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Joana Raquel Simões Lopes

THE WALKING DEAD:
AN ANALYSIS OF THE ROLE OF DIFFERENT CREDITORS IN ZOMBIE FIRMS IN PORTUGAL

Master's Dissertation in Economics, in the speciality of Financial Economics and Industrial Economics, supervised by Professor Carlos Manuel Gonçalves Carreira and presented to the Faculty of Economics of the University of Coimbra.

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Acknowledgments

This dissertation marks the end of a long journey, which, like many others, was a long way to go, full of challenges and obstacles to overcome. With the journey coming to an end, I couldn't leave without thanking the support and assistance that I had from many people, and without their support, it wouldn't be possible to achieve what I achieved.

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Resumo

O fenómeno das empresas *zombie* tem sido amplamente estudado, mas apenas na perspetiva em que o financiamento é proveniente da banca. O caso do Japão foi particularmente investigado na sua estagnação macroeconómica dos anos noventa. Empresas *zombie* são caracterizadas pela sua frágil situação financeira, incapazes de se suportarem autonomamente.

As empresas *zombie* têm efeito negativo nas empresas saudáveis, comprovados por diversos autores ao longo do tempo. Estas empresas afetam negativamente a produtividade dos setores, reduzem o investimento e também são responsáveis por criarem barreiras à entrada a empresas que querem entrar no mercado.

Este estudo explora a hipótese de as empresas *zombie* serem financiadas por outros credores, particularmente o caso dos fornecedores, entre 2010 e 2017. Incide sobre o caso português, um dos países europeus mais afetados por este fenómeno, e analisa as empresas dos setores da indústria transformadora, construção, comércio, alojamento, imobiliário e serviços empresariais. Na ausência de investigações focadas neste objeto de estudo, será relevante realizá-lo, pois há indícios de que a prevalência de empresas zombie por via dos fornecedores seja considerável.

Metodologicamente, estimou-se um modelo *logit* de efeitos fixos. Foram encontradas evidências sobre o financiamento de fornecedores a estas empresas, reforçando a literatura com o facto de as empresas *zombie* afetarem negativamente as empresas não-*zombie* no mercado. Os resultados revelam ainda que os fornecedores, ao contrário do setor bancário, tem menos probabilidade de suportar uma empresa *zombie*, levando a mesma à falência mais facilmente.

Classificação JEL: D22; E22; G32; G33; L25; O47

Palavras-chave: Empresas *Zombie*, Produtividade, Endividamento, Financiamento, Fornecedores.

Abstract

The zombie firm's phenomenon has been widely studied, but only from the perspective of financing that comes from banks. The Japanese case was particularly investigated regarding its macroeconomic stagnation in the 1990s. Zombie firms are characterized by their fragile financial situation, unable to support themselves freely.

Zombie firms harm healthy firms, which, thought the years, it been proven by numerous authors. These firms negatively affect the productivity of the sectors, reduce investment, and are also responsible for creating barriers of entry for firms that want to join the market.

The hypothesis explored in this study will be if zombie firms were financed by other creditors, particularly by suppliers, between 2010 and 2017. The study focuses on Portugal, one of the European countries most affected by this phenomenon, and covers firms operating in the sectors of manufacturing, construction, commerce, accommodation, real estate and business services. In the absence of investigations that focus on this object of study, it will be relevant to carry it out, as there are indications that the prevalence of zombie firms via suppliers is considerable.

Methodologically, a fixed effects *logit* model was estimated. By reinforcing the literature with the fact that zombie firms negatively affect non-zombie firms in the market, evidence was found on financing suppliers to these firms. The results further reveal that suppliers, unlike the banking sector, are less likely to endure a zombie firm, leading to bankruptcy more easily.

JEL Classification: D22; E22; G32; G33; L25; O47

Keywords: Zombie Firms; Productivity; Indebtedness; Financing; Suppliers.

List of Acronyms

BP – *Banco de Portugal*

CAE-Rev.3 – Portuguese Classification of Economic Activities - Review 3

EBIDTA – Earnings Before Interest, Taxes, Depreciation and Amortization

GDP – Gross Domestic Product

INE – *Instituto Nacional de Estatística*

OECD – Organisation for Economic Co-operation and Development

SCIE – *Sistema de Contas Integradas das Empresas*

IES – *Informação Empresarial Simplificada*

SMEs – Small and Medium Enterprises

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1. Introduction

Zombie firms are currently a particular and recurring phenomenon, frequently studied and with great relevance between investigations. The origins of this avenue of study can be traced back to Caballero and co-authors, who studied the zombie phenomenon in the long Japanese stagnation of the 90s (Caballero *et al.*, 2008).

Zombies are firms with a fragile financial situation who are generally financially supported by banks. They end up harming non-zombie firms, resulting in less profit and even less entry of new firms and investment from existing ones. The problem is that by supporting these debtor firms, described zombies, negative effects are created on the rest of the economy. Zombie firms depreciate the market prices of products, they congest the markets and with low prices and high wages, profits are reduced. Consequently, new firms that could enter the market aren't motivated to invest, therefore, they don't enter the market. Caballero *et al.* (2008) highlight two effects of zombie firms: "sclerosis" and "scrambling" effects.

Factors such as productivity, investment and barriers to entry are a result of the prevalence of zombie firms. McGowan *et al.* (2017) conclude that not all firms in an economy are affected by this phenomenon. Looking at the Portuguese case and according to the authors, it means that the most productive firms in a given sector tend to not be affected and, on the contrary, firms with lower productivity are more susceptible to become zombie firm.

There are several studies carried out for Organisation for Economic Co-operation and Development (OECD) countries, including Portugal, which is one of the countries most affected by this phenomenon. However, these studies only consider banks as lenders zombie firms, forgetting the role of others.

The objective of this study is thus to analyse the relationship between non-bank financing and zombie firms in Portugal, especially studying the role of suppliers and whether their behaviour differs from that of banks. Studies regarding the role of other creditors are scarce, despite there are indications that they may have a high influence.

To analyse the relationship between other creditors and zombie firms, we will use a probit and logit model. The database used is a microeconomic data at a firm-level from *Instituto Nacional de Estatística* (INE) covering the period 2010-2017.

Our results show a strong prevalence of the zombie phenomenon in Portugal. Although, it has been shown that suppliers aren't contributed to the increase of zombies, apparently, suppliers were more cautious in allocating credit and sustaining firms artificially.

The study is structured as follows. Section 2 consists of an analysis of the literature about zombie firms. Section 3 provides with an overview of the state of Portuguese business and also, making a preliminary analysis of different factors. Section 4 explores the data, variables and definition of zombies used. Section 5 will present the empirical strategy adopted and the results of this study. And finally, in section 6, the study will conclude with some final considerations.

2. Literature Review

The decreasing productivity of firms has been associated in recent years, by many authors, with zombie prevalence that affects the entire market. This decline in productivity has encouraged several investigations on the subject. The studies carried out on zombie firms consider many definitions for these firms, there are characterized as unhealthy firms that congest the healthy ones, they affect the growth of labour productivity (McGowan *et. al.*, 2017), the influence of competition in the economy (Caballero *et. al.*, 2008), and the damage of the allocation of resources (Gouveia e Osterhold, 2018). Hallak *et al.* (2018) indicate zombie firms as those that don't register profits for an extended period and that, even so, manage to continue to operate in an economy.

Studies by McGowan et. al. (2017) show that not all firms in an economy are affected by this phenomenon, as the most productive firms are less affected. The authors argue that various OECD countries suffer from the existence of zombie firms and that this effect of productivity is also recurrent. The representation of zombie firms has increased in recent years in Europe. Alexandre *et. al* (2017) show that the number of zombie firms between 2011 and 2015 is relevant, assuming values around 20/30%, thus having a significant weight. The significant results of this author suggest that zombie firms are more significant among less dynamic firms since they have solvency problems and are more aided by banks.

First, the studies originate from the analysis of this phenomenon in Japan, with the pioneering article by Caballero, Hoshi and Kashyap in 2008. These authors concluded that the congestion of zombie firms reduces the investment of non-zombie firms, and also reduces the entry of new firms. Japan's economic stagnation has prompted banks[1] to negotiate loans, hoping that firms will recover. The authors also highlight two phenomena by which they explore the effects of zombie firms: "sclerosis" consists of preserving firms with low productivity, which left the market because they had no bank aid; and "scrambling"

[1] Banks must support certain capital minimums, which has led to loans to insolvent firms.

is the withholding of firms and projects (considered less productive than the rest) that don't enter the market or aren't completed due to the congestion and effects of zombie firms.

So, according to Caballero *et al*. (2008), a firm is a zombie if it receives financial aid, even if it has low profitability. The methodology used by this author, as well as others, is to subtract the interest rate paid by these firms with the reference interest rate, and when it presents a negative result, it means that it's a zombie firm.

McGowan *et al.* (2017) use another factor that he considers determinant: the age of the firms[2]. The last decade has focused on barriers to productivity in OECD economies, which is the launch of the authors for this topic, considering that the structural policies of economies may be one of the weaknesses that leads to low productivity. The policies adopted, often relaxed, lead to a misallocation of resources and credits[3]. The authors adopt the study by Caballero *et al.* (2008) but include the age restriction because they believe that it will be difficult to distinguish zombie firms from innovative young firms[4].

The reallocation of resources to increase productivity would imply stronger incentives for productive firms to expand and thus expel less productive firms (Andrews and Petroulakis, 2017).

Hallak *et al.* (2018) observed that new firms are more slowly affected by zombie firms than older firms. They have had results for younger zombie firms, which are more likely to become healthy firms, and show positive profits compared to larger and older firms. The results indicate that the prevalence of zombie firms increases with the size and age of a firm.

Since productivity is one of the important factors that many authors refer to and that decreases with these unhealthy firms, it's also proven that investment is affected by zombie firms, which is an essential condition for the growth of an economy. An economy

[2] The authors believe that zombie firms will be more than 10 years old.

[3] Bank credit, not being the object of study in this work, is referred to since the phenomenon of zombie firms is thus characterized initially.

[4] McGowan report that the fact that young innovative firms have low profitability at the beginning of their lives, and for this reason, it won't be easy to distinguish them from zombie firms. However, they report that zombie firms are mostly large firms because they are more likely to receive subsidies.

that is characterized by low investment and a bad allocation of it, will inevitably have weak growth potential (Alexandre *et al.*, 2017). Industries with the presence of zombie firms have a lower job turnover and lower investment growth, also causing a reduction in profits and guarantees for new firms, which creates barriers to the entry of an industry (Caballero *et al.*, 2008 and McGowan *et al.*, 2017).

Andrews and Petroulakis (2017) conclude that zombie firms are more likely to be supported by a weak bank, implying there is a negative relationship between the health of a bank and the prevalence of zombie firms. There is also a relationship between the misallocation of resources and weak banks: firms operating in industries exposed to healthy banks grow faster than those in industries exposed to weak banks. Weak banks find it more difficult to achieve credit goals and, consequently, tend to invest more in weaker firms.

McGowan *et al.* (2017), Barros *et al.* (2017), Gouveia and Osterhold (2018), Hallak *et al.* (2017) study the phenomenon in Portugal, which serves as a good example to study this phenomenon as it's a country particularly affected by the crisis in Europe and the fact that it's characterized by an increase in zombie firm over time.

Alexandre *et al.* (2017) address the low Portuguese investment related to internal factors (such as maladjusted public policies) and external factors that revealed the immense demand imposed on firms in a circumstance of changes regarding technologies, globalization and integration in Europe. Other authors, as Gouveia *et. al.* (2018), reinforce that public policies can be the solution and the cause for the prevalence of zombie firms, which remain in the economy due to the lack of these policies. When there are shocks in the economies, some accuse the occurrence of higher zombie firms.

However, Portugal implemented some structural reforms during the period between 2004 and 2014 (Monteiro *et al.*, 2017), with the authors reaching an effect of better allocation of resources, with evidence of recovery mechanisms. Whilst not all firms deliver these results, the reforms have generally increased firms' resilience to negative shocks.

The growing literature addresses this phenomenon linked to the financial sector, with banks being one of the players in the process. Still, other lenders can play an important role when studying this subject.

Carreira *et al.* (2020) regard zombie firms as firms that are unable to pay their debts and should be forced to restructure or exit the market. In this study, not only loans from banks were considered, but from all creditors. Results suggest that most firms are in an "entrenched" situation, where the greatest probability is the non-change of state, resulting in the presence of high barriers to recovery and barriers to exit.

This problem is highlighted in INTRUM (2018)[5], where is revealed that creditors can play a role in this phenomenon. In other words, there may be a relationship between zombie firms and creditors, a topic covered in the rest of the investigation. Carreira *et al.* (2020) refer that a quarter of the debts observed in the study come from suppliers, which is our focus of study.

[5] European Payment Industry White Paper 2018.

3. Framework of firms in Portugal

In the last decades, Portugal confronted various changes and challenges that resulted in shocks in the Portuguese economy. Moreover, some authors studying the allocation of resources say that it's a key factor for economic growth, especially in the 2000s and during the financial crisis (e.g. Reis, 2013; Carneiro et. al., 2014 and Carreira and Teixeira, 2016). In periods of stagnation or decline of an economy, it's be expected that firms would undergo several changes over and after that period.

In this section, an analysis of some indicators will be made before applying the model. In this way, it will be possible to understand the behaviour of firms in Portugal.

First, the number of firms in Portugal will be analysed according to the sectors considered for this study[6], represented in figure 1. There has been a noticeable decrease since the beginning of our analysis period, having reached a smaller number of firms in 2013 and 2014.

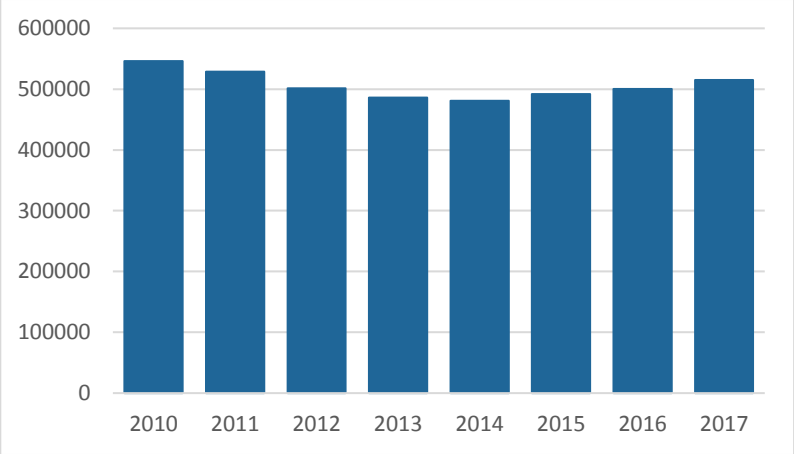

Figure 1 - Total number of firms. Source: INE; PORDATA.

[6] The sectors considered in this study are industry, construction, commerce, accommodation, real estate, and business services. However, and according to the information on the PORDATA website, the economic activities of extractive industries, manufacturing industries, construction, wholesale and retail trade, accommodation, restaurants, and similar activities and real estate activities correspond, in line with *Classificação das Atividades Económicas* (CAE) Rev.3.

Next, the indebtedness of private non-financial firms is observed, considering that it may be a good indicator to previously analyse the behaviour of Portuguese firms. The following figure shows a considerable number at the beginning of the analysed period, having decreased throughout the analysis.

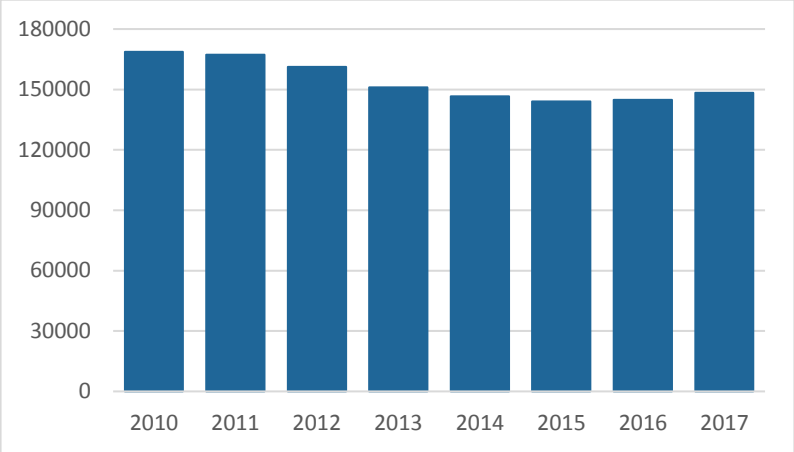

Figure 2 - Indebtedness of private non-financial corporations. Source: INE; PORDATA.

Nevertheless, the INE reported that in 2012 the Portuguese economy suffered the deepest recession since 1975, observing a 3.2% decrease in Gross Domestic Product (GDP).

Corporate investment has a different distribution than debt. While indebtedness declines after the year 2012, the investment has a drop-in that same year and the following. However, it presents a linear increase since that date, as represented in figure 3.

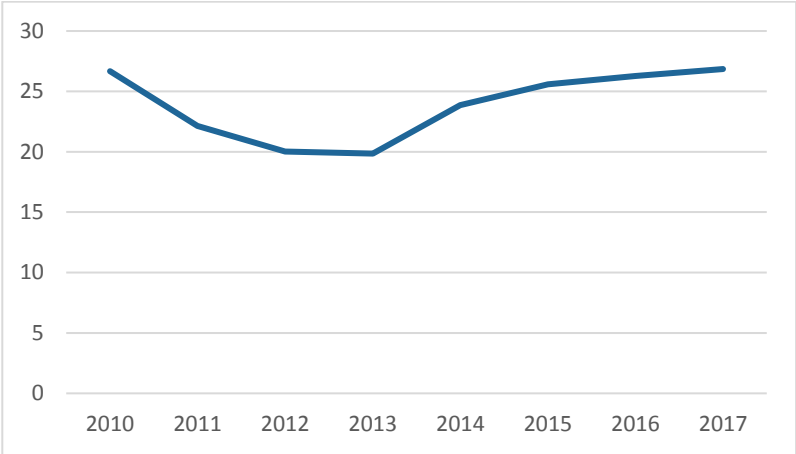

Figure 3 - Investment rate of non-financial firms. Source: INE; PORDATA.

Note: the investment rate of non-financial firms consists of an average of all sectors considered in the survey, calculated by the author.

Analysing the birth and death rate of firms in figure 2013, the curve with the greatest variation corresponds to the birth of companies, which has decreased since 2013. The values indicate a peak in 2013 but remained constant thereafter, showing a recovery of companies from that year. While business deaths have declined, this may be an indicator of how, for example, firms have been supported over time and since 2012 by creditors. In other words, the decrease in the number of firms that file for bankruptcy can be explained by the recession and the extent to which creditors support firms and therefore don't let them die.

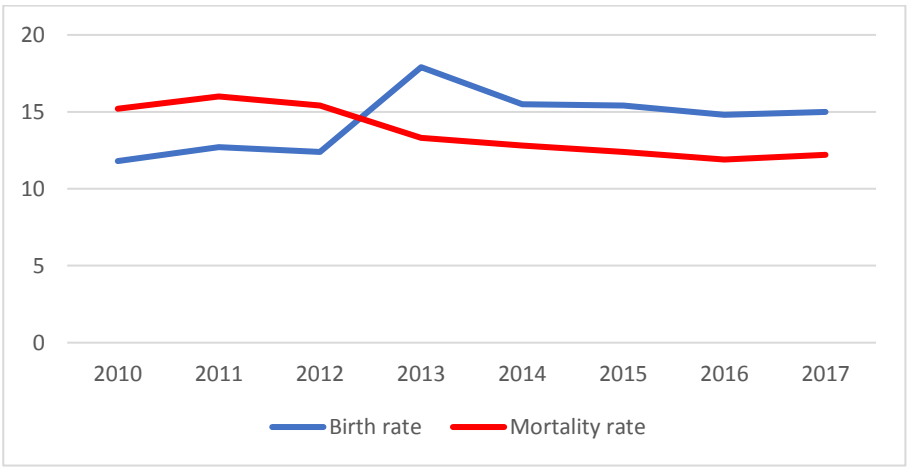

Figure 4 - Number of births of deaths of firms. Source: INE; PORDATA.

The graphics presented above show that there are some variations in the indicators of firms in Portugal, but there was a recession in 2012 that may explain them. However, 2014 was the beginning of the economic recovery, and for this reason, we cannot say with certainty that the figures presented are due to the recession experienced. The fact that the firms' death rate has decreased maybe because in a recovery phase a company is less likely to die.

Zombie firms, given that they have a fragile financial situation, can follow the same behavioural patterns and the indicators mention above can explain their behaviour.

Given the literature, it would be possible that zombie firms at the beginning of the analysis period have gained significant weight to the point of conditioning the market. This fact would explain the decrease in the number of firms, albeit not significant. In the same way, the indebtedness would be higher after this incidence and would subsequently lead to less investment. McGowan *et al*. (2017) refer that zombie firms suffocate the market, resulting in less investment. The last graphic displayed shows a lower number of deaths after the peak, which probably means support from firms. After a recession, the number of firms' deaths would be expected to increase, but it didn't happen, which is an indication of the presence of zombie firms.

This is a preliminary analysis of Portuguese business behaviour, which will provide a basis for the empirical analysis carried out below, where we will also look for links between the two situations.

As mentioned in the previous section, INTRUM (2018)[7] refers to the problems of debt payment delays, which in many cases results in a reduction of liquidity and loss of revenue.

The legislation alluding to this problem isn't considerable, though, Directive n.º 2011/7/EU of the European Parliament and of the Council, the 16th of February 2011, establishes measures to combat late payments in commercial transactions. Not being the first

[7] European Payment Industry White Paper 2018.

legislation for this purpose, in 1995 the problems of relations between firms were reported, but these recommendations were only required in 2000[8], with the reformulation in the directive described above[9].

Although the Committee on the Internal Market and Consumer Protection has assessed the impact of the Directive as a positive one, combined with the adoption of several national measures, INTRUM (2018) states that 52% of European large-firms are aware of the legislation, while a much smaller number (22%) is stated for Small and Medium Enterprises (SMEs).

In the Portuguese case, the *Decreto-Lei* n.º 62/2013 regulates every payment performed as commercial transaction revenues. Even though 2013 marks, in many indicators, the beginning of improvements, it's not possible to admit that the legislation in question should be allowed to emerge. A minimum amount has been established for the legal interest of commercial firms, and in the case of contracts between firms, the payment term doesn't exceed 60 days (a higher value may be agreed if it doesn't constitute as abuse to any of either parties). The legislative decree also states that "creditors must be fairly reimbursed for the costs incurred in collecting arrears."

There isn't enough evidence to conclude any changes in the way firms operate concerning payments, but it's clear that if there is legislation, there will be greater obedience by debtors.

[8] Directive n.º 2000/35/EC, of the European Parliament and of the Council, the 29th of July 2000.

[9] Directive n.º 2011/7/EU.

4. Data, variables and definition of zombie firms

4.1. Data source

For this particular study, the data[10] used are from *Sistema de Contas Integradas das Empresas* (SCIE). SCIE results from a process of integrating statistical information about firms, based on administrative data, with particular emphasis on *Informação Empresarial Simplificada* (IES). This information for individual firms from the Ministry of Finance is complemented, with data from the Statistics Unit File of INE.[11]

The sample used covers the manufacturing and services sectors (public services, the financial sector, and education, health and culture services aren't incorporated in the sample). In particular, it includes the sectors of industry, construction, trade, accommodation, real estate, and business services. Firms with less than three employees are excluded from our sample, as they are family-based firms and don't aim at a profit.

SCIE assigns each firm a unique identification number, which allows a longitudinal analysis. Following Carreira and Teixeira (2016), an exit of a firm consists on the moment when it, permanently, stops their activity production, and that's when the legal death of the firm is declared. But, if a firm ceases production at t, the legal death corresponds to the moment $t + \tau$, and between those two periods described there is no production. t is the year of the firm's death.

Initially, firms that had been inactive for some time were eliminated, as they are usually subject to liquidation or dissolution. Then, observations with values that aren't considered plausible[12] were also eliminated. At last, only firms with three consecutive years of observations were considered for the identification of zombie firms, and when there are gaps of one year these are linearly interpolated.

The choice of the analysis period is taking into account the characteristics of previous studies and the evidence that the phenomenon prevails over time, especially in

[10] Microeconomic data (at the firm-level).

[11] Taken from the INE website.

[12] For example, non-positive results, total net assets or total debt.

times of economic shocks. As the year 2012 had a deep recession, it will be interesting to see how zombie firms in the Portuguese economy behave.

The final sample consists of 214,919 firms with a total of 1,063,158 firm-year observations.

4.2. Definition of zombie firms

The zombie firm's literature has numerous definitions of zombie firms and many criteria defining them.

As previously mentioned, according to Caballero *et al*. (2008), a firm is a zombie if it receives financial support, especially if it has low profitability. The identification method is a comparison of the interest rate paid by these firms with the reference interest rate. By comparing both, the outcome of a negative result means that it's a zombie firm. The methodology by Caballero *et al.* (2008) can't be replicated for us since the firms that the authors used are listed on the Tokyo Stock Exchange and provide data on the debt structure of each firm, information that isn't accessible with the SCIE.

However, this method can lead to some errors. Fukuda and Namakura (2011) identified two types of errors. First, healthy firms may have lower interest rates associated with the rate on the main loans, thus being classified as a zombie. Second, when banks are in serious trouble, they can lower the interest rate, but that doesn't mean that firms who pay the low interest are zombies. These two types of errors happened mainly when the Japanese economy started to recover. As a consequence, Fukuda and Namakura (2011) added two criteria: "profitability criterion" in which firms whose earnings before interest and taxes (EBIT) exceed the hypothetical interest-free payments are excluded and aren't considered zombies; and "evergreen lending criterion", in which leveraged and non-profit firms that have increased their loans are considered zombies.

McGowan *et al*. (2017) explored the strategy of Caballero *et al.* (2008) using criteria for zombie identification: firms with an interest coverage rate (the ratio between operating income and interest expense) less than 1 for three consecutive years. These authors

also put an age criterion, stating that it can be difficult to identify zombie firms from healthy (and innovative) young firms, based only on the measure of profitability.

Schivardi *et al.* (2017) use criteria of "profitability" and "risk of non-compliance", that is, (i) return on assets – measured as the three-year moving average of Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA) on total assets – below the low-risk interest rate; and (ii) leverage (total financial debt over total assets) above the median in the group that comes out of the low return on assets.

In this study, we will follow Carreira *et al.* (2020), that is, a firm is classified as a zombie whenever: (i) it returns an asset lower than the low-risk interest rate, at least for three consecutive years; (ii) its leverage is higher than the industry median of the exit group with low return on assets; and (iii) it's more than 5 years old.

Firms that are in debt and are unable to pay them, have only survived by creditors sustaining them. The return on assets is defined as EBITDA on total assets. The method used is a comparison of the return on assets with the 12-month EURIBOR average annual interest rate. Leverage is defined as the ratio between the sum of debt in current liabilities and long-term debt about total assets. So, and as stated earlier, the objective of this study is to study another type of creditors, since the loans made by the banks are often only studied.

4.3. Empirical model

The main purpose of this project is to study the impact that suppliers have on zombie firms, by studying their births, permanence and death, plus testing the probability of a firm with a higher credit ratio (of suppliers) becoming a zombie firm, or not. To complete this objective, panel data will be used, which consists of a set of firm data observed over different periods. This type of data has an advantage for the discrimination of individual and temporal differences, also allowing greater control of heterogeneity.

First, fixed effects and random effects approaches will be performed and tested by the Hausman test. Then probit and logit models, which are binary response estimation models, will be used further on. STATA software will be used to implement the previous approaches.

The variables used for the empirical model are as next:

Variable	Variable label
YEAR	Fiscal year
ID	Firm's identification number
CAE2	CAE Rev.3 (2 digits)
Z	Zombie dummy: Carreira *et al.* (2020) approach
AGE	Firm's age
LP	Labour productivity = VABcf/Pessoal
RLP	Real labour productivity
lnRLP	log of Real labour productivity (deviation)
LABOUR	Number of employees
lnLABOUR	log of LABOUR
ASSETS	Total (net) assets
lnASSETS	log of ASSETS
DEBT	Total (short and long-term) debts
LEVERAGE	total debt over total assets
BANK	Bank financing long-run

Table 1 - Description of the variables. Source: By the author using STATA software.

Note: Labour productivity (RLP) is the actual GVA (gross value added) per worker. The *lnRLP* is the log deviation from the industry average for the year. Assets and debt are the book value of total assets (net) and total debt. The unit of measurement for ASSETS, DEBT and BANK is euro (€). Labour productivity, the number of employees and total net assets are control variables, as are sector and year dummies variables.

4.3.1. Fixed effects

According to Baltagi (2008), this hypothesis considers the fixed parameters to be estimated and the independent parameters as disturbances, therefore, it's unable to estimate the effects of variables over time or individually. Then, the fixed effects perform a transformation, which consists of passing to centred variables, using an average of the observations.

The fixed-effects model is used to take into account heterogeneity and interdependence, assuming that the coefficients are identical for all individuals in the sample, that, in this study, are the firms. It's assumed that the individual effects are non-random.

As a specific set of firms is being studied, this model is the most appropriate.

4.3.2. Random effects

Nevertheless, our sample is a large one and the number of parameters to be estimated is even higher, so it will be interesting to adopt discrimination, thus isolating from individual differences. If the individual heterogeneity that isn't visible exists, and if it's not correlated with the exogenous variables, random effects estimation can be used, and, therefore, it's a more useful hypothesis. The variations in the sample are identified as random oscillations around a constant mean value.

According to Wooldridge (2012), random effects are used when it's assumed that the unobserved effect isn't correlated with the explanatory variable. But, once the unobserved effect is admitted being correlated with it, fixed effects should be used.

4.3.3. Hausman Test

The purpose of the Hausman test is to compare the estimates made of fixed and random effects. That is, significant differences between the estimates indicate instability of the random effects' estimator, while the lack of correlation among the effects and the regressions indicates that the random effects are more efficient.

4.3.4. Probit and logit model

Greene (1997) confirms that the probit and logit models allows to estimate probabilities, marginal effects and other auxiliary results, but imposes a normal or logistic distribution on the data. The probit model results in a way of estimating the regression for

binary result variables, that is, the dummy variable, where the dependent variable will assume values of 0 or 1.

In binary response models, the interest lies in the probability of response:

$$P(y = 1|x) = P(y = 1|x_1, x_2, \dots, x_k),$$

where *x* represents the complete set of explanatory variables.

5. Discussion of results

In this section, the results for the empirical findings will be presented and according to the estimates and the previous model. A total of 214,919 firms are accounted for, from 2010 to 2017.

Previously, a preliminary analysis[13] was carried out regarding the number of firms and some relevant factors for this investigation. At this stage, the database and the STATA software can be used to confirm the previous information analysed.

Various authors refer to the fact that the productivity of zombie firms is lower than the non-zombie firms, and this is an important factor when analysing the incidence of zombie firms. This detail is described in the literature review section, where authors such as McGowan *et al.* (2017) address this precise theme in several investigations.

Regarding the sample's descriptive statistics, shown below, the weight of corporate debt is broken down. It can be interpreted that 25.9% of firms' debts come from suppliers, and 20.9% from banks. In other words, bank debt turns out to be less, and it's clear that debts related to suppliers are important and should be studied.

But the debt structure isn't being analysed, and it's also not considered. Generally, supplier debt is viewed as short-term debt, and on the contrary, bank debt is long-term. The results achieved, although important, can't be fully compared.

With this result, the existence of zombies through the debt of suppliers is proven, in addition to the other evidence regarding bank credit.

[13] In section 3.

Variable	Obs	Mean	Std. Dev.	Min	Max
SUPP_sh	1,063,158	.2593494	.2501178	0	1
BANK_sh	1,063,158	.2099131	.2781497	0	1
lnRLP	1,063,158	-.0128483	.7532337	-8.36189	2.891062
lnLABOUR	1,063,158	1.685687	1.023312	0	10.11383
lnASSETS	1,063,158	12.35937	1.799046	0	23.26923

Table 2 - Sample descriptive statistics. Source: Author's calculations using STATA software.

Correlation coefficients are important because they help to understand the relationship between different variables. In this case, it will be important to see the relation with the zombie dummy and between supplier and bank debt. But there may be some coefficients that don't have a direct explanation, anyway, all coefficients have a statistical significance of 1%.

The variables of labour productivity, the number of workers and total net assets show negative correlations with the zombie dummy, which is predictable because of the literature review, these factors are affected by the prevalence of zombie firms.

Focusing on the correlation between supplier and bank debt, which seems to be the most important value in this case since it has a negative coefficient (-21.2%). This relation translates the fact that firms that receive more money from banks have less debt from suppliers, so there may be a negative trade-off in this case. How firms are financed, and this relation, may be because firms want to "escape" bank loans and increasingly resort to suppliers, which gives a greater significance to the object of study in this dissertation.

	Z	SUPP_sh	BANK_sh	lnRLP	lnLABOUR	lnASSETS
Z	1.0000					
SUPP_sh	-0.0924	1.0000				
	0.0000					
BANK_sh	0.0395	-0.2121	1.0000			
	0.0000	0.0000				
lnRLP	-0.2933	0.0503	-0.0243	1.0000		
	0.0000	0.0000	0.0000			
lnLABOUR	-0.1372	0.0974	-0.0440	0.2158	1.0000	
	0.0000	0.0000	0.0000	0.0000		
lnASSETS	-0.1525	0.1282	0.0558	0.2402	0.5392	1.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	

Table 3 - Correlation coefficients between variables. Source: Author's calculations using STATA software.

The following tables contain the descriptive statistics for zombie and non-zombie firms, thus making it possible to compare some indicators. By comparing the two types of firms, the conclusion that can be extracted is that zombie firms have higher bank debt and less debt to suppliers.

In this case, it would be more relevant to analyse labour productivity, which is considerably lower in the case of zombie firms, confirming the investigations carried out previously.

When analysing the standard deviation, maximum and minimum values, it’s noted that the effects are transversal between the variables, therefore they don’t have greater relevance in this case.

Variable	Obs	Mean	Std. Dev.	Min	Max
SUPP_sh	946,166	.2674789	.2515653	0	1
BANK_sh	946,166	.2060533	.2734669	0	1
lnRLP	946,166	.0648301	.6542404	-8.36189	2.891062
lnLABOUR	946,166	1.735043	1.026921	0	10.11383
lnASSETS	946,166	12.45585	1.758157	0	23.26923

Table 4 - Descriptive statistics of non-zombie firms. Source: Author's calculations using STATA software.

Variable	Obs	Mean	Std. Dev.	Min	Max
SUPP_sh	116,992	.193603	.2276598	0	1
BANK_sh	116,992	.2411285	.3117115	0	1
lnRLP	116,992	-.6410675	1.118365	-8.36189	2.234727
lnLABOUR	116,992	1.28652	.8990532	0	7.800163
lnASSETS	116,992	11.57914	1.931032	0	21.32026

Table 5 - Descriptive statistics of zombie firms. Source: Author's calculations using STATA software.

The power of zombie firms by sectors was likewise analysed according to CAE-Rev.3[14]. Considering the sectors of industry, construction, trade, accommodation, real estate and business services, the following table shows the prevalence values of zombie firms. The numbers are similar to each other, but it's clear that the accommodation sector has a higher percentage of zombie firms.

Nevertheless, this sector includes catering, which concentrates the majority of the sector. Accommodation is a particular case, and when micro-enterprises are excluded from the sample under study, there are firms in the catering sector that are family businesses but have some workers and for this reason, they aren't excluded from the sample and end up influencing these results.

[14] "CAE-Rev.3, harmonized and integrated into the classifications of economic activities of the European Union (NACE-Rev.2) and the United Nations (CITA-Rev.4), establishes the common framework for classifying economic activities to be adopted at the national level, as of January 1st of 2008. In addition to the statistical objectives, CAE-Rev.3 has other areas of application, in particular, in the registration of the creation of firms and similar entities, in the preparation of studies, in tax returns and incentives for economic activity." (Information taken from the INE Portal website)

Sector	Percentage of zombie firms
Industry	9,7%
Construction	10,1%
Trade	10,8%
Accommodation	18,4%
Real Estate	12,6%
Business Service	7%

Table 6 - Percentage of zombie firms by sector. Source: Author's calculations using STATA software.

As mentioned in the previous section, the Hausman test was performed, measuring the consistency of the fixed and random effects estimators.

```
Test:  Ho:  difference in coefficients not systematic

              chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =         2.49
            Prob>chi2 =       0.9620
```

The Hausman test is applied and we consider the comparison of both estimators. It's considered that if $P < 0.05$ the estimation is accepted using random effects. And linear panel probability models are being executed. Thus, by looking at the results, this relationship doesn't occur, so the estimation of fixed effects is accepted.

Finally, a logit regression of fixed effects is performed, and since the hypothesis of fixed effects is confirmed they can't be used in a probit model[15].

The regression presents the results of the probability of a firm being a zombie in the following year. It can be concluded that given the difference between the supplier and bank debt variable (negative and positive, respectively), these results mean that higher supplier debt corresponds to a smaller number of zombie firms, while a greater bank debt translates that there are more zombie firms.

[15] It should be remembered that the variables of labour productivity, number of workers, and total net assets are control variables, as well as the sector dummies and years.

It’s noteworthy that, as previously mentioned, although supplier debt is linked to zombie firms in a minor extent than bank debt, its importance is undeniable.

F.Z	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
SUPP_sh	-.3543768	.048004	-7.38	0.000	-.4484629	-.2602907
BANK_sh	.1397547	.0332151	4.21	0.000	.0746544	.2048551
lnRLP	-.4291436	.0096477	-44.48	0.000	-.4480527	-.4102346
lnLABOUR	.3417351	.0167323	20.42	0.000	.3089405	.3745298

Table 7 - Regression probability debt suppliers and bank. Source: Author's calculations using STATA software.

The next figure shows the distribution of debt among banks and suppliers, throughout our study period.

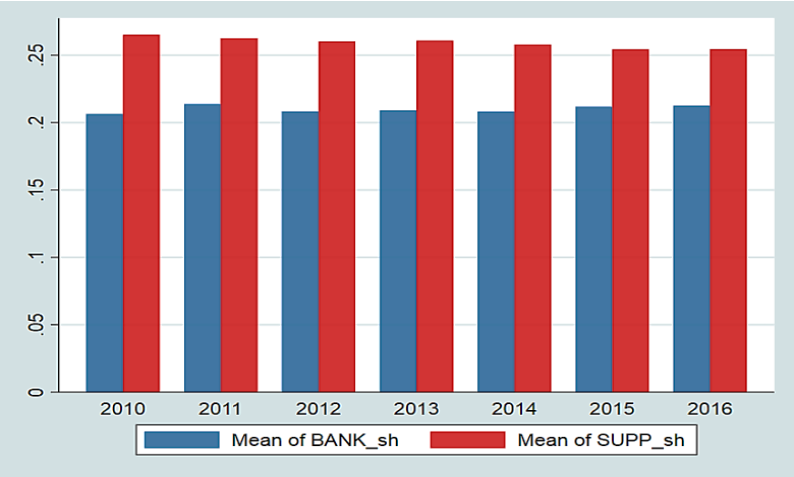

Figure 5 - Debt breakdown between banks and suppliers, by year. Source: Author's calculations using STATA software.

Although the values are very similar, it confirms that after 2012 (and compared with 2016, for example), the number of bank debt increased, and on the contrary, it decreased in terms of suppliers. This may have led to a greater probability of a firm becoming a zombie according to bank financing.

One reason for explaining this behaviour may be that suppliers are more observant and more cautious. Remembering that the types of debts are different, the suppliers don't seem to support (or less than the bank) zombie firms. But, banks have incentives to support these zombie companies, so suppliers do not and that may be the reason for this difference.

In the section "Framework of firms in Portugal", some preliminary indicators are mentioned to analyse the type of firms in Portugal. The last graphic in that section refers to a lower number of firm deaths after 2012, which coincides with the last graphic in which there is a greater number of bank debt after that year.

6. Conclusion

The bad allocation of credit has been studied over the years, and it has been related to zombie firms. These firms damage the entire market and, as several authors argue, have lower productivity.

This study reveals evidence regarding the existence of zombie firms, supported by other creditors, more specifically suppliers during the period between 2010 and 2017. Being a period during which the Portuguese economy recessed, it's very pertinent to analyse how the business behaves in this shock, and consequently the allocation of credit.

The results show that supplier debt is 25.9% and bank debt 20.9%. This shows the importance of studying zombie firms from suppliers, given that it presents a higher percentage of the debt.

The correlation coefficient between the two types of debt is negative, which could mean that firms try to avoid bank financing and choose to finance themselves through suppliers. Zombie firms, in contrast to total debt, have a higher bank debt (24.1%), but those with debts to suppliers can't be devalued, which has an approximate value of 19.3%. It's proven that the debt to suppliers is quite high, and it's important to analyse it in the situation of bad allocation of credit in the corporate structure, even though bank debt is long-term and debt to suppliers is short-term.

Lastly, the regression carried out shows that it's not the suppliers who are contributing to the increase in zombie firms, but actually the bank. Suppliers can define themselves as more cautious about supporting firms artificially, letting them go into bankruptcy more easily than the banking sector. This characteristic raises some questions regarding the functioning and management of banking. An issue that remains open for future investigations to this topic.

Consequently, the banking sector isn't allowing firms to leave rationally in fragile situations, which can induce a bad selection of firms. While suppliers are making a positive contribution to the phenomenon of zombie firms, they are also contributing to a better selection. It will be interesting for future studies to see if the nature of the debt, which differs between suppliers and banks, had any influence on the different behavior of these creditors.

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