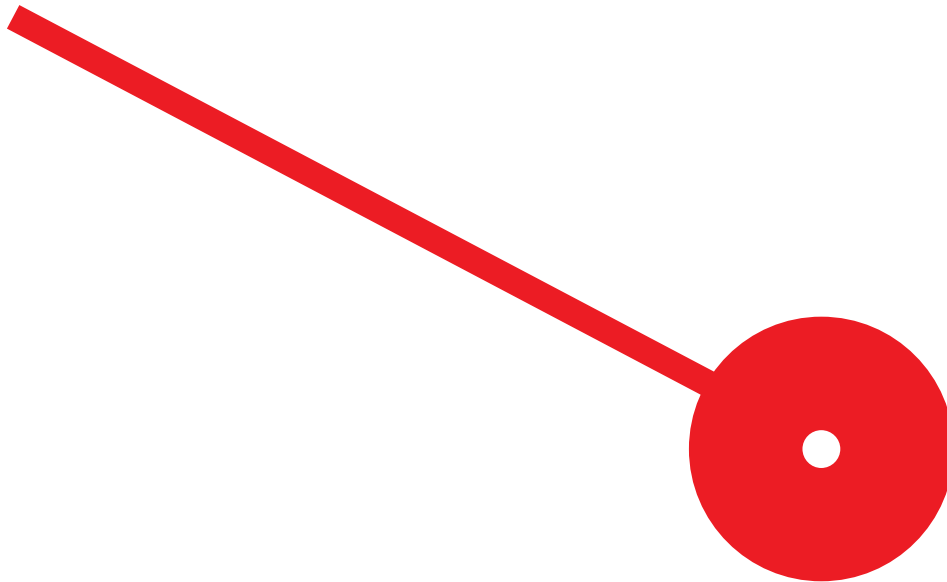


# Zombie Firms in the Eurozone: Characterization, Determinants and Consequences

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2021/2022



**M** MESTRADO  
EM FINANÇAS EMPRESARIAIS

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**Dissertação de Mestrado apresentado ao Instituto Superior de Contabilidade e Administração do Porto para a obtenção do grau de Mestre em Finanças Empresariais, sob orientação de Professor Doutor Armando Mendes Jorge Nogueira da Silva.**



## **Thanks**

First of all, I would like to thank my supervisor Professor Doctor Armando Silva, for his guidance, support and availability in this final phase of the master's, as well as for all the knowledge he transmitted to me, always offering improvement suggestions throughout the process.

Next, I would like to thank my parents and my family for their unconditional motivation and support throughout my career, both academical and professional, having transmitted to me the personal values that made me who I am.

Finally, I would like to thank my friends, who grew up with me or who appeared along my path, for the moments lived, for the company and memories created and that are yet to be experienced.

## **Resumo:**

Algumas definições de empresa zombie classificam-as como empresas que deviam ter cessado a sua atividade, mas continuam a existir devido a créditos mal concedidos por bancos e a subsídios de governos, criando consequências negativas nas restantes empresas saudáveis da economia.

Deste modo, o primeiro objetivo passa pela definição dos determinantes das empresas Zombie, identificando os principais aspetos macroeconômicos ou microeconômicos que tornam uma empresa mais provável de se tornar Zombie. Seguidamente, pretende-se estimar as consequências e os principais efeitos que as empresas Zombie têm sobre outras empresas saudáveis, especificamente em termos de taxa de investimento, crescimento do emprego e produtividade do trabalho. A definição de empresa Zombie utilizada neste estudo indica que as mesmas apresentam cumulativamente: um índice de cobertura de juros inferior a um, por dois anos consecutivos, um resultado líquido negativo por dois anos consecutivos e uma idade de pelo menos dez anos.

A amostra ocorre entre 2014 e 2020 na Zona Euro, incluindo 8833 empresas do setor industrial (Código NACE 10 a 32). Um modelo logit foi aplicado ao estudo dos determinantes das empresas zombie e um modelo de dados em painel com efeitos fixos para indivíduos e tempo foi aplicado na análise das consequências das mesmas nas empresas saudáveis.

Os resultados das regressões indicaram que quando uma empresa tem um excesso de dívida superior à média do seu setor NACE, a mesma tem uma maior probabilidade de se tornar zombie e que quanto maior for a empresa, maior a probabilidade de se tornar zombie.

Foi observado que as empresas zombie geram um efeito negativo na produtividade das empresas saudáveis, mas aumentam o crescimento do emprego das empresas saudáveis, o que constitui um resultado não o esperado. Não foi possível analisar os efeitos na taxa de investimento visto não haver significância estatística na variável.

**Palavras chave:** Consequências; Determinantes; Empresas Zombie; Zona Euro.

## **Abstract:**

According to the definition of a zombie firm, these are businesses that should shut down but don't do so because of substandard bank lending and government aid, leading to unfavourable effects on the economy's remaining viable firms.

In this manner, the first objective is to analyse the causes and determinants of the zombie firms, identifying the macroeconomic and microeconomic factors that increase a company's likelihood of becoming zombie. Then, it is intended to analyse the consequences and main effects that zombie firms have on other healthy companies, particularly in terms of investment rate, employment growth, and labour productivity. According to the definition of a zombie firm employed in this study, it must have been in business for at least ten years, have a negative net result for two consecutive years and have an interest coverage ratio of less than one for two years running.

The sample occurs between 2014 and 2020 in the Eurozone, containing 8833 industrial firms (NACE Code 10 to 32). A panel data model with fixed effects for individuals and time was applied to their consequences on healthy companies. A logit model was applied to the determinants of zombie companies.

The findings of the regressions showed that a company has a higher likelihood of turning into a zombie if its excess debt is higher than the average for its NACE sector, and this likelihood also increases with the size of the firm.

Additionally, it was discovered that, contrary to predictions, zombie businesses actually increase job growth and, going accordingly with predictions, they have an unfavorable impact on the productivity of healthy businesses. As there was no statistical significance in the variable, it was impossible to assess the effects on the investment rate.

**Key words:** Consequences; Determinants; EuroZone; Zombie firm.

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## **CHAPTER- INTRODUCTION**

An increasing financial stagnation that was seen in Japan at the start of the 1990s prompted researchers to look into the zombie firm notion. It was discovered that Japanese banks were issuing loans and restructuring debt for businesses without fully assessing their financial standing. Due to this careless banking practice, the banking industry repeatedly failed to meet the solvency ratios. As a result, the Japanese banks kept on lending, resulting in non-performing loans, in order to preserve the credit flow. This caused businesses to operate on the Japanese market with little financial support, which caused the Japanese economy to stagnate. Although this phenomenon was initially discovered in Japan, the idea of a zombie firm quickly spread to the rest of the world (Caballero et al. 2008; Barros et al. 2017).

There are several definitions for a Zombie firm and the one that was employed was defined by McGowan et al (2017), Hallak (2018) and Barros (2017), classifying firms with an Interest Coverage Ratio inferior to 1 for three consecutive years; with a Net Income negative for three consecutive years and with at least 10 years of age, as Zombie firms.

The factors that cause a firm to turn zombie are explored in this dissertation, and it is anticipated that the easiness of obtaining bank funding and the low interest rates that banks apply have contributed to the development of circumstances that allow non-viable businesses to continue operating on the market. As a result, it is hypothesized that banks are a part to blame for the rise of zombie firms, with excessive debt serving as a potential determinant. Some authors also believe that the size and the age of the firm have an influence on its chance on becoming zombie. In some countries, the government is partly to blame for the formation of zombie firms since it can provide these businesses with governmental subsidies to enable them to survive. Also, investigated are the effects of a zombie company's existence on the other healthy firms. One of the major effects discussed in the literature is the fact that zombie firms' lower investment rates, employment growth, and labour productivity in healthy organizations by sinking assets in their firm, stagnating the industry, and creating obstacles to entry for new, more innovative businesses.

The purpose of this study is to determine the extent of the zombie firm phenomena in the Eurozone from 2014 to 2020. In addition, we are interested in the primary determinants

of this occurrence in Europe during the abovementioned time period, trying to determine which macroeconomic or microeconomic aspects make a firm more likely to become a zombie. Last but not least, the study tries to evaluate the major effects that these firms have on other healthy enterprises, specifically in terms of investment rate, employment growth, and labour productivity.

The current dissertation is divided in four different chapters. The first one is the literature review, that includes an historic contextualization of the zombie firms and their definition, determinants, consequences on other healthy firms and the initial research hypothesis. In the second chapter, the data and methodology utilized in this dissertation are presented, including an exploratory analysis of the statistics of the sample and the utilized variables. The third chapter presents the analysis of the regressions' results, where they are compared with the previously defined research hypothesis, and a robustness test for the variables on the side of the zombie firms' consequences. The last chapter introduces the final conclusions and the study's shortcomings, as well as future research hypotheses.

# **CHAPTER I – LITERATURE REVIEW AND RESEARCH**

## **HYPOTHESIS**

# 1 Literature Review

## 1.1 Historic contextualization of zombie firms

According to Caballero *et al.* (2008) and Barros *et al.* (2017), the zombie firm concept was investigated due to a growing financial stagnation observed in Japan during the beginning of the decade of 1990. It was found that the Japanese banks were granting loans and restructuring companies' debts without properly investigating the financial situation of the corresponded companies. This negligent banking practise led to the successive failure of the banking system to comply with the solvency ratios. Thus, to maintain the credit flow, the Japanese banks continued to lend, incurring in non-performing loans. This led to the existence of firms within the Japanese market with no financial conditions which generated an economic stagnation of the Japanese economy.

This situation happened because of the weak regulation and supervision policies that led to banks having little to no incentive to be strict with their problematic borrowers, that is, a policy of evergreening loans of banks in which a bank grants additional credit to a firm with difficulties allowing it to pay the interest on outstanding loans, avoiding its bankruptcy. This way, they avoid declaring these non-performing loans on their balance sheets, making the bank look better at the eyes of the public (Peek and Rosengren, 2005; Barros *et al.*, 2017). According to McGowan *et al.* (2017), the main reason that made such zombie firms stay active was the fact that banks would try to recover these previous loans instead of reporting them as lost.

Nonetheless, banks still had to obey to the Basel capital minimal capital standards, which meant that banks would have to write off existing capital when they wanted to call in a non-performing loan. This pushed the banks far enough to reach the minimal capital levels. Since the banks were afraid of falling below the capital standards, they would continue to extend credit to their insolvent borrowers, in hope that somehow these firms would recover one day. By acting this way, banks often also deny credit to the healthy needing companies (Caballero, 2008; Peek and Rosengren, 2005; Barros *et al.*, 2017).

During periods of underperformance of companies, banks had become more likely to lend to zombie firms. This happened specifically in the cases where there were strategic alliances between these firms and banks, making an easier access to credit loans. There is evidence that there were differences between cases in which companies and banks were

affiliated and in cases where they were not affiliated (Caballero, 2008; Barros *et al.*, 2017).

McGowan *et al.* (2017) mentioned that although this phenomenon was firstly found in Japan, the concept of zombie firm rapidly expanded to the rest of the world. Hallak *et al.* (2018) studied the effects and indicators of zombie firms in 19 European countries, comparing the 2010 results with those of 2013 and concluded that there was a growing trend towards the emergence of zombie firms at a European level.

The studies on this topic focus primarily on the concession of loans to inefficient companies that do not have sufficient outputs to be able to pay back the debt constricted. In addition, these firms do not show interest in fulfilling such obligations and are not capable to create profit through their main income source.

Also Rao and Wan (2018) concluded that the granting of large government subsidies leads to increased risk of forming zombie firms. Moreover, in a study with SME companies in Shanghai, Luan *et al.* (2018) found that subsidies for R&D reduce the risk of a normal company becoming a zombie firm in the short term. However, if the firm eventually becomes zombie, it will be in a worse position than if it had not received such a subsidy.

The investigation done by Chang *et al.* (2021) studied the effects of government intervention on the creation of zombie firms. Their initial hypothesis was confirmed through robustness tests, indicating that the more state intervention there is, the more likely a company will become a zombie. The authors also concluded that it is through subsidies, exploration support, financial support, and tax support that governments increase the risk of a company becoming a zombie.

## **1.2 Identification and determinants of zombie firms**

In all the different empiric studies realized by many different authors and investigators, there have been used many types of criteria to define the concept of zombie firm. There are some that are broader or narrower than others, but in order to choose the most rigorous definition, we have analysed a lot of different concepts previously used by other authors.

Both McGowan *et al.* (2017) and Barros *et al.* (2017) characterize zombie firms as firms over 10 years old and dependent on bank credit to operate due to the lack of revenue coming from their core business. In addition, these companies often pay excessively high

salaries when compared to the low productivity associated with the sectors in which they are present.

Differently, Caballero *et al.* (2008) ignore productivity and profitability variables and identify zombie firms with only one factor: zombie firms are companies whose credit concession was subsidised, that is, the loan was carried at lower rates when compared to loans made to other companies with better conditions. To be more specific, they consider as zombie every firm in which interest payments are lower than a hypothetical lower bound for interest payments.

According to Banerjee and Hofmann (2018), this identification presents three conflicts. Firstly, it's difficult to identify these types of credits. Secondly, banks may grant credit for other reasons, such as the prior existence of a long-term relationship. Finally, the authors claim that when interest rates are extremely low for a long time in a row, interest rates on subsidized loans would always be close to zero. Then Banerjee and Hofmann (2018) specify that a firm is considered zombie when it meets 3 norms:

- Lack of profitability over an extended period.
- The company is more than 10 years old, as young companies may need more time for their investments to create return.
- The existence of low expectations of value creation in the future.

The latter criterion differs from the first, in that the first refers to the company's historical data during recent years, while the third indicates that the company's future expectations of value creation are low in the eyes of the market.

In the meantime, Kwon *et al.* (2015) consider two criteria in the definition of zombie firm. The first one is about financial support, where they follow the definition of Caballero *et al.* (2008) and define as zombie firm the firms whose total level of debt at the end of the current period is higher than the level of long-term debt at the end of the previous period. The second one is about insolvency, where they classify as zombie firms that have for three consecutive years a sum of operating income and non-operating income or an EBIT lower than the hypothetical measure by Caballero *et al.* (2008), that defines a lower boundary of paid interest by the firms, conjugating some short-, medium- and long-term loans with an average of prime rates of the same time horizon.

Meanwhile, Hallak *et al.* (2018) considered three different definitions for zombie firms.

- Their first definition classifies as zombie A, any firm with a coverage ratio equals to one or less, for three consecutive years. To them, the coverage ratio is defined as the ratio of operational earning (EBIT) to interest payments. They substitute missing interest payments with financial expenses which usually include interest payments with fees on loans added.
- The second definition is named zombie B and adds a restriction to zombie A, which is the fact that zombie firms need to be ten years or older.
- The last definition is named zombie C and it restricts zombie B to firms with a coverage ratio below one during five consecutive years, instead of three.

In their study of the causes of zombie firms for the years 2005 to 2016, Ghoul et al. (2021) used data from firms in 79 different countries. They came to the conclusion that zombie firms tend to have more conservative dividend and investment policies as well as more aggressive leverage policies, and that countries with more effective debt enforcement environments tend to have fewer zombie firms

### **1.3 Consequences of the existence of zombie firms**

Addressing the consequences of the existence of zombie firms, Caballero (2008), Kwon (2015) and McGowan *et al.* (2017) mentioned three main consequences that result from the existence of this typology of companies. Firstly, the ease that these firms have on obtaining bank loans leads to the market getting saturated with inefficient companies. Secondly, companies considered efficient may be unable to develop because they cannot obtain loans, as zombie companies capture the available credit from the banking system. Finally, these companies create entry barriers in the sectors they operate, thus disabling the access of more innovative and productive companies.

Barros *et al.* (2017) studied the effects of Zombie firms in Portugal, grabbing the data through Banco de Portugal (Portugal's National Bank) from 2012 to 2016, utilizing panel data as methodology. They concluded that on one hand, the persistence of zombie firms causes a reduction on the level of productivity of their respective sectors and of the whole economy. On the other hand, the new more innovative companies that want to enter the market need to achieve higher levels of productivity to compensate for the low market profitability present in the market by the prevalence of zombie firms in their sector. This creates a productivity gap between zombie firms and non-zombie firms that will exist until the former ones cease to do so.

Caballero *et al.* (2008) explored the effect of zombie firms through two phenomena. The first one is named “Sclerosis” and it corresponds to a situation where companies with low productivity would be safeguarded by the bank’s negligent loans. The second one is named “Scrambling” and corresponds to the retaining of less productive firms in comparison to those that could have entered the market if it was not congested due to the prevalence of zombie firms. In this context, Caballero *et al.* (2008) investigated the effects that the zombie business congestion has on the performance of an average normal company. Later McGowan *et al.* (2017) took Caballero *et al.* (2008)’s previous model and modified it to add the characteristics of the firms and used data for nine countries between 2003 and 2013:

$$Y^{k}_{isct} = \beta_1 nonZ_{isct} + \beta_2 nonZ_{isct} * Z_{sct} + \beta_3 Firm\ controls_{isct-1} + \delta_{sct} + \varepsilon_{isct}$$

where: Y refers to a measure of activity (the investment rate, the percentage change in employment or the level of multi-factor productivity) in firm *i*, in industry *s*, in country *c*, at time *t*; nonZ represents a dummy equal to 1 if a firm is a non-zombie firm, Z is the share of industry “sunk” assets in zombie firms and firm controls include dummies for firm age (YOUNG=1 if age<6) and firm size (1-10, 11-19, 20-49, 50-99, 100-249 and 250+). The model also includes interacted country, industry and year fixed effects while robust standard errors are clustered at the country-industry-year level. (McGowan *et al.*, 2017)

Caballero *et al.* (2008) found that the zombies' congestion diminishes the earnings for healthy firms, which deters new entry and investment. They confirmed that zombie-dominated industries show weaker productivity and more depressed creation of employment and destruction. We present firm-level regressions that demonstrate how the rise in zombies slowed non-zombie investment and employment growth and worsened the productivity gap between them.

In the same study, McGowan *et al.* (2017) made a cross section analysis from 2010 to 2013 got their full sample from the database *ORBIS*, employing a fixed effects panel data methodology. Therefore, they got results in line with the predictions created by Caballero *et al.* (2008). The results suggested that the presence of zombie firms create distortions that reduce the sector’s productivity by preserving inefficient firms and creating barriers to the entry of newer more efficient companies. This way, the marginal entrants need to clear a higher productivity threshold for entry to compensate for lower profitability

caused by this congestion. Thus, the gap of productivity between zombie and healthy firms gets bigger.

Additionally, McGowan *et al.* (2017) wanted to test for the potential effects of zombie congestion on resource allocation to the more productive firms in each sector. Therefore, they created a new model where the firms with the higher multi-factor productivity (MFP) grow quicker than the remaining firms. Therefore, the second equation utilizes the same data as the previous one and is the following:

$$K_{growth_{isct}} = \alpha + \beta_1 MFP_{isct-1} + \beta_2 MFP_{isct-1} * Z_{sct} + \beta_3 Firm\ controls_{isct-1} + \delta_{sct} + \epsilon_{isct}$$

where  $K$  growth is the change in real capital stock for firm  $i$ , in industry  $s$ , in country  $c$ , at time  $t$ ; MFP denotes a measure of firm-level multi-factor productivity which is a deviation from the country-industry-year average to control for MFP differences across industries and countries;  $Z$  is the share of industry resources (labour or capital) sunk in zombie firms; firm controls are dummies for firm age and firm size as described above. The model also controls for interacted country, industry, and year fixed effects to control for time-varying country-industry-specific shocks, while robust standard errors are clustered at the country, industry, and year level. (McGowan *et al.*, 2017)

McGowan *et al.* (2017) got results that indicated that capital reallocation is, on average, productivity enhancing because there is evidence that firms with higher-than-average productivity rates can attract more capital. Nonetheless, they also proved that more zombie congestion is associated with less productivity-enhancing capital reallocation. Therefore, they concluded that zombie firms can constrain the growth of more productive firms.

Hallak *et al.* (2018) utilized the same definition of zombie firms as McGowan *et al.* (2017), and analysed some micro-level firm data from *Orbis*, for 19 countries in 2010 and 2013, utilizing as methodology a fixed effects panel data analysis. They concluded that zombie Firms create a crowding out effect on the growth and productivity of other newer companies with higher potential, as they found that the higher the percentage of zombie firms present in each country, the lower the growth of non-zombie companies in that same country in question.

Banerjee and Hofmann (2018) studied zombie firms across 14 international countries across a long period of time, from 1987 to 2016. They applied two definitions of zombie

firms. The first one was broader and was based on the proposition created by McGowan *et al.* (2017). On the second one, the authors added to the previous proposition a new requirement: that a firm to be considered zombie should have low expected future growth potential measured through the firm's stock market value. Thus, the firms need to have a ratio of their assets' market value to their replacement cost that is below the median within their sector in any given year. Their findings were consistent with the hypotheses set by Caballero *et al.* (2008) and McGowan *et al.* (2017) that on average, zombie firm's labour productivity and total factor productivity are lower when in comparison with the other's regular healthy firm's productivity in the same sector. They also found that in the second definition of zombie firms there were evidence of congestion effects, which were not visible in the broader definition. They concluded that the non-zombie firms are the ones that invest more and have a greater employment growth and that when the share of zombies in a specific sector rises, the growth of the sector's productivity takes a big fall, but only to the firms covered by the narrow definition.

In short, it is noted that the existence of zombie firms in the market create several negative consequences previously mentioned, among which: they create solvency problems in the banking system; diminish the competitiveness in the market in which they operate; create barriers to the entry of new and more competitive companies; and are a factor of macroeconomic stagnation (Barros *et al.*, 2017).

Caballero (2008), Kwon, (2015) and McGowan *et al.* (2017) indicated that zombie companies usually have low levels of productivity, thus reducing the efficiency of the markets in which they are present.

Zombie Firms rarely turn healthy again, especially when they are old. The authors Hallak *et al.* (2018) found that close to 90% of zombie firms remain zombies or exit the market in the next two years after they were identified as zombies, by any of their three zombie definitions.

#### **1.4 Objectives and initial research hypotheses**

This research's objectives are to estimate the scale of the phenomenon of zombie Firms in the Eurozone during the period 2014-2020. Furthermore, we also want to know the main determinants of this phenomenon in Europe in the aforementioned period, trying to understand which factors increase the likelihood of a company to turn into a zombie,

whether microeconomic or macroeconomic factors. Finally, the research aims also to estimate the main consequences that the permanence of these firms in other healthy firms, specifically in the investment rate, employment growth and labour productivity.

The initial research hypotheses of this investigation should respond and be correlated with the objectives previously established. This investigation is divided in two parts. The first one is about the determinants of a firm to become and stay zombie. The second one is about the consequences that the permanence of these firms have on other companies of the same sector.

So, the hypotheses of the first part are the following:

- **H1:** The firms that show a bigger excess of debt, measured by comparing the firm's debt with the sector's average, have a bigger chance to become zombie. The investigation done by Banerjee and Hofmann (2018) validated this hypothesis.
- **H2:** The bigger a firm is, the higher the chance it has to become zombie. The investigation done by Chang et al (2021) and Gouveia & Osterhold (2018) validated this hypothesis.
- **H3:** The older a firm is, the higher the chance it has to become zombie. McGowan *et al.* (2017) confirmed this hypothesis in their study.

The hypotheses of the second part are the following:

- **H4:** a) An increase in the resources (assets) used by zombie firms reduces the investment of healthy companies.
- b) An increase in the resources (assets) used by zombie firms reduces the employment growth of healthy companies.
- c) An increase in the resources (assets) used by zombie firms reduces the productivity of healthy companies.

The authors Caballero *et al.* (2008) and McGowan *et al.* (2017) were able to validate these three hypotheses.

**CHAPTER II – DATA, METHODOLOGY AND DESCRIPTIVE  
STATISTICS**

## 2 Data and Methodology

### 2.1 Database and sample selection

For the accomplishment of the present study, data about companies in the Eurozone was collected through the European database ORBIS.

The sample was restricted to firms of countries that were members of the Eurozone in 2021 (Belgium, Germany, Ireland, Spain, France, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland, Greece, Slovenia, Cyprus, Malta, Slovakia, Estonia, Latvia and Lithuania) and that belong to the manufacturing sector. Using NACE Rev 2 (*Nomenclature statistique des Activites economiques dans la Communauté Européenne*) classification of activity, defined by the European Union in 1970, we considered for the present study the firms in the following section C -Manufacturing NACE codes:

- 10 - Manufacture of food products
- 11 - Manufacture of beverages
- 12 - Manufacture of tobacco products
- 13 - Manufacture of textiles
- 14 - Manufacture of wearing apparel
- 15 - Manufacture of leather and related products
- 16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
- 17 - Manufacture of paper and paper products
- 18 - Printing and reproduction of recorded media
- 19 - Manufacture of coke and refined petroleum products
- 20 - Manufacture of chemicals and chemical products
- 21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations
- 22 - Manufacture of rubber and plastic products
- 23 - Manufacture of other non-metallic mineral products
- 24 - Manufacture of basic metals
- 25 - Manufacture of fabricated metal products, except machinery and equipment
- 26 - Manufacture of computer, electronic and optical products
- 27 - Manufacture of electrical equipment
- 28 - Manufacture of machinery and equipment

- 29 - Manufacture of motor vehicles, trailers and semi-trailers
- 30 - Manufacture of other transport equipment
- 31 - Manufacture of furniture
- 32 - Other manufacturing

This sample was built for a period of 7 years, from 2014 to 2020.

The selection of the manufacturing sector was made in light of the fact that it is one of the most important sectors of the Eurozone economy (the manufacturing sector represents a large contribution of the GDP of several economies); moreover, having many other authors already released some studies of the manufacturing sector, the analysis becomes even more interesting.

Then, the following additional search criteria were applied to finally define the sample to be studied:

- The search also excluded firms that didn't have any recent financial data; this meaning, the firms that didn't have data for 2020 were excluded.
- The turnover of each firm must be available for the period of analysis 2014-2020. In this criterion, the year 2013 was also selected, as the values of this year will be used for the calculation of time-phased variables, mainly the Employment Growth variable.

After the application of those criteria on ORBIS, the sample consisted of 13580 firms. However, some firms had to be eliminated from the sample. The major bulk of the eliminated firms were from Estonia, Lithuania, Malta, and Netherlands. Their elimination occurred because country's firms didn't publish the amount of paid interest on the *Orbis* database, not allowing us to formulate its Interest Coverage Ratio (one of the criteria utilized to define if a firm is Zombie or not). After all these considerations and the correction and elimination of other errors (such as some firms presenting a constitution date older than the 1900s, not allowing the utilized software to calculate its age, presented in the sample, or some variables for some firms extracted from the *Orbis* database presenting characters in place of numbers), the study had 8833 firms.

Finally, the winsorizing process was applied to treat the outliers of the dependent variables, that is, extreme values that were outside the limits of 1.5 x Interquartile Range. This procedure was applied to variables Zashare, Debt Excess, Investment Rate,

Employment Growth, Labour Productivity, Employees and Total Assets, the observations that were above the upper limit were replaced by the value of 98% quantile and the observations that were below the lower limit were replaced by the value of 2 % quantile.

## 2.2 Sample characteristics

At this point, the characterization of the sample under study is presented, through the description of the total number of companies in each NACE, by country, by age and by size in a set of around 8,833 companies per year.

In Table 1 we can observe that the most representative sectors of the sample are the manufacture of food products, with a total of 15,28% of the firms, and the manufacture of machinery and equipment (NACE 10), with a total of 10,35% of the firms. On the other side, the least representative sectors of the sample are the manufacture of tobacco products (NACE 12), with a total of 0,15% of the firms, and the manufacture of coke and refined petroleum products (NACE 19), with a total of 0,51% of the firms in the sample.

*Table 1- Sample analysis by NACE sector in 2014*

<b>NACE</b>	<b>N° of firms</b>	<b>% of firms</b>	<b>NACE</b>	<b>N° of firms</b>	<b>% of firms</b>
<b>10</b>	1350	15,28%	<b>22</b>	735	8,32%
<b>11</b>	220	2,49%	<b>23</b>	342	3,87%
<b>12</b>	13	0,15%	<b>24</b>	427	4,83%
<b>13</b>	191	2,16%	<b>25</b>	862	9,76%
<b>14</b>	116	1,31%	<b>26</b>	501	5,67%
<b>15</b>	133	1,51%	<b>27</b>	431	4,88%
<b>16</b>	243	2,75%	<b>28</b>	914	10,35%
<b>17</b>	318	3,60%	<b>29</b>	549	6,22%
<b>18</b>	108	1,22%	<b>30</b>	129	1,46%
<b>19</b>	45	0,51%	<b>31</b>	122	1,38%
<b>20</b>	714	8,08%	<b>32</b>	191	2,16%
<b>21</b>	179	2,03%	<b>TOTAL</b>	8833	100%

*Source - Self elaboration*

In Table 2 we can see that the most representative countries of the sample are France, (with a total of 31,31% of the firms), Italy (with a total of 25,62% of the firms) and Germany (with a total of 15,97% of the firms). On the other side, the least representative countries of the sample are Greece (with a total of 0,02% of the firms), and Luxembourg (representing a total of 0,09% of the firms in the sample).

Table 2- Sample analysis by country in 2014

<b>Country</b>	<b>N° of firms</b>	<b>% of firms</b>
<b>France</b>	2766	31,31%
<b>Italy</b>	2263	25,62%
<b>Germany</b>	1411	15,97%
<b>Spain</b>	829	9,39%
<b>Finland</b>	430	4,87%
<b>Austria</b>	343	3,88%
<b>Slovakia</b>	211	2,39%
<b>Belgium</b>	186	2,11%
<b>Slovenia</b>	136	1,54%
<b>Ireland</b>	106	1,20%
<b>Portugal</b>	100	1,13%
<b>Latvia</b>	42	0,48%
<b>Luxembourg</b>	8	0,09%
<b>Greece</b>	2	0,02%
<b>TOTAL</b>	8833	100%

Source - Self elaboration

As can be seen in Table 3, for the year 2020, companies aged between 20 and 50 years old make up most of the sample, representing 63.33% of the total number of companies. Companies between 1 and 20 years old make up the smallest part of the sample, with 17.32% of the total number of companies. In relation to the eldest companies, over 51 years old, they represent 19.35% of the companies in the sample.

Table 3- Sample analysis by age

<b>Age</b>	<b>N° of firms</b>	<b>% of firms</b>
<b>10-20</b>	1530	17,32%
<b>20-50</b>	5594	63,33%
<b>51 or over</b>	1709	19,35%
<b>TOTAL</b>	8833	100%

Source - Self elaboration

For the period analysed, as can be seen in the Table 4, the sample consists mostly of medium companies (between 50 and 249 employees), representing around than 50% of the total number of companies each year. Small companies (between 1 and 49 employees) represent the smallest part of the sample, around 15% of the total number of companies. Regarding companies with 250 or more employees (large companies) they represent between 24% and 28% of the companies in the sample. It is relevant to mention that the

"N.A." are present in the Table 4 due to the fact that the data sample is not complete, as mentioned above.

Table 4- Sample analysis by size in 2014

N° of employees	1-49		50-249		250 or more		N.A.	
	N°	%	N°	%	N°	%	N°	%
<b>2014</b>	1497	16,95%	4197	47,52%	2128	24,09%	1011	11,45%
<b>2015</b>	1433	16,22%	4311	48,81%	2279	25,80%	810	9,17%
<b>2016</b>	1436	16,26%	4468	50,58%	2418	27,37%	511	5,79%
<b>2017</b>	1378	15,60%	4474	50,65%	2450	27,74%	531	6,01%
<b>2018</b>	1281	14,50%	4454	50,42%	2502	28,33%	596	6,75%
<b>2019</b>	1253	14,19%	4417	50,01%	2510	28,42%	653	7,39%
<b>2020</b>	1219	13,80%	4431	50,16%	2368	26,81%	815	9,23%

Source - Self elaboration

## 2.3 Methodology employed

### 2.3.1 Zombie definition

The first part of the empirical methodology is the definition of a Zombie Firm. To define such a type of firm, we applied the approach presented by McGowan et al (2017), Hallak (2018) and Barros (2017), which consists of classifying companies as Zombies according to the following criteria:

- 1°. Firms with an Interest Coverage Ratio inferior to 1 for three consecutive years
- 2°. Firms with a Net Income negative for three consecutive years
- 3°. Firms with at least 10 years of age

However, due to time horizon data limitations, it was necessary to adapt the first two criteria to just 2 years in a row, leaving the third criteria unchanged. Thus, in this study, a company is considered a zombie if it presents an interest coverage ratio of less than one for two consecutive years, a negative net income for two consecutive years and its age, measured in 2020, is equal to or greater than 10 years.

The second part of the empirical methodology must be divided between causes and consequences.

### 2.3.2 Methodology for Zombie Determinants

The second part of the methodology of this dissertation consists of analysing the data by using regression models for panel data, through Generalized Linear Models, taking into

account the fact that the dependent variable is a Dummy (company being a zombie in year  $t = 1$  or not be a zombie in year  $t = 0$ ). This model allows the observation of the behaviour of variables over time for different firms.

According to Baltagi (2008), panel data analyses have several advantages, among which the fact that they provide a greater amount of information, greater data variability, less collinearity between variables, greater number of degrees of freedom and greater efficiency in the estimation, also controlling the individual heterogeneity, thus enriching the empirical analysis.

To estimate the effects of one or more explanatory variables on a quantitative dependent variable that is not normally distributed, the linear regression model is not suitable, so generalized linear models (GLM) are used. If the regression contains at least one categorical variable, then the dependent variable has a distribution that follows the logic of mathematician Bernoulli  $Y \sim B(1,p)$ , using the logit or probit model. Thus, through the validation of several regressions, and through the criteria of the Akaike Information Criterion (AIC), that suggests that the best model to utilize is the one with the smallest AIC, it was concluded that the best model to use would be a Logit Model, given its smaller AIC than the Probit model.

Afterwards, the chosen model went through several tests. One of which being the Variance Inflation Factor (VIF) test, that indicates that if the variable's VIF value is around 1, there is no multicollinearity, which was the conclusion that was drawn for all the variables in this analysis. Furthermore, it was run a Pearson goodness of fit model to the data; since the p-value was higher than 5%, meaning that the model is well fit to the data.

Meanwhile, based on the model presented by Ghoul et al (2021) and by Andrews (2019), the regression equation to be estimated, using the logit model, is the following:

$$\begin{aligned}
 \text{Zombie}_{i,t} = & \beta_0 + \beta_1 \text{Debt\_Excess}_{i,t} + \beta_2 \text{GDP\_pc}_{i,t} + \beta_3 \text{Total\_Assets}_{i,t} + \beta_4 \text{Age}_i \\
 & + \beta_5 \text{Employees}_{i,t} + \alpha_{NACE} + \alpha_{Country} + \alpha_i + \alpha_t + \varepsilon_{ist}
 \end{aligned}
 \tag{1}$$

In which:

*Zombie* – dummy variable identifying a Zombie Firm in year  $t$ ;

*Debt\_Excess* – Excess of Debt (that is defined below)

*GDP\_pc* – GDP *per capita* of each firm's country;

*Total\_Assets* – Total of Assets;

*Age* – Age of each firm;

*Employees* – Number of employees;

*i* – Firms = 1,...,8833;

*t* – Years = 2014,...,2020;

$\alpha_{\text{NACE}}$  - individual fixed effects of the NACE sector NACE= 10,...,32;

$\alpha_{\text{Country}}$  - individual fixed effects of the Country Country= Austria,...,Slovakia;

$\alpha_i$ -individual fixed effects of the firms  $i= 1,...,8833$ ;

$\alpha_t$ -fixed effects of the year  $t= 2014,...,2020$ ;

$\varepsilon_{ist}$ -error term.

### **2.3.3 Methodology for Zombie Consequences**

The second part of the methodology of this dissertation consists in analysing the data, using panel data models, assessing the consequences of the existence of zombie firms.

The panel data methodology can be applied through the pooled OLS (Ordinary Least Squares) model, Fixed Effects model or Random Effects model. In order to choose the most appropriate econometric model, several tests were performed.

First, the OLS model was compared with the Fixed Effects for individuals' model, which tests the null hypothesis that there are no effects for individuals. Using the F test for the due effect, a p-value <5% was obtained, so the null hypothesis is rejected, and a Fixed Effects model for Individuals should be chosen. The F test was also performed, in order to test the OLS model with the Fixed Effects model for time; a p value<5% was obtained, which rejects the null hypothesis that there are no time effects, thus we opt for a Fixed Time Effects model. It is concluded with these two tests that the Fixed Effects model is preferable to the OLS model.

Then, it was needed to make a choice between the Fixed Effects model for Individuals, Fixed Effects for Time or for both effects. Through the F test, the Fixed Effects model for individuals and time was first compared with the fixed effects model for individuals, in order to test the null hypothesis that there are no effects for time, and a p value <5%; as the null hypothesis is rejected, we conclude that there are effects for time. Next, the Fixed Effects model for both effects was compared with the Fixed Effects model for Time, which tests the null hypothesis that there are no effects for individuals. Using the F test, a p-value <5% was obtained, which rejects the null hypothesis, concluding that there are effects for individuals. In conclusion, the most appropriate model to use was the Fixed Effects for Individuals and for Time.

Finally, the Hausman test was used to decide which model was the most appropriate, between the Fixed Effects model and the Random Effects model; in the Hausman test the null hypothesis tests the absence of correlation between residual effects and explanatory variables meaning the Random Effects model. Through this test, a p-value <5% was obtained, which rejects the null hypothesis, and therefore indicating that a Fixed Effects model should be chosen.

After all these tests and based on the model presented by McGowan et al. (2017), the regression equations to be estimated will be using the panel data model with fixed effects for time and individuals are the following:

$$\begin{aligned} InRate_{ist} = & \beta 1 NonZ_{ist} + \beta 2 NonZ_{ist} \times Zashare_{st} + \beta 3 Employees_{ist} + \beta 4 Age_{ist} \\ & + \alpha_i + \alpha_t + \varepsilon_{ist} \end{aligned} \tag{2}$$

$$\begin{aligned} JobVar_{ist} = & \beta 1 NonZ_{ist} + \beta 2 NonZ_{ist} \times Zashare_{st} + \beta 3 Employees_{ist} + \beta 4 Age_{ist} \\ & + \alpha_i + \alpha_t + \varepsilon_{ist} \end{aligned} \tag{3}$$

$$\begin{aligned} JobPct_{ist} = & \beta 1 NonZ_{ist} + \beta 2 NonZ_{ist} \times Zashare_{st} + \beta 3 Employees_{ist} + \beta 4 Age_{ist} \\ & + \alpha_i + \alpha_t + \varepsilon_{ist} \end{aligned} \tag{4}$$

In which:

*InRate* – Investment Rate;

*JobVar* – Employment Growth;

*JobPct* – Labour Productivity;

*NonZ* – Dummy variable that identifies the firms that are Healthy, that is, not Zombie;

*Zashare* - Share of industry “sunk” assets in zombie firms;

*Employees* – Number of employees;

*Age* – Age of each firm:

*i* – Firms = 1, ..., 8833;

*s* – Sector (NACE, from sector 10 to 32);

*t* – Years = 2014, ..., 2020;

$\alpha_i$  – individual fixed effects of the firms  $i = 1, \dots, 8833$ ;

$\alpha_t$  – fixed effects of the year  $t = 2014, \dots, 2020$ ;

$\varepsilon_{ist}$  – error term.

## 2.4 Variables

### 2.4.1 Variables for zombie determinants

As mentioned before, according to slight alterations of the definitions presented by McGowan et al (2017), Hallak (2018) and Barros (2017), the variables Interest Coverage Ratio, Net Income and Age were used as criteria to classify companies as zombies:

- Interest Coverage Ratio: variable that must be inferior to one for two consecutive years and that is calculated as follows:

$$\text{Interest Coverage Ratio}_t = \frac{\text{Operational Result (EBIT)}_t}{\text{Supported Interest}_t}$$

(5)

- Net Income: variable that should be negative for two consecutive years
- Age: should be higher or equal to ten years old; was obtained through the difference between the last year of the study (2020) and the year of incorporation of the company.

As the variables Interest Coverage Ratio and Net Income have the condition of the two consecutive years, data for these variables were also collected from 2013, so it was possible to identify companies as zombies in 2014, the year in which the study begins.

After identifying the zombie firms and having as main objective of this part to analyse the determinants that turn a firm into a Zombie, the **explained variable** to be studied is the following:

**Zombie Firm (*Zombie*):** it's a dummy variable that identifies the Zombie firms (which are characterized as companies with an interest coverage ratio of less than one for two consecutive years, negative net income for two consecutive years and companies with 10 or more years of seniority).

Considering the objectives of the investigation and the hypotheses defined above, the **independent variables** of this study are the following:

**Excess of Debt (*Debt\_Excess*):** concerns the amount of debt that the company has in relation to the average value of the variable in firms of the same sector; that is, it will be measured by comparing the debt ratio of each firm in each year (analysed through the amount of current and non-current financing debt divided by global assets) - in view of the average debt ratio, in that same year, of the sector to which each firm belongs; thus, it will be possible to affirm that the company will be excessively indebted if its debt ratio is above the average of the sector of activity to which it belongs.

**Logarithm of Number of employees (*Employees*):** represents the dimension of the firm, to analyse if the size is a determinant to being a zombie.

**Logarithm of Age (*Age*):** analyses the age of the firm, so it can be verified whether the age of the firm is a determinant to being a zombie.

#### **Control Variables:**

**Logarithm of *Total\_Assets*:** analyses the value of assets, so it can be verified whether the size of the firm is a determinant to being a zombie.

**NACE Code (*NACE*):** analyses if there is a most common sector among zombie firms that influences a “regular” firm to become a Zombie.

**Country (*Country*):** analyses if there is a most common country among zombie firms that influences a “regular” firm to become a Zombie.

**Logarithm of GDP per capita of each country (*GDP\_pc*):** analyses if the GDP per capita of the country in which each firm is inserted is a determinant to being a zombie.

**Year (*Year*):** represents the year of each data analysed.

## 2.4.2 Variables for Zombie Consequences

### 2.4.2.1 Dependent Variables

After identifying the zombie firms and also having as main objective to analyse the effects that the prevalence of zombie firms has on the remaining firms, the explained variables to be studied are the Investment Rate in tangible assets, the Employment Growth and Labour Productivity, which are constructed as follows:

$$\text{Investment Rate (InRate)} = \frac{\text{Fixed Assets}_t - \text{Fixed Assets}_{t-1} + \text{Depreciations}_t}{\text{Fixed Assets}_{t-1}} \quad (6)$$

$$\text{Variation in Employment (JobVar)} = \frac{N^{\circ} \text{ of Employees}_t - N^{\circ} \text{ of Employees}_{t-1}}{N^{\circ} \text{ of Employees}_{t-1}} \quad (7)$$

$$\text{Labour Productivity (JobPct)} = \frac{\text{Turnover}_t}{N^{\circ} \text{ of Employees}_t} \quad (8)$$

### 2.4.3.2 Independent Variables

Considering the objectives of the investigation and the hypotheses defined above, the independent variables of this study are the following:

**Healthy Firms (*NonZ*):** it's a dummy variable that identifies the Healthy firms, the firms that are not defined as Zombie (which are characterized as companies with an interest coverage ratio of less than one for two consecutive years, negative net income for two consecutive years and older than 10 years old), where the value 1 is assigned to these companies; and the value 0 for Zombie firms.

**Share of assets sunk in zombie firms (*Zashare*):** represents the assets of companies in each sector (NACE) that belong to firms considered zombie and measures the weight of zombie firms in each activity sector. This variable is calculated as follows:

$$Zashare_t = \frac{\text{Total of Assets of the Zombie Firms in each NACE}_t}{\text{Total of Assets of all Firms in each NACE}_t} \quad (9)$$

**Number of employees (Employees):** represents the dimension of the firm, to verify the relation between this variable and the dependent variables.

**Age (Age):** represent the age of the firm, to verify the relationship between this variable and the dependent variables.

## 2.5 Descriptive statistics

### 2.5.1 Descriptive analysis of the sample

In this first point, we present a descriptive analysis of the incidence of zombie firms in the sample under study by year, age, size, country, and NACE for the period from 2014 to 2020.

*Table 5- Zombie firms analysis by number*

<b>Year</b>	<b>N° of Zombie Firms</b>	<b>% of Zombie Firms</b>
<b>2014</b>	889	10,06%
<b>2015</b>	811	9,18%
<b>2016</b>	759	8,59%
<b>2017</b>	703	7,96%
<b>2018</b>	785	8,89%
<b>2019</b>	916	10,37%
<b>2020</b>	892	10,10%

*Source - Self elaboration*

From the analysis of Table 5, it appears that the prevalence of zombie firms in the EuroZone (in the sectors under study) varied between 7,96% in 2017 and 10.37% in 2019, where it reached the minimum and maximum value, respectively. In the period from 2014 to 2017, there was a decrease of 2.1 percentage points in the percentage of zombie firms (from 10.06% in 2014 to 7.96% in 2017), and from 2017 onwards the number and the weight of zombie companies began to increase again.

Table 6- Zombie firm analysis by age in 2014

Age	N° of Zombie firms	% of Zombie firms
"10-36"	557	6,31%
"36-50"	165	1,87%
51 or more	167	1,89%

Source -Self elaboration

Regarding the age of the zombie firms in 2014 (as an example), on Table 6 it can be seen that 6.31% of the firms aged from 10 to 36 years old are considered zombie, thus representing the age class with the highest percentage of this type of firms. The other two categories represent roughly the same amount of zombie firms (1,9% of older firms). The presented choice of the upper and lower limit of the younger and medium age of the firms being 36 years, is due to this value corresponding to the average age of the firms in the sample (calculated in the descriptive statistics of chapter 2.5.2).

Table 7- Zombie analysis by size

N° of employees	"1-49"		"50-249"		250 or more		N.A.	
	N°	%	N°	%	N°	%	N°	%
2014	73	0,83%	491	5,56%	237	2,68%	88	1,00%
2015	54	0,61%	435	4,92%	243	2,75%	79	0,89%
2016	56	0,63%	411	4,65%	227	2,57%	65	0,74%
2017	55	0,62%	384	4,35%	216	2,45%	48	0,54%
2018	51	0,58%	412	4,66%	262	2,97%	60	0,68%
2019	69	0,78%	478	5,41%	302	3,42%	67	0,76%
2020	57	0,65%	467	5,29%	298	3,37%	70	0,79%

Source - Self elaboration

Meanwhile, regarding the size of companies, it can be seen in Table 7 that the highest percentage of zombie firms is observed in the medium size firms (between 50 and 249 employees), throughout the period analysed. The smallest firms (10 to 49 firms) are the ones with the least of Zombie representation, for the period analysed.

Table 8- Zombie firm analysis by Country in 2014

Country	2014	
	N°	%
<b>Luxembourg</b>	2	25,00%
<b>France</b>	351	12,69%
<b>Spain</b>	104	12,55%
<b>Ireland</b>	13	12,26%
<b>Finland</b>	48	11,16%
<b>Slovakia</b>	20	9,48%
<b>Germany</b>	120	8,50%
<b>Italy</b>	174	7,69%
<b>Belgium</b>	14	7,53%
<b>Austria</b>	25	7,29%
<b>Portugal</b>	7	7,00%
<b>Slovenia</b>	9	6,62%
<b>Latvia</b>	2	4,76%
<b>Slovakia</b>	20	9,48%

Source - Self elaboration

Regarding the number of zombie firms on each country, it can be seen in Table 8 that the country with the highest percentage of zombie firms is Luxembourg with 25%, but it is necessary to bear in mind that this country only has 8 firms in the sample. The following countries with the highest percentage of zombie firms are France, with 12,69% of the firms being Zombie, and Spain, with 12,55% of the firms in the sample being Zombie. On the other half, the countries that have the lowest percentage of zombie firms are Greece (that only has 2 firms in the sample), with 0%, Latvia, with 4,76% and Slovenia, with 6,62% of the firms in the sample being Zombie

Table 9- Zombie analysis by NACE in 2014

2014					
NACE	Nº	%	NACE	Nº	%
<b>10</b>	95	7,04%	<b>22</b>	66	8,98%
<b>11</b>	10	4,55%	<b>23</b>	59	17,25%
<b>12</b>	0	0,00%	<b>24</b>	65	15,22%
<b>13</b>	17	8,90%	<b>25</b>	76	8,82%
<b>14</b>	15	12,93%	<b>26</b>	42	8,38%
<b>15</b>	8	6,02%	<b>27</b>	45	10,44%
<b>16</b>	29	11,98%	<b>28</b>	84	9,19%
<b>17</b>	43	13,52%	<b>29</b>	83	15,12%
<b>18</b>	15	13,89%	<b>30</b>	19	14,73%
<b>19</b>	3	6,67%	<b>31</b>	17	13,93%
<b>20</b>	70	9,80%	<b>32</b>	14	7,33%
<b>21</b>	14	7,82%			

Source - Self elaboration

From the analysis of Table 9, it appears that the NACE sectors with the highest percentage of Zombie firms are 23 - Manufacture of other non-metallic mineral products, with 17,25%, 24 - Manufacture of basic metals, with 15,22%, and 29 - Manufacture of motor vehicles, trailers and semi-trailers, with 15,12% of the firms being Zombie. On the other side, the NACE sectors with the lowest percentage of Zombie firms are 12 - Manufacture of tobacco products (that only has 2 firms in the sample), with 0%, 11 - Manufacture of beverages, with 4,55%, and 15 - Manufacture of leather and related products, with 6,02% of the firms being a Zombie.

### 2.5.2 Descriptive statistics of the variables

The Table 10 presents the descriptive statistics of variables used in regressions, through the average, median, standard deviation, minimum and maximum.

Table 10- Descriptive analysis of the variables

<b>Variables</b>	<b>Average</b>	<b>Median</b>	<b>Standard Deviation</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Debt_Excess (p.p.)</b>	0,0060	-0,0430	0,1087	-0,0960	0,3590
<b>Total_Assets (thousand €)</b>	78083	28818	143841,6	6095	801141
<b>GDP_pc (€)</b>	32711	33430	7474,59	11850	101760
<b>InRate (p.p.)</b>	21,47	13,33	31,13	-35,05	153,19
<b>JobVar (p.p.)</b>	-2,90	0	23,78	-100	37
<b>JobPct (thousand €)</b>	469	302,80	494,63	89,30	2735
<b>Zashare (p.p.)</b>	22,54	22	10,67	7	47
<b>Employees (n°)</b>	265,10	133	369,31	14	1983
<b>Age (years)</b>	36,46	33	17,52	10	117

Source - Self elaboration

Through the analysis of the Table 10 it appears that the firms in the sample for the period between 2014 and 2020 have, on average, a positive Debt excess of 0,6%. Regarding the total of assets, it appears that the firms of the sample have on average 78 million on assets, and that on average, the GDP per capita of all the firm's country's is around 33 thousand euros per capita.

Additionally, it appears that the companies in the sample for the period between 2014 and 2020 have, on average, a positive investment rate of 21.47% and in average a slight negative employment growth with a value average of -2,90%. In terms of labour productivity, these companies have an average turnover of 469 thousand euros per employee.

Regarding the “sunk” assets variable (*Zashare*), it appears that on average 22.54% of the assets are “sunk” in zombie firms, that is, they belong to zombie firms in the sectors under study, representing a very large portions of the firms in study.

Finally, it is observed that the firms that make up the sample have an average age of around 36 years old and size of 265 employees.

Table 11 shows the descriptive statistics (average, median, standard deviation. minimum, and maximum) for the 3 dependent variables under study for the consequences of zombie firms (Investment Rate, Employment Growth and Labour Productivity), but discriminated in order to compare the zombie and non-zombie firms.

Table 11- Descriptive analysis of the variables by Zombie

<b>Variables</b>	<b>Tipology</b>	<b>Average</b>	<b>Median</b>	<b>Standard Deviation</b>	<b>Minimum</b>	<b>Maximum</b>	<b>N.A.</b>
<b>InRate (%)</b>	Zombie	16,78	9,75	29,54	-32,15	151,61	30
	Not Zombie	22,6	13,92	30,31	-20,36	152,21	372
<b>JobVar (%)</b>	Zombie	-6,43	-1,87	25,07	-100	40	577
	Not Zombie	-1,6	0,7	21,9	-100	37	4313
<b>JobPct (€)</b>	Zombie	335,65	238,22	298,53	79,38	1645,10	477
	Not Zombie	484,11	311,27	512,41	91,38	2836,55	3641

Source - Self elaboration

By analysing the Table 11, it is observed that the zombie firms in the sample for the period between 2014 and 2020, have an average investment rate of 16,78%, while non-zombie firms have a higher average investment rate of 22,60%. Regarding the employment growth, both zombie and non-zombie firms register a negative average value, having the later one (-1,6%) a better rate than the first one (-6,43%). It can also be seen that zombie firms have an average value of 335,65 thousand euros in turnover per worker, while non-zombie firms have a higher average value of 484,11 thousand euros in turnover per worker.

Thus, it appears that zombie firms in the sectors under study, on average, invest less, have lower employment growth and are less productive, compared to the non-zombie firms in study.

## **CHAPTER III – RESULTS AND ITS DISCUSSION**

### 3 Results of Regressions

#### 3.1 Analysis of the regression results

##### 3.1.1 Analysis of the Zombie Determinants results

In this subsection, we present the estimates of the coefficients of the Logit model where the dependent variable is the dummy *Zombie Firm*.

Given the main objective of this dissertation, which is to analyse which variables have influence in turning a firm into a *Zombie*, the most important coefficients is the *Debt\_Excess* one, which measures if the firm having excess of debt raises its probability of a firm becoming *Zombie*. These coefficients and variables obtained from a Logit model directly can be observed on Table 12.

Table 12 -Coefficients of the estimated value of the determinants' regression

Variable	Coefficients
<b>Debt_Excess</b>	1,80E+00*** (1,35E-01)
<b>Employees</b>	4,78E-01*** (2,44E-02)
<b>Age</b>	-3,06E-01*** (3,20E-02)
<b>Control: GDP_pc</b>	-1,62E+00** (6,14E-01)
<b>Control: Total_Assets</b>	-3,26E-01*** (2,18E-02)

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; “.” Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self elaboration

Bearing in mind that this is a logit model, there is a linear regression, called the odds ratio, which is the ratio of the probabilities of the two possible events in the study; so, when there is an increase of one unit in a variable  $X_i$ , *ceteris paribus*, a multiplication of the odds ratio by the factor  $e^{\beta_i}$  is needed. In this way, with a Logit Model, to interpret the results, we should not utilize these coefficients, but the coefficient's exponential value, as exposed in the Table 13.

Table 13 - Exponential coefficients of the estimated value of the determinants' regression

Variable	Coefficients
<b>Debt_Excess</b>	6,04E+00*** (1,14E+00)
<b>Employees</b>	1,61E+00*** (1,02E-01)
<b>Age</b>	7,37E-01*** (1,03E-01)
<b>Control: GDP_pc</b>	1,97E-01** (1,85E-01)
<b>Control: Total Assets</b>	7,22E-01*** (1,02E-01)

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; “.” Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self elaboration

It can be observed that all the variables (Debt Excess, Employees, Age, GDP\_pc and Total Assets,) are statistically significant.

In a quantitative analysis it appears that for each additional percentage point in the excess of debt of a firm, *ceteris paribus*, the odds ratio of a company being a zombie over not being a zombie increases by about 604%, suggesting that when a firm has a bigger debt than it's NACE Code sector average, it has a higher probability of becoming Zombie. This means validating the H1 starting hypothesis that suggests that the firms that show a bigger excess of debt have a bigger chance to become zombie.

Regarding the size of the firm, it can be seen that for each additional employee in the number of employees of a firm, *ceteris paribus*, the odds ratio is of 161%, therefore suggesting that the bigger a firm is, the higher is the odds ratio between the probability of a firm to be a zombie over the probability of not being a zombie. Validating the H2 starting hypothesis that suggests that the bigger a firm is, the higher the chance it has to become Zombie.

Regarding the age of the firm, it can be observed that for each additional year a company completes, *ceteris paribus*, the odds ratio is of 73,7%, suggesting that the probability of a firm to be a zombie is lower than the probability of not being a zombie, not validating the H3 starting hypothesis that suggests that the older a firm is, the higher the chance it has to become Zombie.

### 3.1.2 Analysis of the Zombie Consequences results

In this subsection, we present the estimates of the coefficients of the panel data models with Fixed Effects for the dependent variables (Investment Rate, Employment Growth and Labour Productivity), and the analyses of the effect that each independent variable generates on each of the dependent variables.

Given that one of the main objectives of this dissertation is to analyse the effects that the zombie firms causes on the activity of healthy companies, the most important coefficient is that of the interaction of Non-Zombie firms with the portion of the share of assets sunk in the zombie firms (*NonZ x Zashare*). This interaction variable allows us to analyse the main objective, given that the prevalence of zombie firms is measured by the “sunk” asset variable, which represents the weight of zombie firms in each sector, through the fraction of assets retained in these companies.

Table 14- Results of the Zombie consequences' investment rate regression

Investment Rate	
Variable	Estimated Value
<i>NonZ</i>	5,5251E-02*** (1,41E-02)
<i>Zashare</i>	-7,20E-02 (6,82E-02)
<i>Employees</i>	8,3925E-05*** (2,30E-05)
<i>NonZ x Zashare</i>	-2,00E-02 (5,34E-02)
<b>R<sup>2</sup></b>	0,0018891

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; “.” Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self elaboration

According to the results presented in Table 14 for the Investment Rate, it is verified that the independent variables *NonZ* and *Employees* are statistically significant, while the “sunk” assets variable *Zashare* and its interaction with the *NonZ* variable are not statistically significant, the later being the most important coefficient to analyse.

Regarding the variable *NonZ*, it presents a positive coefficient, indicating that, on average, healthy firms invest more 5.53 percentage points than zombie firms in the sectors and regions under study, *ceteris paribus*. Thus, we can conclude that the healthy firms have

higher investment rates than the Zombie firms, according with what was observed in Table 11.

The variable *Employees* shows a positive coefficient, indicating that, on average, an increase of 1 employee in firms generates an increase of 0,0084 percentage points in the investment rate of the firms in the sectors and regions under study, *ceteris paribus*. Thus, it can be concluded that, on average, as the size of the firms increases, so does its investment rate.

At last, the main variable of this section, the interaction between the coefficients of the “sunk” assets variable *Zashare* and the *NonZ* variable did not show itself statistically significant, so there cannot be any analysis on its effect on the dependent variable, Investment Rate. So, it is not possible to verify the validity of the H4 a) hypothesis that indicates that an increase in the resources (assets) used by zombie firms reduces the investment rate of healthy companies.

Table 15- Results of the Zombie consequences' employment growth regression

<b>Employment Growth</b>	
<b>Variable</b>	<b>Estimated Value</b>
<i>NonZ</i>	8,53E-03 (5,65E-03)
<i>Zashare</i>	-5,8275E-02* (2,70E-02)
<i>Employees</i>	5,7568E-04*** (9,02E-06)
<i>NonZ x Zashare</i>	3,5622E-02 (2,13E-02)
<b>R<sup>2</sup></b>	0,085356

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; “.” Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self elaboration

Meanwhile, according to the results presented in Table 15 for the Employment Growth, it is verified that all the independent variables are statistically significant, with the exception of the variable that defines a firm as a Healthy firm, *NonZ*.

Furthermore, the “sunk” assets variable *Zashare* has a negative coefficient, suggesting that, on average, and increase of 1 percentage point in the assets “sunk” in the Zombie firms, represents a reduction of 5,83 percentage points in the employment growth of firms

in the sectors and regions under study, *ceteris paribus*. This way, it can be concluded that the higher the percentage of resources held by Zombie firms, the lower the employment growth of the analysed firms.

The variable *Employees* shows a positive coefficient, indicating that, on average, an increase of 1 employee in firms generates an increase of 0,058 percentage points in the employment growth of the firms in the sectors and regions under study, *ceteris paribus*. Thus, it can be concluded that, on average, as the size of the firms increases, so does its employment growth.

The most important variable of the study, the interaction variable with the fraction of “sunk” assets in Zombie firms *NonZ x Zashare* has a positive coefficient with the Employment Growth, revealing that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates an increase of around 3,56% of the employment growth of the healthy firms in the sectors and regions under study, *ceteris paribus*. Therefore, the higher the percentage of resources retained in zombie firms, the higher the employment growth of the analysed firms. These results are contrary to the H4 b) starting hypothesis which indicates that an increase in the resources (assets) used by zombie firms reduces the employment growth of healthy companies, not allowing us to validate it. A justification for these unexpected results may lie in the fact that the analysed firms didn't show much change in their number of employees over the years.

As seen in Table 11, zombie companies had lower average employment growth than healthy companies, both remaining negative. Thus, leading to the belief that the few investments in the assets of zombie companies would lead to some lay-offs in their firms, which represented a slight increase in the number of employees of healthy firms since there were more available employees in the market for healthy firms to hire, bearing in mind that the typology of sectors under analysis is generally labour intensive.

Table 16- Results of the Zombie consequences' labour productivity regression

<b>Labour Productivity</b>	
<b>Variable</b>	<b>Estimated Value</b>
<i>NonZ</i>	4,18E+01 <sup>***</sup> (6,97E+00)
<i>Zashare</i>	6,10E+01 <sup>.</sup> (3,36E+01)
<i>Employees</i>	-6,30E-01 <sup>***</sup> (1,11E-02)
<i>NonZ x Zashare</i>	-5,01E+01 <sup>.</sup> (2,63E+01)
<b>R<sup>2</sup></b>	0,066558

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; "." Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self elaboration

According to the results presented in Table 16 for the labour Productivity, it is verified that all the independent variables are statistically significant.

Regarding the variable *NonZ*, it presents a positive coefficient, indicating that, on average, healthy firms have a higher labour productivity of around 42 thousand euros than zombie firms in the sectors and regions under study, *ceteris paribus*. This way, we can conclude that the healthy firms are more productive than the Zombie firms, according with what was observed in Table 11.

Regarding the variable "sunk" assets *Zashare*, it has a positive sign, which means that, on average, an increase of 1 percentage point in "sunk" assets in zombie firms, generates an increase of about 61 thousand euros in labour productivity of the general firms in the sectors and regions under analysis, *ceteris paribus*. Therefore, the higher the percentage of resources held by zombie companies, the higher the labour productivity of the firms analysed.

The variable *Employees* has a negative coefficient, which suggests that, on average, an increase of 1 employee in a firm generates a decrease of 0.63 thousand euros in the labour productivity of companies in the sectors under study, *ceteris paribus*. Thus, as the size of companies increases, their labour productivity decreases.

The most important variable of the study, the interaction variable with the fraction of "sunk" assets in Zombie firms *NonZ x Zashare* has a negative coefficient with the Labour

Productivity, revealing that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates a decrease of around 50,15 thousand euros of the labour productivity of the healthy firms in the sectors and regions under study, *ceteris paribus*. Therefore, the higher the percentage of resources retained in zombie firms, the lower the labour productivity of the analysed firms. These results allow us to validate the H4 c) starting hypothesis which indicates that an increase in the resources (assets) used by zombie firms reduces the productivity of the healthy companies.

We can conclude that under the sectors, countries and years studied, an increase in the resources (assets) used by zombie firms reduces the productivity of the healthy firms, as expected, but increases the employment growth of the healthy firms under analysis, being contrary to what was expected. At the same time no conclusion could be taken from the investment rate perspective.

We can also conclude that the healthy firms present a higher investment rate and labour productivity, when compared to the Zombie Firms, and that the bigger the size of the firm, the bigger the size of its investment rate and employment growth.

## **3.2 Robustness Analysis**

At this point, a robustness analysis will be carried out in order to analyse the impact of zombie firms on the activity of healthy companies in each of the countries, age groups and size groups analysed separately.

### **3.2.1 Robustness analysis by country**

In this area, the sample will be divided into several subsamples corresponding to each of the countries in question (Austria, Belgium, Germany, Spain, Finland, France, Ireland, Italy, Latvia, Portugal, Slovenia, Slovakia). We couldn't estimate the regressions to the firms in Greece, because as mentioned before, our sample doesn't include any Zombie Firms of this country. Furthermore, we also couldn't include an analysis to the firms present in Luxembourg due to the fact that the firms from this country had strongly correlated variables and the R software wouldn't allow us to estimate the regression unless we made a massive change in our sample. The same thing happened in the Investment Rate regression for Slovakia.

Table 17- Robustness analysis by country investment rate results (part 1)

Variable	Austria	Belgium	Germany	Spain	Finland	France
<b>NonZ</b>	1,78E-01* (7,13E-02)	2,34E-02 (1,21E-01)	6,99E-03 (3,12E-02)	3,06E-02 (4,11E-02)	1,08E-01 (6,41E-02)	4,25E-02* (2,07E-02)
<b>Zashare</b>	1,14E+00** (3,46E-01)	-5,04E-01 (4,99E-01)	2,72E-02 (1,34E-01)	-1,34E-01 (2,19E-01)	8,63E-02 (3,09E-01)	3,27E-02 (1,12E-01)
<b>Employees</b>	5,73E-05 (1,28E-04)	-3,05E-04 (2,65E-04)	1,50E-04*** (3,91E-05)	1,29E-04* (5,56E-05)	1,24E-04 (1,02E-04)	7,49E-05 (3,92E-05)
<b>NonZ x Zashare</b>	-6,01E-01* (2,51E-01)	-2,59E-02 (4,31E-01)	9,84E-02 (1,12E-01)	-3,69E-02 (1,63E-01)	-8,96E-02 (2,50E-01)	3,72E-02 (8,01E-02)
<b>R2</b>	0,007674	0,0042357	0,003038	0,0021025	0,007031	0,002879

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; "." Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self elaboration

Table 18- Robustness analysis by country investment rate results (part 2)

Variable	Ireland	Italy	Latvia	Portugal	Slovenia
<b>NonZ</b>	4,50E-02 (1,35E-01)	7,01E-02 (3,73E-02)	-2,77E-01 (3,81E-01)	2,63E-01* (1,33E-01)	6,00E-02 (1,27E-01)
<b>Zashare</b>	-2,22E-01 (6,31E-01)	-4,88E-01** (1,72E-01)	-2,15E+00 (1,93E+00)	1,17E+00* (5,87E-01)	5,88E-01 (5,90E-01)
<b>Employees</b>	-6,75E-05 (3,07E-04)	9,42E-05 (7,33E-05)	-2,05E-04 (5,07E-04)	-1,82E-04 (2,96E-04)	3,03E-05 (1,30E-04)
<b>NonZ x Zashare</b>	3,04E-01 (5,08E-01)	7,51E-03 (1,43E-01)	1,53E+00 (1,87E+00)	-1,11E+00* (4,58E-01)	4,82E-02 (5,02E-01)
<b>R2</b>	0,007182	0,003219	0,00714	0,011569	0,006885

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; "." Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self elaboration

Through the analysis of the Table 17 and Table 18, for the regression of the Investment Rate, it appears that for Austria, all the independent variables are statistically significant, except the Employees variable. The Non-Zombie variable *NonZ* has a positive sign, which reveals that healthy firms have investment rates 17,8 percentage points higher than zombie firms in the country of Austria, *ceteris paribus*. The “sunk” assets *Zashare* has a positive sign, which means that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates an increase of about 114 percentage points in the investment rate of firms in the country of Austria, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a negative relationship with the Investment Rate, which indicates that a 1 percentage

point increase in “stuck” assets in zombie firms, reduces the investment rate of healthy companies in the country of Austria by 60,1 percentage points, *ceteris paribus*.

Regarding Belgium, in the investment rate regression, we can see that none of the variables are statistically significant.

Germany, in the investment rate regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a positive relationship with the investment rate, which indicates that an increase of 1 employee in the firms generates an increase of 0,015 percentage points in the investment rate of the firms in the country of Germany, *ceteris paribus*.

Spain, in the investment rate regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a positive relationship with the investment rate, which indicates that an increase of 1 employee in the firms generates an increase of 0,013 percentage points in the investment rate of the firms in the country of Spain, *ceteris paribus*.

Finland, in the investment rate regression, presents only one significant variable, the *NonZ* variable. The Non-Zombie variable *NonZ* has a positive sign, which reveals that healthy firms have investment rates 10,8 percentage points higher than zombie firms in the country of Finland, *ceteris paribus*.

France, in the investment rate regression, presents two significant variables, the *NonZ* variable and the *Employees* variable. The Non-Zombie variable *NonZ* has a positive sign, which reveals that healthy firms have investment rates 4,25 percentage points higher than zombie firms in the country of France, *ceteris paribus*. The *Employees* variable shows a positive relationship with the investment rate, which indicates that an increase of 1 employee in the firms generates an increase of 0,075 percentage points in the investment rate of the firms in the country of France, *ceteris paribus*.

Ireland, in the investment rate regression, we can see that none of the variables are statistically significant.

Italy, in the investment rate regression, presents two significant variables, the *NonZ* variable and the *Zashare* variable. The Non-Zombie variable *NonZ* has a positive sign, which reveals that healthy firms have investment rates 7,01 percentage points higher than zombie firms in the country of Italy, *ceteris paribus*. The “sunk” assets *Zashare* has a

negative sign, which means that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates a decrease of about 48,80 percentage points in the investment rate of firms in the country of Italy, *ceteris paribus*.

Regarding Latvia, in the investment rate regression, we can see that none of the variables are statistically significant.

Portugal, in the investment rate regression, presents three significant variables, the *NonZ* variable, the *Zashare* variable and the *NonZ x Zashare*. The Non-Zombie variable *NonZ* has a positive sign, which reveals that healthy firms have investment rates 26,30 percentage points higher than zombie firms in the country of Portugal, *ceteris paribus*. The “sunk” assets *Zashare* has a positive sign, which means that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates an increase of about 117 percentage points in the investment rate of firms in the country of Portugal, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a negative relationship with the Investment Rate, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, reduces the investment rate of healthy firms in the country of Portugal by 111 percentage points, *ceteris paribus*.

Regarding Slovenia, in the investment rate regression, we can see that none of the variables are statistically significant.

Table 19- Robustness analysis by country employment growth results (part 1)

Variable	Austria	Belgium	Germany	Spain	Finland	France
<b>NonZ</b>	-1,09E-02 (3,21E-02)	8,97E-03 (3,40E-02)	5,69E-03 (1,15E-02)	3,99E-02* (1,83E-02)	5,35E-02* (2,40E-02)	9,66E-03 (1,04E-02)
<b>Zashare</b>	-4,50E-01** (1,64E-019)	-1,64E-01 (1,41E-01)	-6,17E-02 (4,94E-02)	-5,27E-03 (9,72E-02)	4,56E-02 (1,16E-01)	1,79E-02 (5,61E-029)
<b>Employees</b>	7,75E-04*** (6,06E-05)	5,73E-04*** (7,46E-05)	3,92E-04*** (1,37E-059)	4,52E-04*** (2,50E-05)	6,77E-04*** (3,85E-05)	8,68E-04*** (2,01E-05)
<b>NonZ x Zashare</b>	1,22E-01 (1,15E-01)	1,28E-01 (1,21E-01)	3,17E-02 (4,11E-02)	-1,25E-01 (7,23E-02)	-1,25E-01 (9,39E-02)	3,03E-02 (4,01E-02)
<b>R2</b>	0,12886	0,060544	0,093976	0,064571	0,13664	0,15038

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; “.” Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self elaboration

Table 20- Robustness analysis by country employment growth results (part 2)

Variable	Ireland	Italy	Latvia	Portugal	Slovenia	Slovakia
<b>NonZ</b>	-5,65E-02 (3,94E-02)	1,56E-03 (1,26E-02)	-1,59E-01 (1,20E-01)	6,78E-02 (4,79E-02)	-9,45E-02 (4,88E-02)	6,89E-03 (4,07E-02)
<b>Zashare</b>	-2,23E-01 (1,84E-01)	-9,49E-02 (5,79E-02)	-8,56E-01 (6,07E-01)	-6,23E-03 (2,12E-01)	-2,94E-01 (2,28E-01)	-2,91E-02 (1,96E-01)
<b>Employees</b>	4,64E-04*** (8,96E-05)	6,83E-04*** (2,47E-05)	6,77E-04*** (1,60E-04)	4,97E-04*** (1,07E-04)	4,93E-04*** (5,00E-05)	4,61E-04*** (4,71E-05)
<b>NonZ x Zashare</b>	3,35E-01* (1,48E-01)	8,44E-02 (4,81E-02)	7,17E-01 (5,90E-01)	-1,30E-01 (1,65E-01)	4,45E-01* (1,95E-01)	-2,26E-02 (1,33E-01)
<b>R2</b>	0,0569	0,054893	0,081291	0,042998	0,12247	0,089737

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; "." Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self elaboration

Through the analysis of the Table 19 and Table 20 for the regression of the employment growth, it appears that for Austria, the only independent variables that are statistically significant, are the *Zashare* variable and the *Employees* variable. The “sunk” assets *Zashare* has a negative sign, which means that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates a decrease of about 45 percentage points in the employment growth of firms in the country of Austria, *ceteris paribus*. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,0078 percentage points in the employment growth of the firms in the country of Austria, *ceteris paribus*.

Belgium, in the employment growth regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,057 percentage points in the employment growth of the firms in the country of Belgium, *ceteris paribus*.

Germany, in the employment growth regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,039 percentage points in the employment growth of the firms in the country of Germany, *ceteris paribus*.

Spain, in the employment growth regression, presents three significant variables, the *NonZ* variable, the *Employees* variable and the *NonZ x Zashare* variable. The Non-Zombie variable *NonZ* has a positive sign, which reveals that healthy firms have an employment growth 3,99 percentage points higher than zombie firms in the country of Spain, *ceteris paribus*. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,045 percentage points in the employment growth of the firms in the country of Spain, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a negative relationship with the employment growth, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, reduces the employment growth of healthy firms in the country of Spain by 12,5 percentage points, *ceteris paribus*.

Finland, in the employment growth regression, presents two significant variables, the *NonZ* variable and the *Employees* variable. The Non-Zombie variable *NonZ* has a positive sign, which reveals that healthy firms have an employment growth 5,35 percentage points higher than zombie firms in the country of Finland, *ceteris paribus*. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,068 percentage points in the employment growth of the firms in the country of Finland, *ceteris paribus*.

France, in the employment growth regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,087 percentage points in the employment growth of the firms in the country of France, *ceteris paribus*.

Ireland, in the employment growth regression, presents two significant variables, the *Employees* variable and the *NonZ x Zashare* variable. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,046 percentage points in the employment growth of the firms in the country of Ireland, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a positive relationship with the employment growth, which indicates that a 1 percentage point

increase in “stuck” assets in zombie firms, increases the employment growth of healthy firms in the country of Ireland by 33,5 percentage points, *ceteris paribus*.

Italy, in the employment growth regression, presents two significant variables, the *Employees* variable and the *NonZ x Zashare* variable. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,068 percentage points in the employment growth of the firms in the country of Italy, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a positive relationship with the employment growth, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, increases the employment growth of healthy firms in the country of Italy by 8,44 percentage points, *ceteris paribus*.

Latvia, in the employment growth regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,068 percentage points in the employment growth of the firms in the country of Latvia, *ceteris paribus*.

Portugal, in the employment growth regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,049 percentage points in the employment growth of the firms in the country of Portugal, *ceteris paribus*.

Slovenia, in the employment growth regression, presents two significant variables, the *Employees* variable and the *NonZ x Zashare* variable. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,049 percentage points in the employment growth of the firms in the country of Slovenia, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a positive relationship with the employment growth, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, increases the employment growth of healthy firms in the country of Slovenia by 44,5 percentage points, *ceteris paribus*.

Slovakia, in the employment growth regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,046 percentage points in the employment growth of the firms in the country of Slovakia, *ceteris paribus*.

Table 21- Robustness analysis by country labour productivity results (part 1)

Variable	Austria	Belgium	Germany	Spain	Finland	France
<b>NonZ</b>	3,11E+07 (3,08E+07)	-5,02E+01 (5,52E+01)	4,39E+01 (1,62E+01)	4,14E+01 (2,36E+01)	1,12E+02 <sup>***</sup> (2,32E+01)	1,63E+01 (1,27E+01)
<b>Zashare</b>	1,99E+08 (1,49E+08)	-7,90E+01 (2,28E+02)	6,38E+01 (6,93E+01)	6,53E+01 (1,26E+02)	3,35E+02 <sup>**</sup> (1,12E+02)	7,07E+00 (6,90E+01)
<b>Employees</b>	-3,63E-01 <sup>***</sup> (5,52E-02)	-7,94E-01 <sup>***</sup> (1,21E-01)	-4,95E-01 <sup>***</sup> (1,90E-02)	-3,44E-01 <sup>***</sup> (3,19E-02)	-7,13E-01 <sup>***</sup> (3,70E-02)	-1,04E+00 <sup>***</sup> (2,41E-02)
<b>NonZ x Zashare</b>	-1,80E+07 (1,08E+08)	3,06E+02 (1,97E+02)	-3,61E+01 (5,78E+01)	-3,57E+00 (9,33E+01)	-3,88E+02 <sup>***</sup> (9,08E+01)	2,35E+01 (4,91E+01)
<b>R2</b>	0,031428	0,045485	0,082343	0,026808	0,15843	0,12859

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; "." Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self elaboration

Table 22- Robustness analysis by country labour productivity results (part 2)

Variable	Ireland	Italy	Latvia	Portugal	Slovenia	Slovakia
<b>NonZ</b>	2,12E+02 <sup>***</sup> (6,20E+01)	7,07E+01 <sup>***</sup> (1,55E+01)	-2,42E+01 (1,63E+02)	-9,94E-01 (4,72E+01)	1,57E+02 <sup>**</sup> (5,42E+01)	7,22E+00 (2,13E+01)
<b>Zashare</b>	3,95E+02 (2,90E+02)	6,27E+01 (7,13E+01)	-1,16E+03 (8,24E+02)	-1,54E+02 (2,09E+02)	3,82E+02 (2,52E+02)	-1,76E+02 (1,03E+02)
<b>Employees</b>	-2,72E-01 (1,41E-01)	-6,60E-01 <sup>***</sup> (3,04E-02)	-4,00E-01 (2,17E-01)	-3,90E-01 <sup>***</sup> (1,05E-01)	-2,96E-01 <sup>***</sup> (5,56E-02)	-2,12E-01 <sup>***</sup> (2,49E-02)
<b>NonZ x Zashare</b>	-7,74E+02 <sup>***</sup> (2,34E+02)	-1,32E+02 <sup>*</sup> (5,92E+01)	5,25E+07 (8,01E+02)	9,80E+01 (1,63E+02)	-4,15E+02 (2,14E+02)	-2,30E+01 (7,01E+01)
<b>R2</b>	0,030003	0,037441	0,044514	0,026971	0,049911	0,070926

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; "." Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self elaboration

Through the analysis of the Table 21 and Table 22, for the regression of the labour productivity, it appears that for Austria, the only independent variable that is statistically significant is the *Employees* variable. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee

in the firms generates a decrease of 0,363 thousand euros in the labour productivity of the firms in the country of Austria, *ceteris paribus*.

Belgium, in the labour productivity regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,794 thousand euros in the labour productivity of the firms in the country of Belgium, *ceteris paribus*.

Germany, in the labour productivity regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,495 thousand euros in the labour productivity of the firms in the country of Belgium, *ceteris paribus*.

Spain, in the labour productivity regression, presents two significant variables, the *NonZ* variable and the *Employees* variable. The Non-Zombie variable *NonZ* has a positive sign, which reveals that, on average, healthy firms have a labour productivity 41,4 thousand euros higher than zombie firms in the country of Spain, *ceteris paribus*. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,344 thousand euros in the labour productivity of the firms in the country of Spain, *ceteris paribus*.

Finland, in the labour productivity regression, presents all of the variables as significant. The Non-Zombie variable *NonZ* has a positive sign, which reveals that, on average, healthy firms have a labour productivity 112 thousand euros higher than zombie firms in the country of Finland, *ceteris paribus*. The “sunk” assets *Zashare* has a positive sign, which means that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates an increase of about 335 thousand euros in the labour productivity of the firms in the country of Finland, *ceteris paribus*. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,713 thousand euros in the labour productivity of the firms in the country of Finland, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a negative relationship with the labour productivity, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, decreases the labour

productivity of healthy firms in the country of Finland by 338 thousand euros, *ceteris paribus*.

France, in the labour productivity regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 1,04 thousand euros in the labour productivity of the firms in the country of France, *ceteris paribus*.

Ireland, in the labour productivity regression, presents three significant variables, the *NonZ* variable, the *Employees* variable and the *NonZ x Zashare* variable. The Non-Zombie variable *NonZ* has a positive sign, which reveals that, on average, healthy firms have a labour productivity 212 thousand euros higher than zombie firms in the country of Ireland, *ceteris paribus*. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,272 thousand euros in the labour productivity of the firms in the country of Ireland, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a negative relationship with the labour productivity, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, decreases the labour productivity of healthy firms in the country of Ireland by 774 thousand euros, *ceteris paribus*.

Italy, in the labour productivity regression, presents three significant variables, the *NonZ* variable, the *Employees* variable and the *NonZ x Zashare* variable. The Non-Zombie variable *NonZ* has a positive sign, which reveals that, on average, healthy firms have a labour productivity 70,7 thousand euros higher than zombie firms in the country of Italy, *ceteris paribus*. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,66 thousand euros in the labour productivity of the firms in the country of Italy, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a negative relationship with the labour productivity, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, decreases the labour productivity of healthy firms in the country of Italy by 132 thousand euros, *ceteris paribus*.

In Latvia, in the labour productivity regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,40 thousand euros in the labour productivity of the firms in the country of Latvia, *ceteris paribus*.

In Portugal, in the labour productivity regression, presents only one significant variable, the *Employees* variable. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,39 thousand euros in the labour productivity of the firms in the country of Portugal, *ceteris paribus*.

In Slovenia, in the labour productivity regression, presents three significant variables, the *NonZ* variable, the *Employees* variable and the *NonZ x Zashare* variable. The Non-Zombie variable *NonZ* has a positive sign, which reveals that, on average, healthy firms have a labour productivity 157 thousand euros higher than zombie firms in the country of Slovenia, *ceteris paribus*. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,296 thousand euros in the labour productivity of the firms in the country of Slovenia, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a negative relationship with the labour productivity, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, decreases the labour productivity of healthy firms in the country of Slovenia by 415 thousand euros, *ceteris paribus*.

In Slovakia, in the labour productivity regression, presents two significant variables, the *Zashare* variable and the *Employees* variable. The “sunk” assets *Zashare* has a negative sign, which means that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates a decrease of about 176 thousand euros in the labour productivity of firms in the country of Slovakia, *ceteris paribus*. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,212 thousand euros in the labour productivity of the firms in the country of Slovakia, *ceteris paribus*.

At the end, we can conclude that for Austria and Portugal, an increase in the resources (assets) used by zombie firms reduces the investment rate of the healthy firms, as

expected, and for Finland, Ireland, Italy and Slovenia, it reduces the labour productivity of the healthy firms, also as expected and verified above. In terms of employment growth, an increase in the recourses (assets) used by zombie firms reduces the employment growth of the healthy firms only in Spain, being the opposite effect verified in Ireland, Italy and Slovenia.

We can also conclude that the healthy firms in Austria, Finland, France, and Portugal present a higher investment rate, when compared to the Zombie firms, while the healthy firms in Spain and Finland present a higher employment growth and the healthy firms in Spain, Finland, Ireland, Italy, and Slovenia present a higher labour productivity than the Zombie firms in each of the analysed countries.

Furthermore, we can conclude that for the firms in all countries, the bigger the size of the firm, the bigger the size of their employment growth and the smaller their labour productivity. Regarding to the investment rate, it is observed that, for Germany, Spain and France, he bigger the size of the firm, the bigger the size of their investment rate is.

Finally, it is important to mention that an increase in the resources (assets) used by zombie firms will lead to a decrease on a general firm's employment growth in Austria, labour productivity in Slovakia and investment rate in Italy. On the other hand, it was verified that an increase in the resources (assets) used by zombie firms will lead to an increase on a general firm's labour productivity in Finland and Investment rate in Austria and Portugal, regardless of whether it is Healthy or Zombie firm.

### **3.2.2 Robustness analysis by age**

In this section, the sample will be divided into three subsamples corresponding to each of the following age ranges: 10 to 20 years old, 20 to 36 years old, 36 to 50 years old, 50 to 75 years old and over 75 years old.

Table 23 - Robustness analysis by age on the investment rate results

Variable	"10-20"	"20-36"	"36-50"	"50 to 75"	"Over 75"
<b>NonZ</b>	3,08E-02 (3,30E-02)	7,41E-02*** (2,18E-02)	8,21E-02* (3,21E-02)	7,10E-02* (3,06E-02)	-8,44E-02 (6,32E-02)
<b>Zashare</b>	-2,49E-01 (1,69E-01)	-6,92E-02 (1,02E-01)	-1,05E-01 (1,46E-01)	4,24E-01** (1,56E-01)	4,52E-02 (3,33E-01)
<b>Employees</b>	1,62E-05 (6,16E-05)	8,58E-05*** (3,32E-05)	2,21E-04*** (5,39E-05)	4,88E-06 (4,35E-05)	4,16E-05 (9,18E-05)
<b>NonZ x Zashare</b>	6,39E-02 (1,24E-01)	-8,53E-02 (8,12E-02)	-5,38E-02 (1,20E-01)	-2,04E-01 (1,22E-01)	2,67E-01 (2,45E-01)
<b>R<sup>2</sup></b>	0,001669	0,002156	0,0044293	0,001385	0,0025017

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; "." Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self Elaboration

Through the analysis of the Table 23 for the regression of the Investment Rate, we can observe that for the firms aged between 10 and 20 years old, no variable is statistically significant. For the firms between 20 and 36 years old, the independent variables that are statistically significant are the *NonZ* variable and *Employees* variable. The Non-Zombie variable *NonZ* has a positive sign, which reveals that healthy firms have investment rates 7,4 percentage points higher than zombie firms aged 20 to 36 years old, *ceteris paribus*. The *Employees* variable shows a positive relationship with the investment rate, which indicates that an increase of 1 employee in the firms generates an increase of 0,0086 percentage points in the investment rate of the firms aged 20 to 36 years old, *ceteris paribus*.

For the firms aged 36 to 50 years old, in the investment rate regression, we can observe that both the *NonZ* variable and the *Employees* variable are statistically significant. The Non-Zombie variable *NonZ* has a positive sign, which reveals that healthy firms have investment rates 8,21 percentage points higher than zombie firms aged 36 to 50 years old, *ceteris paribus*. The *Employees* variable shows a positive relationship with the investment rate, which indicates that an increase of 1 employee in the firms generates an increase of 0,022 percentage points in the investment rate of the firms aged 36 to 50 years old, *ceteris paribus*.

For the firms aged 50 to 75 years old, in the investment rate regression, we can observe that the *NonZ* variable, the *Zashare* variable and the *NonZ x Zashare* variable are statistically significant. The Non-Zombie variable *NonZ* has a positive sign, which

reveals that healthy firms have investment rates 7,1 percentage points higher than zombie firms aged 50 to 75 years old, *ceteris paribus*. The “sunk” assets *Zashare* has a positive sign, which means that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates an increase of about 42,4 percentage points in the investment rate of general firms between 50 and 75 years old, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a negative relationship with the investment rate, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, decreases the investment rate of healthy firms aged between 50 and 75 years old by 20,4 percentage points, *ceteris paribus*.

In the case of the firms aged over 75 years old, in the investment rate regression, we can observe that no variable is statistically significant. This means that the only subgroup of firms that shows the negative impacts of zombie firms is the one with firms aged between 50 and 75 years old.

Table 24- Robustness analysis by age on the employment growth results

Variable	"10-20"	"20-36"	"36-50"	"50 to 75"	"Over 75"
<b>NonZ</b>	1,21E-02 (1,26E-02)	9,09E-03 (8,46E-03)	1,86E-02 (1,22E-02)	-1,34E-02 (1,46E-02)	6,54E-02* (2,85E-02)
<b>Zashare</b>	-8,12E-02 (6,42E-02)	-3,33E-02 (3,95E-02)	-8,94E-02 (5,47E-02)	-8,67E-02 (7,31E-02)	3,10E-01* (1,49E-01)
<b>Employees</b>	5,43E-04*** (2,45E-05)	4,84E-04*** (1,23E-05)	6,65E-04*** (2,03E-05)	7,17E-04*** (2,06E-05)	3,40E-04*** (4,54E-05)
<b>NonZ x Zashare</b>	1,60E-02 (4,76E-02)	4,25E-02 (3,15E-02)	6,77E-03 (4,53E-02)	9,50E-02 (5,74E-02)	-2,20E-01* (1,10E-01)
<b>R<sup>2</sup></b>	0,06164	0,072989	0,097437	0,13834	0,048559

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; “.” Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self Elaboration

Through the analysis of the Table 24, for the regression of the employment growth, it appears that for the age categories of 10 to 20 years old, 20 to 36 years old and 36 to 50 years old there is only one independent variable that is statistically significant, the *Employees* variable. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,054 percentage points in the employment growth of the firms aged 10 to 20 years old, *ceteris paribus*. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms

generates an increase of 0,048 percentage points in the employment growth of the firms aged 20 to 36 years old, *ceteris paribus*. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,067 percentage points in the employment growth of the firms aged 36 to 50 years old, *ceteris paribus*.

For the age category of between 50 and 75 years old there are two independent variables that are statistically significant, the *Employees* variable and the *NonZ x Zashare* variable. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,072 percentage points in the employment growth of the firms aged 50 to 75 years old, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “stuck” assets in zombie firms *NonZ x Zashare* has a positive relationship with the employment growth, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, increases the employment growth of healthy firms aged between 50 and 75 years old by 9,5 percentage points, *ceteris paribus*, going against what was expected, just like on the main regression on Table 15.

For the age category of over 75 years old there are two independent variables that are statistically significant, the *Employees* variable and the *NonZ x Zashare* variable. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,034 percentage points in the employment growth of the firms aged over 75 years old, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “stuck” assets in zombie firms *NonZ x Zashare* has a negative relationship with the employment growth, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, decreases the employment growth of healthy firms aged between 50 and 75 years old by 22 percentage points, *ceteris paribus*, going accordingly to what was expected and defined in the H4 b) starting hypothesis.

Table 25- Robustness analysis by age on the labour productivity results

Variable	"10-20"	"20-36"	"36-50"	"50 to 75"	"Over 75"
<b>NonZ</b>	8,36E+01 <sup>***</sup> (1,56E+01)	4,17E+01 <sup>***</sup> (1,02E+01)	2,90E+01 <sup>*</sup> (1,42E+01)	1,22E+01 (1,99E+01)	7,20E+00 (2,87E+01)
<b>Zashare</b>	3,04E+02 <sup>***</sup> (7,98E+01)	-1,33E+00 (4,79E+01)	-5,72E+01 (6,48E+01)	1,00E+02 (1,01E+02)	-2,20E+02 (1,51E+02)
<b>Employees</b>	-6,43E-01 <sup>***</sup> (2,91E-02)	-5,35E-01 <sup>***</sup> (1,50E-02)	-7,12E-01 <sup>***</sup> (2,40E-02)	-8,43E-01 <sup>***</sup> (2,82E-02)	-7,23E-02 (4,17E-02)
<b>NonZ x Zashare</b>	-1,71E+02 <sup>**</sup> (5,88E+01)	-1,45E+01 (3,80E+01)	3,74E-01 (5,31E+01)	-3,13E+01 (7,91E+01)	2,68E+01 (1,11E+02)
<b>R2</b>	0,063336	0,060153	0,078812	0,098891	0,0056227

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; "." Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self Elaboration

Through the analysis of the Table 25, for the regression of the labour productivity, it appears that for the firms aged 10 to 20 years old, all of the independent variables are statistically significant. The Non-Zombie variable *NonZ* has a positive sign, which reveals that, on average, healthy firms have a labour productivity 83,6 thousand euros higher than zombie firms aged between 10 and 20 years old, *ceteris paribus*. The “sunk” assets *Zashare* has a positive sign, which means that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates an increase of about 304 thousand euros in the labour productivity of the general firms aged between 10 and 20 years old, *ceteris paribus*. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,643 thousand euros in the labour productivity of the firms aged between 10 and 20 years old, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a negative relationship with the labour productivity, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, decreases the labour productivity of healthy firms aged between 10 and 20 years old by 7171 thousand euros, *ceteris paribus*. This means that the only subgroup of firms that show the negative impacts of zombie firms is the youngest of all.

For the firms aged 20 to 36 years old, for the regression of the labour productivity, it appears that the independent variables *NonZ* and *Employees* are statistically significant. The Non-Zombie variable *NonZ* has a positive sign, which reveals that, on average, healthy firms have a labour productivity 41,7 thousand euros higher than zombie firms

aged between 20 and 36 years old, *ceteris paribus*. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,535 thousand euros in the labour productivity of the firms aged between 20 and 36 years old, *ceteris paribus*.

For the firms aged 36 to 50 years old, in the labour productivity regression, we can observe that both the *NonZ* variable and the *Employees* variable are statistically significant. The Non-Zombie variable *NonZ* has a positive sign, which reveals that, on average, healthy firms have a labour productivity 29 thousand euros higher than zombie firms aged between 36 and 50 years old, *ceteris paribus*. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,712 thousand euros in the labour productivity of the firms aged between 36 and 50 years old, *ceteris paribus*.

In the case of the firms aged between 50 and 75 years old, in the labour productivity regression, we can observe that only the *Employees* variable is statistically significant. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,843 thousand euros in the labour productivity of the firms aged between 50 and 75 years old, *ceteris paribus*.

In the case of the firms aged over 75 years old, in the labour productivity regression, we can observe that no variable is statistically significant.

At the end, we can conclude that for the firms aged between 50 and 75 years old, an increase in the resources (assets) used by zombie firms reduces the investment rate of the healthy firms, as expected, but increases the employment growth of the healthy firms, going against what was expected, but accordingly to what was verified in Table 15. Furthermore, the subgroup of firms aged over 75 years old presented that an increase in the resources (assets) used by zombie firms reduces employment growth of the healthy firms, as expected. Lastly, for the firms aged between 10 and 20 years old, an increase in the resources (assets) used by zombie firms reduces the labour productivity of the healthy firms, as expected.

### 3.2.3 Robustness analysis by size

In this section, the sample will be divided into two subsamples, containing a separation between big and small firms accordingly with the European Unions' Total Assets criteria. This way, we can consider that small firms have a total of assets inferior to 43 million euros and big firms have a total of assets superior to 43 million euros, as presented.

Table 26- Robustness analysis by size on the investment rate results

Variable	Inferior to 43 M€	Superior to 43 M€
<b>NonZ</b>	4,71E-02** (1,82E-02)	5,53E-02* (2,28E-02)
<b>Zashare</b>	-2,49E-01** (9,04E-02)	2,25E-01* (1,06E-01)
<b>Employees</b>	7,11E-05 (6,26E-05)	6,16E-05** (2,38E-05)
<b>NonZ x Zashare</b>	2,79E+00 (7,08E-02)	-4,66E-02 (8,27E-02)
<b>R2</b>	0,0021209	0,0020544

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; “.” Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self Elaboration

Through the analysis of the Table 26, for the regression of the Investment Rate, it appears that the variable *NonZ x Zshare* is not statistically significant for any of the subgroups, so there is no evidence of unfavourable effects of zombie firms on the investment rate of healthy companies.

Additionally, for the small sized firms, with a total of assets inferior to 43 million euros, the *NonZ* and *Zashare* independent variables are statistically significant. The Non-Zombie variable *NonZ* has a positive sign, which reveals that healthy firms have investment rates 4,71 percentage points higher than zombie firms with a total of assets inferior to 43 million euros, *ceteris paribus*. The “sunk” assets *Zashare* has a negative sign, which means that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates a decrease of about 24,9 percentage points in the investment rate of general firms with a total of assets inferior to 43 million euros, *ceteris paribus*.

For the big sized firms, with more than 43 million euros in total assets, in the investment rate regression, we can observe that the *NonZ* variable, the *Zashare* variable and the *Employees* variable are statistically significant. The Non-Zombie variable *NonZ* has a

positive sign, which reveals that healthy firms have investment rates 5,53 percentage points higher than zombie firms with a total of assets superior to 43 million euros, *ceteris paribus*. The “sunk” assets *Zashare* has a positive sign, which means that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates an increase of about 22,5 percentage points in the investment rate of general firms with more than 43 million euros in total assets, *ceteris paribus*. The *Employees* variable shows a positive relationship with the investment rate, which indicates that an increase of 1 employee in the firms generates an increase of 0,0062 percentage points in the investment rate of the firms with more than 43 million euros in total assets, *ceteris paribus*.

Table 27- Robustness analysis by size on the employment growth results

Variable	Inferior to 43 M€	Superior to 43 M€
<b>NonZ</b>	1,87E-02** (7,10E-03)	-6,16E-03 (9,59E-03)
<b>Zashare</b>	-1,69E-02 (3,49E-02)	-8,46E-02 (4,45E-02)
<b>Employees</b>	1,23E-03*** (2,40E-05)	4,63E-04*** (9,80E-06)
<b>NonZ x Zashare</b>	-5,17E-03 (2,75E-02)	7,06E-02* (3,47E-02)
<b>R2</b>	0,89023	0,12776

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; “.” Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self Elaboration

Through the analysis of the Table 27, for the regression of the employment growth, it appears that for the small sized firms, with less than 43 million euros in total assets, there are two independent variables that are statistically significant, the *NonZ* variable and the *Employees* variable. The Non-Zombie variable *NonZ* has a positive sign, which reveals that healthy firms have an employment growth 1,87 percentage points higher than zombie firms with less than 43 million euros in total assets, *ceteris paribus*. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,123 percentage points in the employment growth of the firms with less than 43 million euros in total assets, *ceteris paribus*.

For the big sized firms, with more than 43 million euros in total assets, in the employment growth, we can observe that the *Zashare* variable, the *Employees* variable and the *NonZ*

$x$  *Zashare* variable are statistically significant. The “sunk” assets *Zashare* has a negative sign, which means that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates a decrease of about 8,46 percentage points in the employment growth of general firms with a total of assets superior to 43 million euros, *ceteris paribus*. The *Employees* variable shows a positive relationship with the employment growth, which indicates that an increase of 1 employee in the firms generates an increase of 0,046 percentage points in the employment growth of the firms with more than 43 million euros in total assets, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a positive relationship with the employment growth, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, increases the employment growth of healthy firms with more than 43 million euros in total assets by 7,06 percentage points, *ceteris paribus*, going against what was expected, just like on the main regression on Table 15.

Table 28- Robustness analysis by size on the labour productivity results

Variable	Inferior to 43 M€	Superior to 43 M€
<b>NonZ</b>	3,32E+01 <sup>***</sup> (8,01E+00)	5,77E+01 <sup>***</sup> (1,30E+01)
<b>Zashare</b>	-5,78E+00 (3,97E+01)	1,18E+02 (6,05E+01)
<b>Employees</b>	-1,04E+00 <sup>***</sup> (2,73E-02)	-5,79E-01 <sup>***</sup> (1,33E-02)
<b>NonZ x Zashare</b>	-3,63E+01 (3,11E+01)	-7,85E+01 (4,69E+01)
<b>R2</b>	0,049125	0,10786

Note: \*\*\* Significance Level of 0.1%; \*\* Significance Level of 1%; \* Significance Level of 5%; “.” Significance Level of 10%; Values in parentheses correspond to the Standard Error.

Source - Self Elaboration

Through the analysis of the Table 28 for the regression of the labour productivity, it appears that for the small firms, with a total of assets inferior to 43 million euros, the variables *NonZ* and *Employees* are statistically significant. The Non-Zombie variable *NonZ* has a positive sign, which reveals that, on average, healthy firms have a labour productivity 33,2 thousand euros higher than zombie firms with a total of assets inferior to 43 million euros, *ceteris paribus*. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee

in the firms generates a decrease of 1,04 thousand euros in the labour productivity of the firms with a total of assets inferior to 43 million euros, *ceteris paribus*.

For the big firms, with a total of assets superior to 43 million euros, all of the variables are statistically significant. The Non-Zombie variable *NonZ* has a positive sign, which reveals that, on average, healthy firms have a labour productivity 57,7 thousand euros higher than zombie firms with a total of assets superior to 43 million euros, *ceteris paribus*. The “sunk” assets *Zashare* has a positive sign, which means that, on average, an increase of 1 percentage point in “sunk” assets in zombie firms, generates an increase of about 118 thousand euros in the labour productivity of general firms with a total of assets superior to 43 million euros, *ceteris paribus*. The *Employees* variable shows a negative relationship with the labour productivity, which indicates that an increase of 1 employee in the firms generates a decrease of 0,579 thousand euros in the labour productivity of the firms with a total of assets superior to 43 million euros, *ceteris paribus*. The Non-Zombie interaction variable with the fraction of “sunk” assets in zombie firms *NonZ x Zashare* has a negative relationship with the labour productivity, which indicates that a 1 percentage point increase in “stuck” assets in zombie firms, decreases the labour productivity of healthy firms with more than 43 million euros in total assets by 78,5 thousand euros, *ceteris paribus*, going accordingly with what was expected.

At the end, we can conclude that for the big firms with more than 43 million euros in total assets, an increase in the resources (assets) used by zombie firms increases the employment growth of the healthy firms, going against what was expected, but accordingly to what was verified in Table 16. Furthermore, the same subgroup of firms presented that an increase in the resources (assets) used by zombie firms reduces the labour productivity of the healthy firms, as expected. For the investment rate regression, the main variable of the study did not show any statistical significance.

## **CHAPTER IV – CONCLUSIONS**

The concept of zombie firms has been a highly contentious subject in the literature. These being firms without viable financial circumstances that should be removed from the market but continue to operate because of bank loans and government subsidies.

The goal of this study is to estimate the primary determinants of this typology of firms, followed by the estimation of primary effects of the existence of these companies on the healthy firms. Using a sample of 8833 firms from the industrial sector (NACE 10 to 32) in the Euro Zone, for the period between 2014 and 2020. It was decided to use an approximate definition of a zombie firms provided by McGowan et al. (2017), which states that these firms are defined as having an interest coverage ratio of less than one for two years in a row, a negative net result for two years in a row, and an age of at least ten years. A logit model was applied to the determinants of zombie firms, and a panel data model with fixed effects for individuals and time was applied to assess the consequences for healthy firms.

A simple empirical analysis of the sample was realized and indicated that the countries with the highest percentage of zombie firms, in the sample, were France and Spain and that the age group with the biggest percentage of zombie firms was the one where the firms were between 10 and 36 years old. Regarding the size of the zombie firms, we can conclude that most of them had between 50 and 249 employees. Finally, the NACE code sectors with the highest percentage of Zombie firms were 23 - Manufacture of other non-metallic mineral products, 24 - Manufacture of basic metals, and 29 - Manufacture of motor vehicles, trailers and semi-trailers.

Next, the analysis of the results of the regressions in question was carried out, indicating that when a firm has a bigger debt than it's NACE Code sector average, it has a higher probability of becoming Zombie. Furthermore, it was concluded that the bigger a firm is the higher the chance it has to become Zombie just as expected.

Regarding the regressions assessing the effects of the zombie firms on the healthy firms, it was observed that a rise in the resources (assets) used by zombie firms decreases the productivity of the healthy firms, as anticipated, but increases the growth of employment at the healthy firms under analysis, contrary to the initial hypothesis.

For each country, age group and size group, a robustness analysis was conducted in an effort to get more consistent results. From there, we could draw the conclusion that, in

accordance with the defined starting hypothesis, an increase in the resources (assets) used by zombie firms lowers the investment rate of the healthy firms for Austria and Portugal and lowers the labour productivity of the healthy firms for Finland, Ireland, Italy, and Slovenia. However, in terms of employment growth, a rise in the resources (assets) used by zombie firms only slows the growth of healthy firms in Spain, while speeding it up in the countries of Ireland, Italy, and Slovenia.

Furthermore, it could be proven that for the firms aged between 50 and 75 years old, an increase in the resources (assets) used by zombie firms reduces the investment rate of the healthy firms, as expected. While for firms over 75 years old an increase in the resources (assets) used by zombie firms presented a reduction of the employment growth and for firms aged between 10 and 20 years old an increase in the resources (assets) used by zombie firms generated a reduction of the labour productivity of the healthy firms. Nonetheless, in firms with more than 43 million euros in total assets, an increase in the resources (assets) used by zombie firms reduces the labour productivity of the healthy firms, as expected. This shows that there is evidence that confirms the starting hypotheses, even if the subsample is small.

The limitations on this study were mainly the fact that some of the firms in the sample didn't present their full data, not allowing us to utilize a complete dataset, compromising some of the results and not allowing the analysis of some countries due to the fact that their firms didn't publish the necessary data for this analysis. Another limitation was the fact that the ORBIS database didn't account for the government subsidies that each firm received and didn't allow the extraction of data prior to the last 10 years and most of the firms had not published their data in the most recent years, making it so the analysis couldn't be as recent or long and it would be wished.

In future investigation, bearing in mind the presented limitations, it would be interesting to analyse the full Covid-19 pandemic's effects on the formation of more Zombie firms, since most companies had to halt their production for quite a long time. In addition, it would be interesting to analyse the services sector since there isn't much literature that covers those firms, making it possible to lead to some interest results. It also would be interesting to utilize more databases to test if the government subsidies could be a determinant to the formation of a Zombie firm, because it would be in line with some presented literature. Lastly, it would be interesting to continue the work developed in this

dissertation by investigating why certain countries, age groups and size groups showed the expected result while others didn't.

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