors (finance, insurance and public administration) perform better in the EZIndex. With regard to location, regions with larger business fabrics show greater risk, i.e. Madrid, Catalonia, Galicia and Valencia in the case of Spain. This corroborates the initial hypothesis put forward by Hoshi (2006). Communities with a more highly developed business fabric can provide clear advantages for business activities, but it is their easier access to outside financing that seems to carry the greatest weight. Finally, large companies are the riskiest because they do not show good levels in any of the four dimensions of the index (extent, contagion, recovery signs and immediacy). Professionalism and information systems at large companies do not prevent them incurring situations of negative equity in all four dimensions. This suggests that creditors protection could be behind this permissibility and that the "too big to fail" effect is translated to companies.

Our main contribution is twofold: firstly, the EZIndex could be used to analyse rigorously the extreme zombie problem taking into consideration its four dimensions (extent, contagion, recovery signs and immediacy) and it is transferable to other geographical contexts. The results observed on the basis of the EZIndex in terms of the presence of zombie firms in the economy differ from those of earlier studies. This means that factoring in additional dimensions such as recovery signs and immediacy may have a substantial influence on the analysis of the problem. Secondly, we encourage governments to assess the impact of this risky financial problem of companies and take appropriate decisions: strict regulation, size limitations and dispersion of companies across regions. Moreover, they should inform and monitor all types of company independently of their industry, size or region: extreme zombie firms are everywhere and they are highly contagious.

LIMITATIONS AND FUTURE LINES OF RESEARCH

The theory of zombie firms is still developing and is based mainly on the case of Japan. The fact that the theory is still growing limits the contributions of research in this line, since comparability and discussion are limited by a lack of results and contributions with different views. It is positive, on the other hand, because the extent and potential of the theory that is under construction are unlimited. In any case, our contribution adds to a growing literature on the zombie effect, and it is important to take this into account when the results are analysed. Secondly, the index shown in this paper is based on data for Spain, so at this time the results cannot be extended to other countries. However, similar results can be expected, at least elsewhere in Europe.

This is an open, growing research problem with at least three clear lines for further research. The first – extreme zombie firms – is not only a Spanish problem. Therefore, although this

case enables the extent and contagion, and also the recovery potential and immediacy of extreme zombiness to be studied, it will be necessary to analyse how this extreme zombie problem affects the European economy. A second recommendation for future research is therefore to measure all types of firm, because a global EZIndex can help provide an understanding of zombie theory and enable a global ranking to be established to assess the scale of the problem overall for companies, helping to detection future problems. Finally, future research might also theorise about the profiles of zombies, e.g. the gender of managers, indicators of independence in decision-making, whether the main stockholders are individuals or companies, etc., with a view to analysing how to stop the problem spreading when results are significantly negative.

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Annex I

Table A. Descriptive analysis: Industry view.

Industry Type	N	Mean	Std. Dev.	Median	Minimum	Maximum
More leveraged industries	914	0.46965	0,0300	0.4588	0.3852	0.6574
Less leveraged industries	357	0.46513	0,0386	0.4601	0.2775	0.7339
Less regulated industries	114	0.46576	0,0327	0.4594	0.3852	0.7339
Highly regulated industries	1157	0.45733	0,0325	0.4555	0.2775	0.5602
Intangible-intensive industries	165	0.46715	0,0456	0.4591	0.2775	0.7339
Less intangible-intensive industries	1106	0.46469	0,0302	0.4591	0.3852	0.6574

Table B: Descriptive Analysis: Community view.

Type of community	N	Mean	Std. Dev.	Median	Minimum	Maximum
Larger business fabric	863	0.46679	0,0343	0.4614	0.2775	0.7339
Smaller business fabric	408	0.46126	0,0284	0.4556	0.3987	0.6574
Greater leveraging	889	0.46500	0,0321	0.4589	0.3951	0.7339
Lesser leveraging	382	0.46507	0,0339	0.4603	0.2775	0.7139

Table C. Descriptive Analysis: Size view.

Type of Size	N	Mean	Std. Dev.	Median	Minimum	Maximum
Large	1162	0.48433	0,0312	0.4843	0.4316	0.5585
Medium	96	0.46761	0,0457	0.4619	0.2775	0.7339
Small	13	0.46458	0,0374	0.4587	0.3852	0.7140