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The Norwegian Living Dead

An empirical study of the prevalence of zombie firms in Norway, their characteristics, consequences and policy implications

Aida Matre & Are Nikolai Solli

Supervisor: Aksel Mjøs

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Acknowledgements

This master thesis was written as a part of the master of science in economics and business administration with specialisation in finance at the Norwegian School of Economics.

Over the last years, several papers have been written about zombie firms, in particular by the OECD. However, as the topic has been investigated only to a very limited degree for Norway, it has truly been an interesting exercise getting a deep insight into the topic. It has also been both a challenging and rewarding task to handle such a big data set. We hope and believe that the results could be of interest to others.

We would like to express our sincere gratitude to our supervisor, Aksel Mjøs, for valuable input and guidance throughout the semester. In addition, we would like to thank Carl Gjersem at the Ministry of Trade, Industry and Fisheries, Erik Storm at the Ministry of Finance, and Valentine Millot and Chiara Criscuolo at the OECD. They have all been helpful by answering our questions and clarifications.

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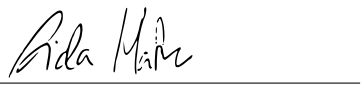

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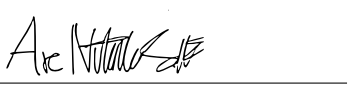

Are Nikolai Solli

Abstract

Zombie firms are mature firms having persistent problems meeting their interest payments. Previous research links the rise of these firms to falling productivity performance in the OECD, one of the most important drivers of welfare. In this thesis, we study Norwegian zombie firms over time using a data set consisting of all Norwegian firms. We find that the prevalence of zombie firms has increased over time, from 0.97 percent in 1997 to 2.12 percent in 2016, which is in line with the development in several other OECD countries. However, we question whether this is a clear trend, as the share of zombies has been falling since 2011.

Our results suggest that increased total assets decrease the probability of being a zombie for the relatively smaller firms, but increase the probability for relatively bigger firms. We also find that foreign ownership increases the chance of being a zombie and that the probability of being a zombie firm tends to decrease with the number of employees. Furthermore, we investigate the consequences of the zombie firms, taking a closer look at their possible distortionary effects on healthy firms. Controlling for cyclical effects at the industry level, we find indications that higher shares of industry capital sunk in zombies distort capital and employment growth for the average non-zombie in the period 1999–2016. Our results also suggest that young firms are disproportionately affected. These results could be of interest to policy makers in the design of insolvency regimes, ensuring a viable environment for productivity growth.

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1 Introduction and Main Findings

Several researchers have tried to explain the causes and consequences of weaker global productivity growth. Some are pointing at differences between current developments and earlier important discoveries, e.g. the steam engine or electricity, while an ageing workforce or the fading ICT boom also have been up for discussion as possible causes (Adler et al., 2017; Gordon, 2017). Others are focusing on a rising productivity dispersion across firms (Andrews, Criscuolo, & Gal, 2016), rising capital misallocation (Gopinath, Kalemli-Özcan, Karabarbounis, & Villegas-Sanchez, 2017) as well as declining business dynamism (Decker, Haltiwanger, Jarmin, & Miranda, 2017).

Potential output growth in the OECD has slowed down with about one percentage point yearly since the late 1990s, Norway not being an exception (McGowan, Andrews, & Millot, 2017b; OECD, 2018). Whilst recognising that oil resources have been crucial for Norwegian economic growth, productivity growth in mainland Norway has always been the most important driver for welfare (Produktivitetskommisjonen, 2015). Particularly in an era where income from the oil sector is expected to decline, sustained high productivity growth is an increasingly important issue.

Following this, a related concern is the rise of the so-called *zombie firms*, which would typically exit in a competitive market. The zombies may crowd-out growth opportunities of other firms and deter the entry of young firms, in addition to dragging down aggregate productivity growth through having low productivity themselves (McGowan et al., 2017b). Research on zombie firms has been conducted for several OECD countries. To our knowledge, there are no published studies about zombie firms in Norway.

An increased understanding of the prevalence and consequences of zombie firms may provide useful information to governments, in particular in the context of policy making. Based on OECDs new indicators of insolvency regimes, McGowan, Andrews, and Millot (2017a) argue that reform to insolvency regimes can contribute to reducing the share of zombie firms.

We use a detailed, high-quality firm level database of Norwegian firms in addition to supplementary bankruptcy data and monetary variables used for deflation purposes. We

have examined the prevalence and characteristics of Norwegian *zombie firms* (defined as firms being aged ten years or older and having an interest coverage ratio less than one for three consecutive years) and how resources sunk in zombies have distortionary effects on the non-zombie firms within industries.

We find that 2.12 percent of all Norwegian firms in 2016 can be defined as zombie firms. The same share was about 0.97 percent in 1997, and there seems to be a somehow unclear trend towards increased zombie prevalence in Norway. This is in line with results from several of the other countries in the OECD. We also find that 15 to 20 percent of the zombie firms remain zombies after three years and that zombie firms rarely remain zombies for a long period of time.

In the introductory part of the empirical analysis, we focus on zombie characteristics, and investigate whether various characteristics influence the probability of being a zombie firm. Our results indicate that for relatively smaller firms, increased total assets seem to reduce the likelihood of being zombie, while for the relatively bigger firms, increased total asset seem to increase the likelihood of being a zombie. Furthermore, the probability of being a zombie firm decreases with the number of employees. We also see indications that the probability of being a zombie firm increases if a firm has foreign owners.

In the second part of the empirical section, we investigate whether capital sunk in zombies reduces employment and capital growth amongst non-zombies within industries (and regions), using both interacted fixed effects of time-industry and time-region-industry (the latter only for the measure of employment growth). We see indications that zombies distort capital and employment growth within industries in Norway. Our results also suggest that young firms (aged less than six years) are disproportionately affected by the zombie spillovers in terms of capital growth. Considering employment growth, this is also true if assuming that the relevant labour market is the regional. We consider this to be a reasonable assumption in Norway.

Our thesis structure is as follows: Chapter 2 presents relevant literature on the area of zombie firms. Chapter 3 describes in depth the different procedures we have performed to prepare the data. Chapter 4 presents descriptive statistics, including the prevalence of zombie firms in Norway in 1997–2016. Chapter 5 introduces the empirical sections and presents possible characteristics that increases or decreases the probability of being

a zombie firm. Chapter 6 investigates possible distortionary effects on healthy firms. Chapter 7 present a discussion of the results, including limitations of the analysis, policy discussion and suggestions of future research. Finally, chapter 8 presents our conclusion and last thoughts.

2 Literature Review

In this part of the thesis, we present relevant evidence from important literature on the field of zombie firms. Firstly, we present literature on the Japanese stagnation during the 1990s, before we explain what existing litterateur has identified as main characteristics of zombie firms, their prevalence in OECD, their consequences on healthy firms and insolvency regimes.

2.1 The Japanese Stagnation

The research conducted in the area of the distortionary effects of zombie firms on healthy firms largely builds on the experiences from Japan during the 1990s, and focuses on forbearance lending (Caballero, Hoshi, & Kashyap, 2008; Hoshi, 2006). The following part is a brief presentation and explanation of the stagnation in Japan during the 1990s.

It is commonly agreed that the trigger factor for the stagnation was falling stock and land prices. The decade was characterised by economical underachievement, and the stock prices fell by 60 percent in three years from 1989, while the commercial land prices were reduced by about 50 percent between 1992 and 2002 (Caballero et al., 2008; Hoshi & Kashyap, 2004). Considering that land often is used as collateral, it was likely that the financial sector in Japan would experience difficulties, although the financial challenges were disproportionately large compared to the macroeconomic stagnation (Hoshi & Kashyap, 2004).

Caballero et al. (2008) argue that comprehensive reforms and restructuring of the banks were delayed as the Japanese government imposed few restrictions on the banks. However, the banks still had to fulfil international standards such as the Basel capital standards. The rules required banks to write off capital if they called in nonperforming loans. To avoid a situation where the banks failed to meet the capital standards, many of the banks continued providing credit to insolvent firms, the so-called *zombies*.

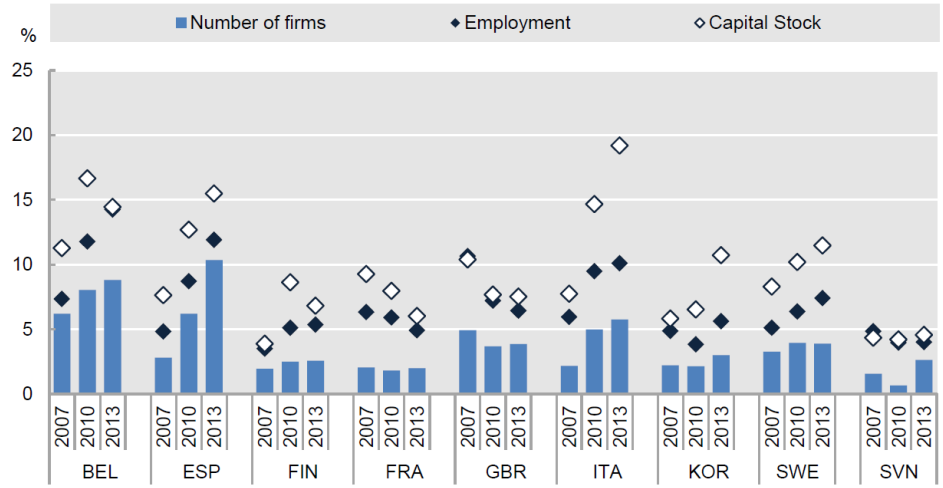
As the zombies were kept alive, they distorted competition in the economy (Caballero et al., 2008). The distortions included higher wages, reduced prices, market congestion

and reduction in profits. The healthy firms experienced the same pattern, and the low prices and high wages contributed to reduced profits and collateral that they otherwise could have generated. This hindered entry and investment. As a result, there were few attractive options, also for the solvent banks.

McGowan et al. (2017b), amongst others, argue that the Japanese experience could contribute to explaining the current productivity developments in the OECD area. The OECD has produced a range of studies studying the zombie firms over the period 2003–2013 (Gouveia & Osterhold, 2018).

2.2 Prevalence of Zombie Firms in the OECD

Figure 2.1: Prevalence of zombie firms in various OECD countries



Note: "*Firms aged ≥ 10 years and with an interest coverage ratio <1 over three consecutive years. Capital stock and employment refer to the share of capital and labour sunk in zombie firms. The sample excludes firms that are larger than 100 times the* 99^{th} *percentile of the size distribution in terms of capital stock or number of employees.*" (McGowan et al., 2017b)
Source: McGowan et al. (2017b) (OECD calculations based on ORBIS)

The OECD has conducted research on zombie firms and their characteristics in various OECD countries. The zombie firm shares in some of these countries for 2007, 2010 and 2013 are illustrated in figure 2.1.

According to McGowan et al. (2017b) the prevalence and resources sunk in zombie firms have increased over time. However, this development neither applies for all the countries in their sample, nor for all time periods. Figure 2.1 shows that the share of zombies declined in France, the United Kingdom, and Slovenia from 2007 to 2010, while it increased for

the rest of the sample. Concerning the share of capital sunk in zombie firms in 2013, estimates show that the extremities are Slovenia (under 5%) and Italy (19%), while the share of labour sunk is highest in Belgium (14%) and lowest in Slovenia (under 5%).

2.3 Characteristics of Zombie Firms

McGowan et al. (2017b) argue that bigger firms, in terms of the number of employees, tend to have a higher likelihood of being a zombie. Hoshi (2006) argues that size by assets or employment tends to decrease the likelihood of being a zombie among listed firms in Japan. However, this seems to be reversed for the smaller firms; where the relatively larger are more likely to be zombies. According to McGowan et al. (2017b) there seems to be an increasing relationship between the likelihood of being a zombie and the firm age. This is especially true for firms over the age of 40 years. Hoshi (2006) argues that firms located outside metropolitan areas are more likely to be zombies, perhaps because of pressure to protect firms outside the metropolitan areas.

2.4 Existing Research on the Consequences of Zombie Firms

In our presentation of existing research on the consequences of zombie firms, the main focus will be on the consequences the zombies have on healthy (non-zombie) firms, i.e. the distortionary effects. In this regard, "The Walking Dead?" by McGowan et al. (2017b) is amongst the particularly relevant articles. However, the literature on zombie firms also focuses on bank health, insolvency regimes and other areas (Andrews & Petroulakis, 2017; Banerjee & Hofmann, 2018; McGowan et al., 2017a).

McGowan et al. (2017b) apply the framework suggested in Caballero et al. (2008) to countries in the OECD, and find that a higher share of industry capital sunk in zombie firms crowds out growth opportunities of average healthy firms in the same industry. Thus, zombie firms might reduce potential output growth, by limiting the expansion possibilities of healthy firms. The results presented in Caballero et al. (2008) also point towards zombies lowering job creation and industry productivity.

Research points towards zombie congestion lowering market profitability through increasing wages compared to productivity and lowering market prices (McGowan et al., 2017b). The multi-factor productivity (MFP) gap between zombies and non-zombies increases, as productivity threshold for entrants gets bigger to compensate for reduced profitability. This hinders the potential entry of innovative and productive firms.

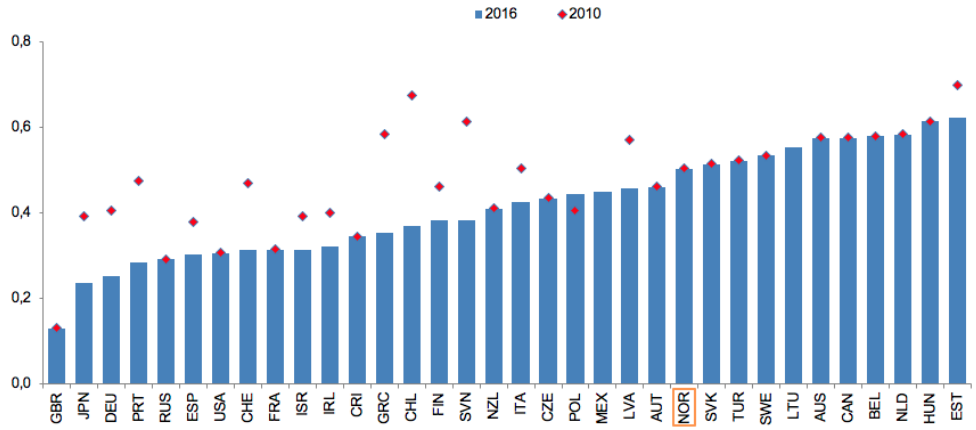
Furthermore, McGowan et al. (2017b) ask the very relevant question; are young firms (defined as less than six years) disproportionately affected by zombie congestion? They find that the zombie congestion in an industry has a particularly big impact on employment growth of small firms, that the effect on investment is not very different for the young and mature firms and that the MFP gap between zombies and non-zombies is prominent for young firms.

2.5 Insolvency Regimes

Much of the research connects the prevalence of zombie firms to policy discussions, as zombies could be a symptom of structural policy weaknesses (McGowan et al., 2017b). The design of insolvency regimes has proven to be an important factor in explaining weak market selection, presence of zombie firms, and inefficient capital allocation (McGowan & Andrews, 2018). The OECD splits the various regulations into the treatment of failed entrepreneurs, preventing and streamlining, restructuring tools, and other factors (McGowan & Andrews, 2018). Increased understanding of the indicators' effects can contribute to a reallocation of resources invested in zombie firms.

Figure 2.2 shows that the overall insolvency regimes span from the United Kingdom (GBR) having the least strict insolvency regime mix, and Estonia (EST) having the most strict (McGowan & Andrews, 2018). Norway is ranked as number twenty-four of a total of thirty-four countries in the OECD insolvency regimes indicator ranking. The insolvency regime in Norway has been characterised by, in relative terms, medium personal costs to failed entrepreneurs, medium to high lack of prevention and streamlining, and high barriers to restructuring.

Figure 2.2: Composite indicators ranking for a selection of OECD countries



Note: OECD's composite indicators ranking of OECD countries in 2010 & 2016. Indicators include the treatment of failed entrepreneurs, preventing and streamlining, restructuring tools, and other factors.
Source: McGowan and Andrews (2018)

2.6 Definition

"In economic terms, a zombie is a firm that is not viable and therefore, when competitive forces are at play, should be compelled to exit the market or, where feasible, restructure." (Gouveia & Osterhold, 2018).

Researchers have used several definitions trying to quantify a definition of a zombie firm. While some have used profitability conditions, others have used subsidised credit (Caballero et al., 2008; McGowan et al., 2017b). The challenge is often related to access of information, as neither the debtor or creditor have incentives to reveal a mispriced loan (Caballero et al., 2008). Without detailed debt information, it is also challenging to back out separate debt portions based on balance sheet figures, in particular if firms have multiple debt facilities and lending relationships. It is therefore an intricate challenge trying to connect interest expense portions to debt portions in the aim of revealing mispriced credit.

Caballero et al. (2008) describe a zombie firm to be a firm with poor profitability which receives financial help. This is usually done by comparing interest rates paid by a firm, to interest rates paid by the highest quality borrowers (Gouveia & Osterhold, 2018). A modified version, shown in equation 2.1, is presented in McGowan et al. (2017b).

$$R^*_{i,t} = rs_{t-1}BS_{i,t-1} + \left(\frac{1}{5}\sum_{j=1}^{5} rl_{t-j}\right) BL_{i,t-1} \tag{2.1}$$

Where $R^*_{i,t}$ is the calculated minimum interest paid, rs_t is the prime short-term interest rate, $BS_{i,t}$ the amount of short-term debt outstanding, rl_t is the prime long-term interest rate, and $BL_{i,t}$ is the long-term debt. This definition seeks to identify a lower bound for interest payments. The lower bound would represent an interest rate that is extremely lucrative for the borrower, which is why they assume that firms paying less than this lower bound receive subsidised credit. Most firms would thus have higher interest rates payments. Gouveia and Osterhold (2018) argue that this measure is unsuitable, as they use the whole population of Portuguese firms, and it would probably be too rigid to use AAA-listed firms as benchmarks. In contrast, Caballero et al. (2008) use a data set consisting of maximum 2,500 firms per year. We consider this to be a relevant point also for our data set which contains all Norwegian firms and move on to another possible definition.

Bank Of Korea (2013) uses operating characteristics in their classification of zombies and defines firms as zombies if they have interest coverage ratios less than one for three consecutive years. Thus, we will classify a firm as a zombie in the year 2013 if it had interest coverage ratios less than one in 2011, 2012 and 2013. The interest coverage ratio is defined as operating income divided by interest expenses. We have translated operating income to "driftsresultat" and interest expenses to "rentekostnad" following Berner, Mjøs, and Olving (2016). As explained in the next chapter, we give priority to consolidated figures whenever available. However, an issue evolves for foreign owned firms and Norwegian firms reporting interest expenses to group companies without being registered in a group. To account for this, these firms get their interest expenses to group companies added to, if any, other reported interest expenses. Work by the OECD (e.g. McGowan et al. (2017b)) adds an age criterion of ten years to this definition, intending to avoid misclassification of start-ups as zombies.

We will focus our analysis on the definition suggested by the OECD. This definition covers channels other than subsidised credit which can contribute to keeping zombies alive, such as non-performing loans, government guarantees to small and medium-sized enterprises (SMEs) and weak insolvency regimes (McGowan et al., 2017b).

A challenge concerning this definition is the changes in accounting standards over time, e.g. the transition to IFRS (International Financial Reporting Standards), particularly for bigger firms. Furthermore, the suggested definition contradicts the assumption that zombies receive subsidised credit, (Storz, Koetter, Ralph, & Westphal, 2017). If they received subsidised credit, one could expect their interest payments to be low, making them difficult to identify as zombies using the OECD definition.

3 Data Description

3.1 Data Sources

3.1.1 SNF's and NHH's Database of Accounting and Company Information for Norwegian Companies

We are using SNF's (Centre for Applied Research at NHH) and NHH's (Norwegian School of Economics) Database of Accounting and Company Information for Norwegian Companies. The database consists of standardised accounting and enterprise information from 1992 to 2016, and includes all Norwegian firms and groups. In addition to this, the database consists of firm variables such as industry codes, centrality measures and the number of board members. The database has been updated yearly with supplementary data submitted to SNF from the Brønnøysund Register Centre via Bisnode D&B Norway AS and Menon Business Economics AS.

As Berner et al. (2016) explain, some of the included variables are inconsistent over time, e.g. changes in variable names and reporting standards. This has raised the need for standardisation and quality assurance. The variables in the database are organised in accordance with the Accounting Act.

It is also worth noting that the database only consists of firms imposed by law to file financial statements. For example, all private limited companies ("AS") are obliged to file these figures, while sole proprietorships only must submit financial statements if they have assets worth more than NOK 20 million or more than twenty employees. Due to this, the number of firms in the database does not match the number of firms registered in official business registers. The financial statements for all firms of a certain size are subject to statutory audit according to current regulations. Norwegian private limited companies ("AS") of a certain size in terms of revenue, assets and employees can choose not to audit their financial statements. Nearly 85 percent of the observations in our final sample have audited statements, which presumably increase the quality of the data set.

Some places in this thesis we underline which variables we have used from SNF's and

NHH's database of accounting and company information for Norwegian companies. In those situations, the variable names are noted in parenthesis in the text when used.

3.1.2 Bankruptcy Data

We have used supplementary information concerning bankruptcies from the Register of Bankruptcies at Brønnøysund Register Centre. This has been done in order to get the latest record of bankruptcy of each firm since the database we use only contains the first time a firm enters bankruptcy (some firms have multiple records of initiated liquidation proceedings).

3.2 Preparation of Data Set

To ensure comparability, we have based much of the preparation of data set on the procedures in McGowan et al. (2017b). McGowan et al. (2017b) have closely followed the suggestions presented in Kalemli-Ozcan, Sorensen, Villegas-Sanchez, Volosovych, and Yesiltas (2015) and Gal (2013). However, we have not followed the suggestions mechanically, and the places we follow the above-mentioned researchers are clearly marked.

3.2.1 Sample Selection

We have combined yearly company accounts and consolidated accounts. Our initial data consists of 4,750,513 observations for the period 1992–2016. Some firms have both company- and consolidated accounts, and whenever applicable we give priority to the consolidated accounts. This elimination excludes 121,825 observations. The sample now consists of 4,628,688 observations.

The accounting figures are now prepared to be combined with files containing additional company information consisting of 4,710,169 observations. Before this combination, we remove all Norwegian firms being part of a group and not being the parent company from the company information files. This means that a firm like "Kiwi Norge AS" will not appear in our data set because its parent company, "NorgesGruppen ASA", reports consolidated accounts for firms in its group. The rationale behind this adjustment is

mainly that it contributes to avoiding potential problems with entities being profit or cost centres of a group. Firms with foreign classified ownership reported to be part of a group have been retained to account for missing consolidated figures. These measures decrease the sample size to 3,818,888 observations.

The accounting figures and company information is then combined. We choose to only keep firm observations included in both sources to ensure a high level of data consistency. After this combination, the sample consists of 3,652,660 observations.

To ensure that holding firms and similar entities do not influence our results, we remove firms without any employees or missing reporting of employees from the sample. This excludes in total 1,807,387 observations, where approximately 20 percent is removed due to missing registration of employees.

We have removed all observations of firms not being classified with limited liability. This excludes mainly sole proprietorships, partnerships, firms with no clearly defined ownership, and firms made for use by the public sector. The main argument for this removal is to only keep firms with a clear distinction between the finances of the firm and the owners. This removes 95,417 observations from the sample.

All Norwegian Registered Foreign Companies ("NUF") have been excluded from our sample. The reason is that these entities often report consolidated figures which not necessarily reflect the Norwegian branch of the group (Berner et al., 2016). This step removes 26,017 observations.

As suggested by Kalemli-Ozcan et al. (2015), we drop every observations of a firm if total assets, sales, employment, or fixed tangible assets are negative in any year. This restriction removes 8,750 observations. We have also ensured that there are no firms in the sample that have missing information on total assets, operating revenue and sales.

We are using NACE[1] Rev.2 (*bransjek_07_2s*) codes 10–83, excluding 64–66 (McGowan et al., 2017b). This excludes agriculture, forestry and fishing (NACE codes 01–03), mining and quarrying (NACE codes 05–09), financial and insurance activities (NACE codes 64–66), and sectors mainly used by the public (NACE codes > 83) e.g. hospitals and schools. The removal of the mentioned NACE codes removes 155,362 observations.

[1]NACE is an abbreviation of "The Statistical classification of economic activities in the European Community"

Next, we remove all observations with accounting year before 1999[2]. We base this restriction on the intention to only keep observations that include essential variables for the analysis later in the thesis. This removes 389,815 observations.

All observations without NACE Rev.2 code are removed to ensure that our sample only includes firms that are possible to classify using NACE Rev.2 codes. This step removes 162,117 observations.

To avoid outliers, firms that are larger than 100 times the 99^{th} percentile of the size distribution in terms of the size distribution of capital stock (real tangible assets) or the number of employees are excluded from the sample (McGowan et al., 2017b). This last step removes 278 observations.

Our final sample consists of 1,007,517 observations for the years of 1999–2016.

In addition, to ensure correct data treatment we follow Kiwi Norge AS, NorgesGruppen ASA, and Oslo Universitetssykehus HF (Oslo University Hospital) throughout the selection process. These firms are handled correctly and only NorgesGruppen ASA remains in the final sample.

3.2.2 Deflation of Monetary Values

The monetary values have been deflated from nominal to real values with deflators provided by Statistics Norway (SSB).

The following formula has been used to achieve the correct deflated figures for the data:

$$X_{it}^{Real,t_0} = \frac{X_{it}^{Nominal}}{P_t^{t_0}} \tag{3.1}$$

where each monetary value X_{it}, for firm i and year t is converted from nominal ($X_{it}^{Nominal}$) to real (deflated) value (X_{it}^{Real,t_0}) through dividing by Consume Price Index (CPI) ($P_t^{t_0}$), in year t. The base year is 2015. Deflation has been applied in order to allow for comparison of monetary variables over time.

[2]This restriction is set to 1997 when creating graphs for parts of the descriptive section due to illustrative purposes.

3.2.3 Estimating the Capital Stock at the Firm Level

Gal (2013) suggests how to estimate the capital stock at the firm level, which is followed by McGowan et al. (2017b). This involves using the standard Perpetual Inventory Method (PIM) to estimate the level of real capital stock, K_{it}, for each firm i in year t as

$$K_{it} = K_{i,t-1}(1 - \delta_{it}) + I_{it} \tag{3.2}$$

where I_{it} is real investment; the difference between time t and t_{t-1} of industry deflated (PI_t) book values of fixed tangible assets (K^{BV}) plus depreciation ($DEPR^{BV}$). It should be noted that we use CPI as deflator in our thesis.

$$I_{it} = (K_{it}^{BV} - K_{i,t-1}^{BV} + DEPR_{it}^{BV})/PI_t \tag{3.3}$$

The depreciation rate is calculated as $\delta_{it} = DEPR_{it}^{BV}/K_{i,t-1}^{BV}$. The first year of each firm (t_0), $K_{i,t-1}$ is missing, and the real capital stock is the net capital stock:

$$K_{it} = K_{it}^{BV}/PI_t \tag{3.4}$$

In the database, the variable of depreciation (*avskr*) comprises values for both tangible and intangible fixed assets, while Gal (2013) uses the term "depreciation" exclusively about tangible assets. Correspondingly, "amortisation" accounts for intangible assets. In other words, "depreciation" and "amortisation" are not separated in our data set, while they are in the suggestions by Gal (2013). Thus, we cannot follow the suggestions mechanically. This mismatch of Norwegian accounting standards and the required input in the suggested model have been resolved by using the observed net capital stock for all years in our sample (equation 3.4), when calculating each firm's capital stock.

We face the same challenges related to calculating real investments (I_{it}), which we will need in chapter 6: Zombie distortions on healthy firms. Our suggested solution is, as an alternative to equation 3.3, to use the change in real capital (using natural logarithms), following Gouveia and Osterhold (2018). It is worth noticing that if a firm goes from zero to a positive number of real tangible assets, the observation is lost as the logarithm of

zero is undefined.

The database only contains information on tangible fixed assets (*vardrmdl*) from 1999 due to changes in Norwegian accounting standards, implying that we are only able to calculate the capital stock from 1999 to 2016.

4 Descriptive Statistics

This part of the thesis presents summary statistics and descriptive insights regarding specific variables such as the prevalence, size, and age of the zombie firms.

4.1 Summary Statistics

Table 4.1: Firm Level Summary Statistics - 2013

	Zombie Firms			Non-Zombie Firms			t-test
	N	mean	sd	N	mean	sd	p
Sales Revenues	1,809	19,497	113,443	28,967	42,875	448,821	**
Payroll Expenses	1,809	5,906	42,746	28,967	9,835	100,782	*
Interest Expenses	1,809	1,246	13,226	28,967	348	5,038	***
Operating Profit/Loss	1,809	-1,647	17,333	28,967	2,648	40,503	***
Interest Coverage Ratio	1,809	-42.03	355.69	20,068	132.77	825.50	***
Fixed Assets	1,809	41,401	335,076	28,967	19,638	267,220	***
Tangible Fixed Assets	1,809	20,528	252,722	28,967	11,383	159,625	**
Total Assets	1,809	56,754	405,259	28,967	39,820	480,985	-
Short-term Liabilities	1,809	11,480	64,355	28,967	13,734	199,181	-
Long-term Liabilities	1,809	24,144	241,385	28,967	10,436	162,170	***
Equity Ratio	1,803	-1.94	26.34	28,906	-0.80	50.41	-
Firm Age	1,809	22.48	13.99	28,967	21.49	12.11	***
Employees	1,809	7.92	42.61	28,967	11.30	75.26	*
Centrality Index	1,787	4.12	2.79	28,578	4.02	2.78	-
Observations	1,809			28,967			

Note: All accounting figures included in rounded NOK '000 and CPI adjusted. All firms with firm age less than ten years are excluded. Last column includes a two-sample t-test for difference of means, where significance is denoted by; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

Table 4.1 summarises firm-level statistics in 2013 for the firms remaining after the sample selection described in the previous chapter. For this specific purpose, we remove all firms under the age of 10 years to ensure a reasonable comparison of zombies and non-zombies. The zombie firm share this year was about 2.79 percent.

The first group of variables contain income statement figures. We observe that sales revenues and payroll expenses were significantly higher for non-zombie firms, compared to

zombies. Interest expenses were significantly higher for zombie firms. Operating profit/loss and interest coverage ratio were both significantly higher for non-zombie firms. However, note from the standard deviations that the interest coverage ratio is driven by firms with extreme values. The median interest coverage ratio for non-zombies in 2013 was 6.5, whilst the median interest coverage ratio for zombies was -2.95. These differences between zombies and non-zombies are as expected.

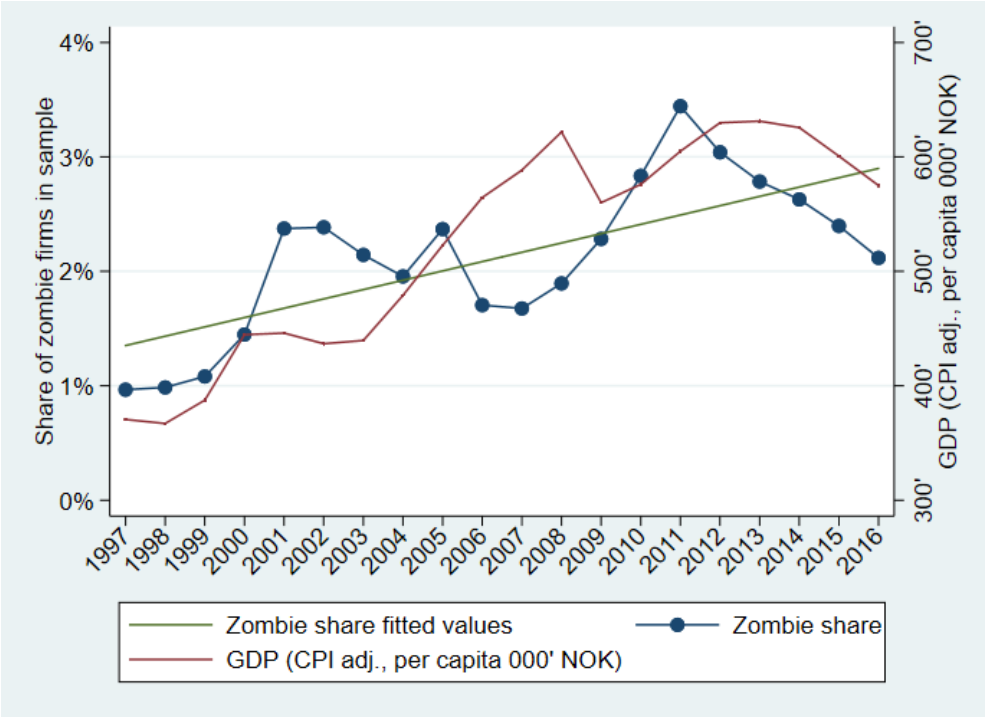
The second group includes balance sheet variables. We see that zombie firms in 2013 had significantly higher values for fixed assets, tangible fixed assets, and long-term liabilities. The zombies also had higher mean value than non-zombies for total assets and lower mean for short-term liabilities. However, these variables are not significantly different between the groups. The mean equity ratio was negative for both groups with no significant difference in the means.

The last group includes some non-financial figures. Firm age was quite similar for both groups but still significantly different from each other. However, remember that both groups only consist of firms being older than ten years. The number of employees is significantly different with zombie firms having a lower mean of 7.92 against 11.30 amongst the non-zombies. The centrality index has a range from 1 to 9, where 1 corresponds to the most central locations. We see that the difference between the means for centrality is not significantly different between the two groups.

4.2 Zombie Prevalence

Figure 4.1 shows the share of zombie firms in our sample in Norway over the period from 1997 to 2016. The database contains, as described, accounting figures starting from 1992, but the first zombie firm is observed in 1997 due to missing interest expense data until 1995. Interest coverage ratio has been calculated as the ratio of operating income to interest expenses (Bank Of Korea, 2013; McGowan et al., 2017b). Furthermore, zombie firms only include firms being ten years or older with an interest coverage ratio less than one for three consecutive years. When choosing whether to restrict the overall population of firms to those younger than ten years, we follow McGowan et al. (2017b) and Gouveia and Osterhold (2018) and keep all firms in the sample. Thus, for the sake of international

Figure 4.1: The share of zombie firms in Norway (1997–2016)



Note: Share of firms with age $\geq$ 10 years and an interest coverage ratio $<$ 1 over three consecutive years. Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies & SSB (2019).

comparability, we do not impose the minimum ten year restriction on other firms in the sample. Figure 4.1 shows an increased share of zombies in the population of Norwegian firms from 1997 to 2016. This is in line with the findings for several other OECD countries (McGowan et al., 2017b). However, we do also see a reduced share of zombies from 2011, suggesting that the increase from 2007 perhaps is associated with the financial crisis. Other countries such as Belgium, Spain, Finland, and Italy also experienced an increased share of zombie firms between 2007–2010 and 2010–2013.

The mean zombie share ranges between the extremities of 0.97 percent in 1997 to 3.44 percent in 2011. The overall average zombie share in the period is 2.13 percent. Figure 4.1 indicates that the zombie share of firms in Norway across this period has been increasing. The development could also indicate that the zombie share is affected by cyclical movements in the economy. It seem like the share of zombies increase during economic downturns, and do not fully recover, similar to the results in Banerjee and Hofmann (2018).

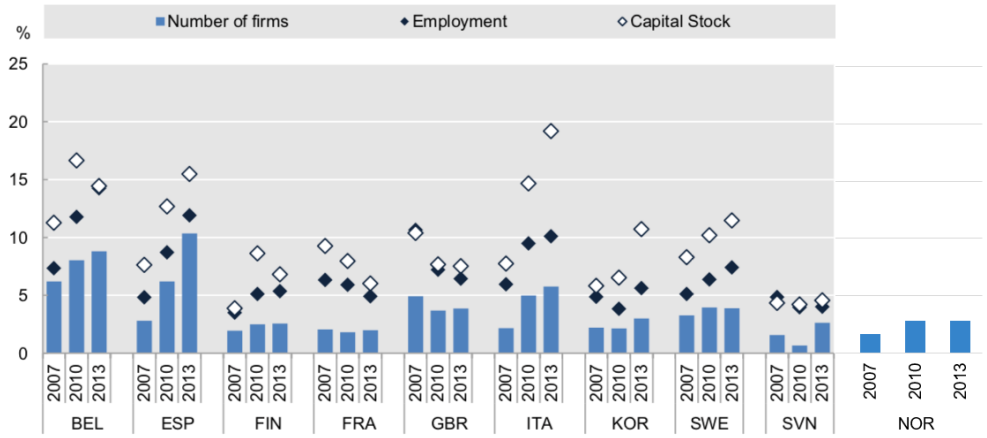
Figure A0.1 in the appendix shows a graph of the prevalence where the age restriction also

is imposed also for non-zombie firms. The zombie prevalence is approximately doubled compared to figure 4.1.

Figure 4.2 shows a comparison of zombie firm shares in various OECD countries including Norway for the years 2007, 2010 and 2013. The shares for all countries except Norway have been estimated in McGowan et al. (2017b). Norwegian zombie shares are based on our own estimates. We can see from the figure that Norway, relative to the other included countries, is amongst the countries with the lowest share of zombie firms during the selected years.

It should be noted that McGowan et al. (2017b) use the ORBIS Database, which in contrast to the database we use, does not cover all firms in the countries included. Thus, even though ORBIS is the largest cross-country firm-level database accessible and available for financial research, there are some drawbacks related to under-representation of certain industries, small and young firms. However, McGowan et al. (2017b) have used a conservative strategy when choosing countries to include in their research, focusing on countries where data coverage is more complete, perhaps reducing the problem related to the representativeness of their data. This hopefully makes their data set more comparable to ours.

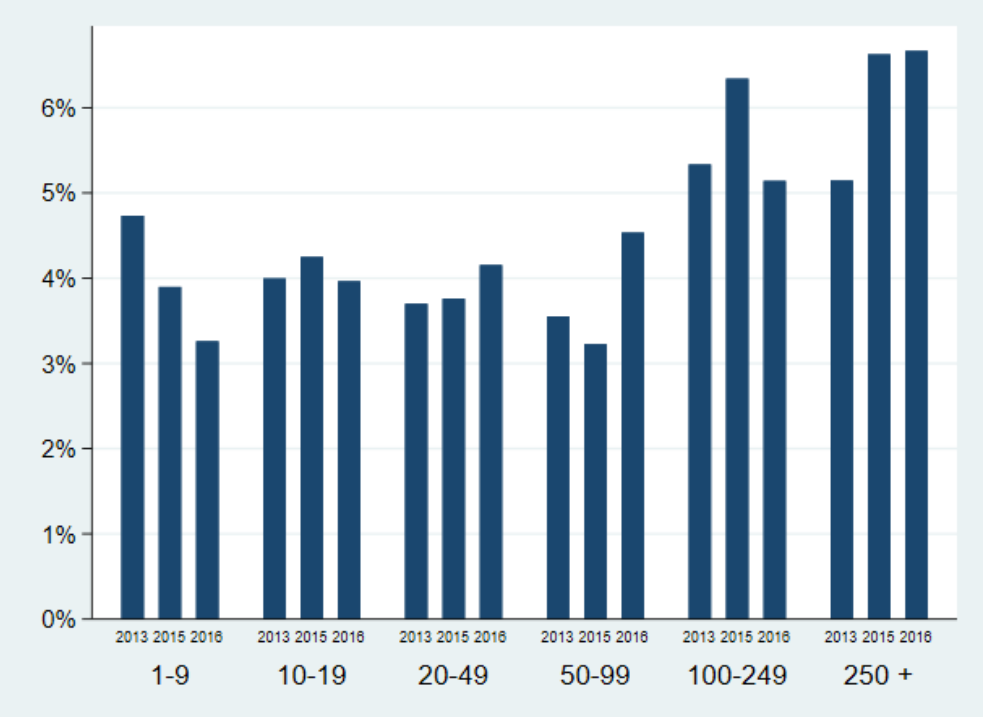
Figure 4.2: The share of zombie firms in ten OECD countries (2007, 2010 and 2013)



Note: "*Firms aged ≥ 10 years and with an interest coverage ratio < 1 over three consecutive years. Capital stock and employment refer to the share of capital and labour sunk in zombie firms. The sample excludes firms that are larger than 100 times the* 99^{th} *percentile of the size distribution in terms of capital stock or number of employees*" (McGowan et al., 2017b) Please note that differences in samples and sample selection procedures may affect the comparability between Norway and the other countries.
Source: McGowan et al. (2017b) based on ORBIS. The Norwegian estimates are our own based on SNF's and NHH's database of accounting and company information for Norwegian companies.

4.2.1 Size in Terms of Number of Employees

Figure 4.3: The share of zombie firms in each size category (number of employees)



Note: The share of firms with an interest coverage ratio < 1 over three consecutive years, over different sizes categories (number of employees).
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

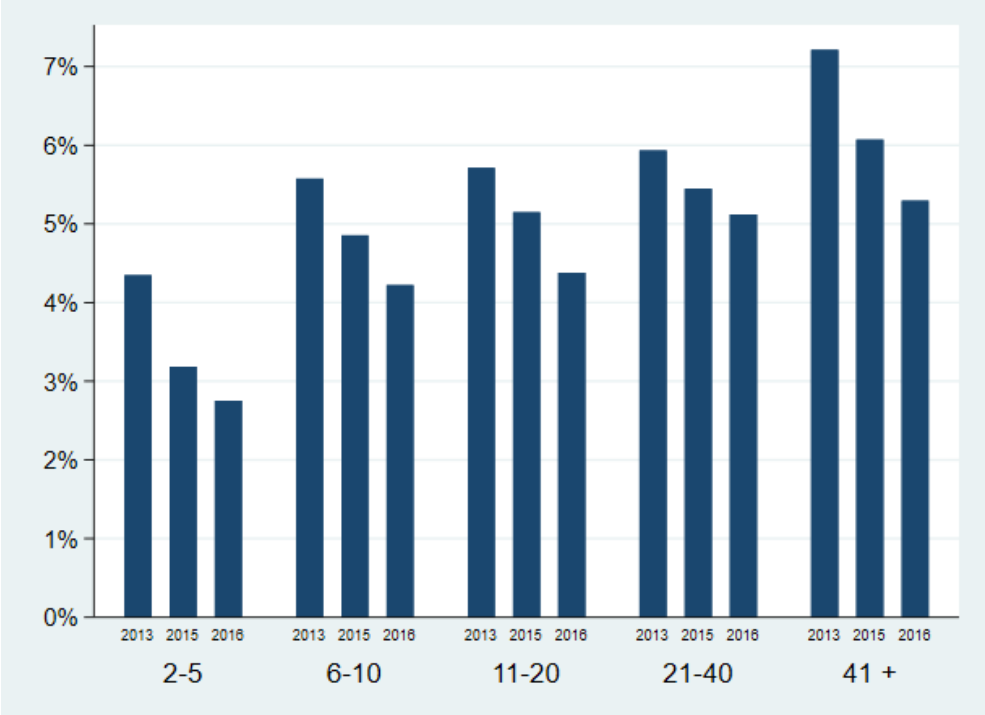
When taking a closer look at the characteristics of the zombie firms, we remove the restriction concerning minimum firm age for the zombie firms. Figure 4.3 is calculated using a simple average across zombie firms in 2013, 2015 and 2016. The calculations for 2013 is chosen for the sake of comparability to McGowan et al. (2017b), and the two latter years are chosen as they are the two most recent years in the database. It should be noted that 84 percent of the firms in 2013 belonged to the smallest size category, whereas only 0.21 percent belonged to the biggest. The median was three employees.

Figure 4.3 could indicate a positive relationship between firm size in terms of number of employees and the likelihood of being a zombie firm. However, one could note that the first four employment size categories do not show an obvious trend, perhaps even a falling probability of being a zombie with increased size, making it hard to conclude. The two largest categories seem to indicate a higher probability of being a zombie compared to the first four, however there are not many firms belonging to the two bigger categories. The

results in McGowan et al. (2017b) show a more steady increase.

4.2.2 Firm Age

Figure 4.4: The share of zombie firms in each firm age category

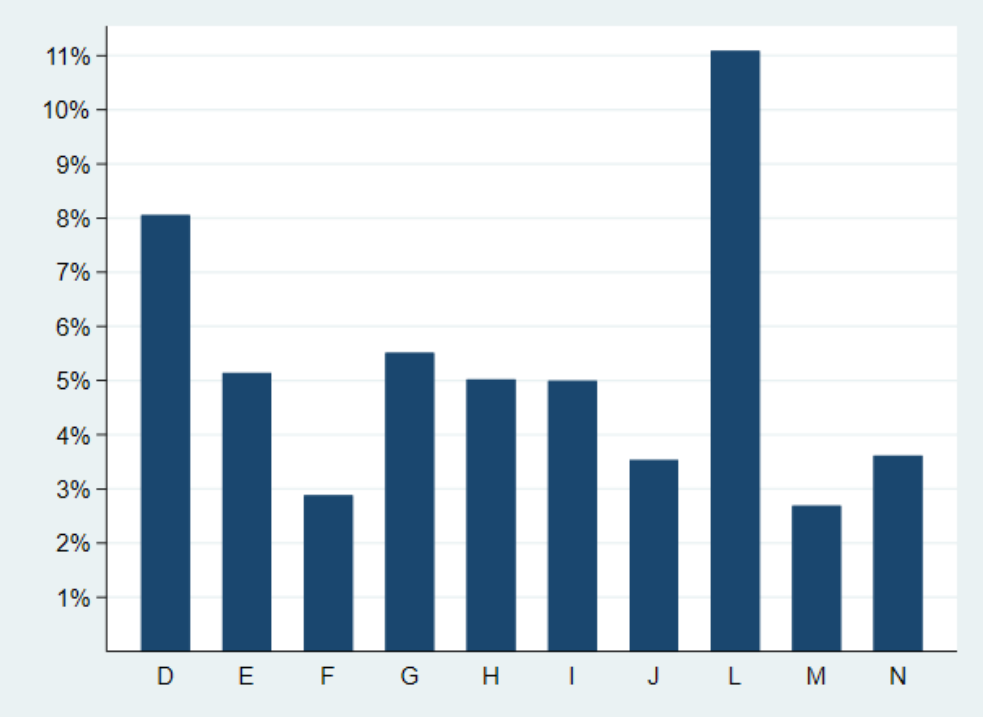


Note: The share of firms with an interest coverage ratio < 1 over three consecutive years, over different firm age categories.
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

We calculate the age of firms as the difference between accounting year and year of incorporation (*stiftaar*) (Gal & Hijzen, 2016). Recall that we at this stage do not impose the age criteria of minimum ten years to be classified as a zombie firm, ensuring comparability to McGowan et al. (2017b). The youngest category of firm age starts at two years since this is the first age at which zombies can be identified. It can be noted that in 2013 the distribution of firms within the four first categories was quite even, whilst there were fewer observations in the group covering the oldest firms. Our findings from the age categories, shown in figure 4.4, indicate that the mean number of observed zombie firms is lowest for the youngest age category and increasing with firm age. McGowan et al. (2017b) observe a quite similar trend in terms of an increasing share of zombie firms with firm age.

4.2.3 Industry Level

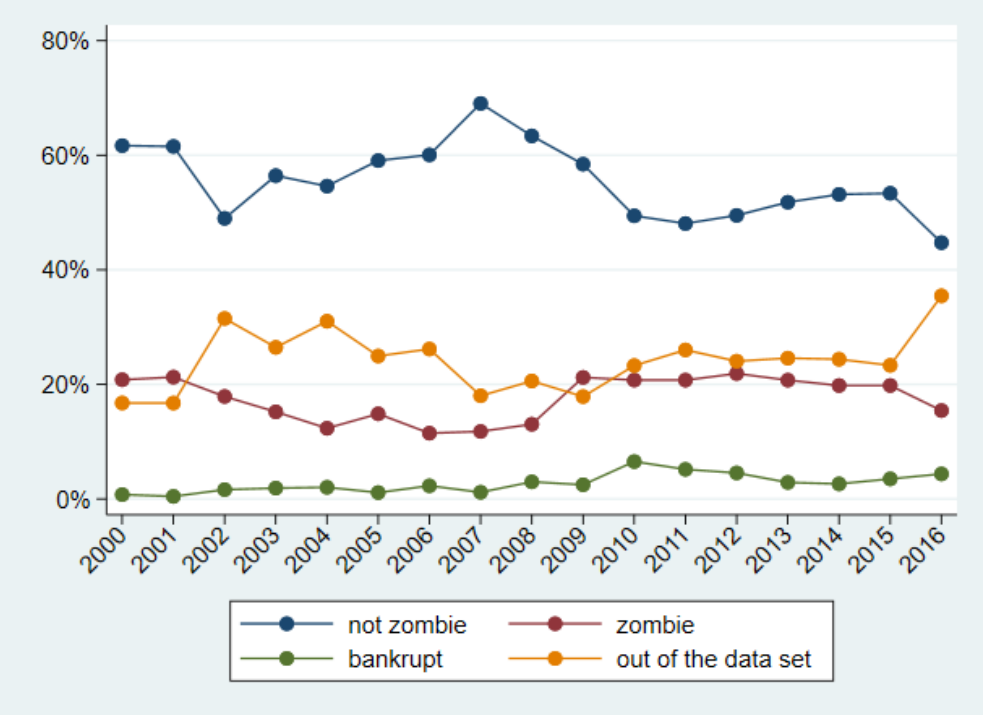
Figure 4.5: The share of zombie firms in NACE alphabetical code industries (2013)



Note: The share of firms with an interest coverage ratio < 1 over three consecutive years, in relevant NACE Rev.2 alphabetical code industries.
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

Figure 4.5 is made for illustrative purposes, and we continue using two-digit NACE Rev.2.2 classifications for the rest of the thesis[3]. The graph suggests that there are large differences in zombie shares across industries. Interestingly, real estate activities (L), which presumably has tangible assets to pledge as collateral, had the biggest share of zombies in 2013. Electricity, gas, steam and air condition supply (D) also had a relatively high within industry zombie shares compared to the rest of the industries. Industries such as professional, scientific and technical activities (M), and construction (F), presumably with less tangible assets, had the lowest zombie shares.

Figure 4.6: Firm classification three years after zombie classification



Note: The classification at t_2 for firms which at t_0 were aged ≥ 10 years and had an interest coverage ratio < 1 over three consecutive years. I.e. the firm classification three years after being classified as a zombie firm.
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

4.2.4 Survival of Zombie Classified Firms

From this point, we reimpose the restriction concerning the minimum age of zombie firms (ten years).

Figure 4.6 has been made with inspiration from Rodano and Sette (2019). The figure shows zombie firm classification at t_2 (e.g. 2004) for firms being classified as zombies at t_0 (e.g. 2002), with the first year being 2000. The graph could give us valuable information about what happens with the zombies after their classification. Our findings for the Norwegian sample suggest that around 45–65 percent of the zombie firms at t_0 have become non-zombies at t_2, 20–30 percent are out of the data set, 15–20 percent remains zombies and less than 10 percent have been declared bankrupt. These shares are relatively

[3]The alphabetical letters cover the following industries: C - Manufacturing, D - Electricity, gas, steam and air condition supply, E - Water supply, sewerage, waste management and remediation activities, F - Construction, G - Wholesale and retail trade, repair of motor vehicles and motorcycles, H - Transportation and storage, I - Accommodation and food service activities, J - ICT, L - real estate activities, M - Professional, scientific and technical activities, N - Administrative and support services

stable over time. Being out of the data set could mean that a firm has closed down without bankruptcy, missing data (not submitted annual accounts) or that the firm has passed an exclusion criteria for the sample selection, e.g. changed industry code. The bankruptcy variable is constructed using the latest bankruptcy registration for each firm[4]. Note that in the last year, 2016, the shares could be affected by missing bankruptcy data since firms still could be in the process of termination. Rodano and Sette (2019) uses Italian data and find that three years after a firm's zombie classification, between 30 and 40 percent have remained zombies, whilst about the same share have changed status to non-zombies.

We have also examined the zombie classification six years (t_5) after the firms' initial zombie classification (t_0). The results, shown in the appendix figure A0.2, display that after six years the share of firms out of the data set increased to 30–45 percent, while the share of firm remaining zombies decreased. This is a relatively stable trend over time.

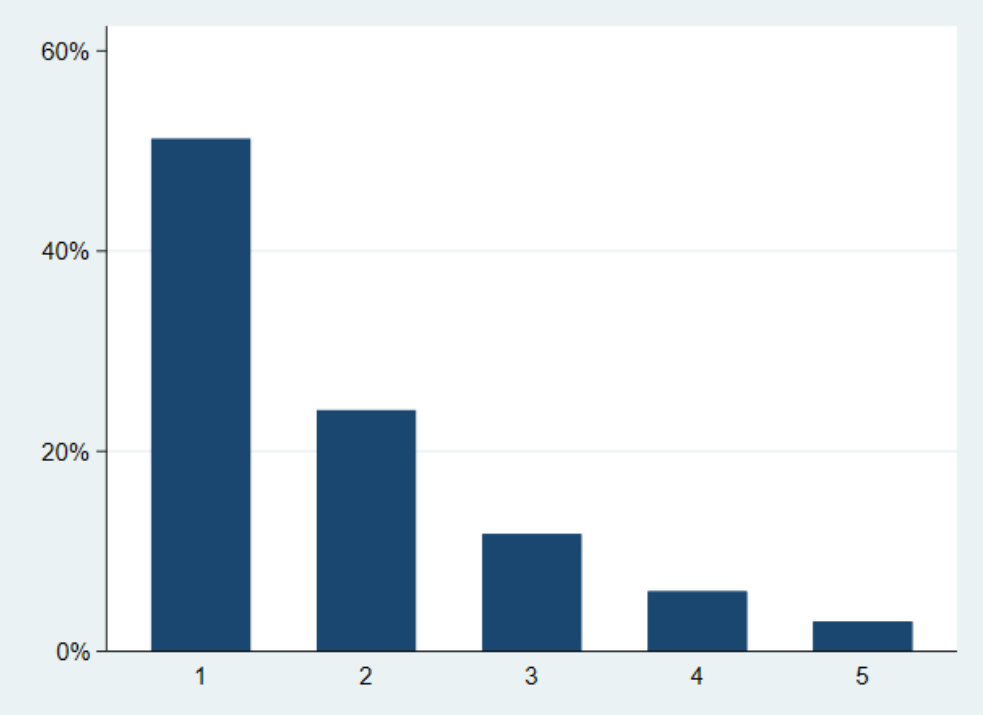
Overall the results from this part could indicate that firms once classified as zombie firms are more likely to either escape the zombie classification or (for different reasons) disappear from the data set than to remain classified as a zombie. Findings in McGowan et al. (2017b) show that the survival of zombie firms has increased. However, we do not observe indications of a similar trend in our data. Still, a notable share of the zombies are able to continue being alive over time, without changing zombie status.

Figure 4.7 shows the distribution of how long firms remain zombies after being classified as a zombie firm. For firms being reclassified as zombies several times, the longest lasting period is shown. A zombie firm classification period is the number of consecutive years a firm has been a zombie firm (interest coverage ratio less than one for three consecutive years and firm age of 10 years or more). This figure is restricted to the period 1999–2011, to ensure that all zombie-classified firms in the sample could remain at least five years after their initial zombie-classification. We see that the majority of the classification periods are relatively short, where approximately 85 percent last for three years or less. Around half of the zombie firms are only zombies one year before returning to a non-zombie classification (i.e. only having three years of consecutive interest coverage ratio below one), going out of the data set, or going bankrupt. However, a noticeable share of the firms have multiple

[4]Some firms in our sample selection have multiple bankruptcy occurrences registered. We assume here that the latest record of bankruptcy caused the firm to exit the market if the record is in the last year (or after) the last reported accounting figures.

non-consecutive zombie classification periods, in particular one-year periods.

Figure 4.7: Numbers of years classified as zombie firms (1999–2011)



Note: Distributions of number of years classified as a zombie firm (1999–2011). A zombie firm is a firm aged $\geq$ 10 years with an interest coverage ratio $<$ 1 over three consecutive years. For firms with multiple non-consecutive zombie classification periods, we have only included the longest lasting period.
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

5 Probability of Being a Zombie Firm

In the following two chapters, we will take a closer look at both who the zombies are, and the potential distortions they might create for healthy firms. In this chapter, we investigate different characteristics that can shed light on which firms are more likely to be zombies. Using the linear probability model, we investigate whether firms size, financial structure, age, public sector ownership, foreign ownership, female general manager, female chairperson and female board member share increase or decrease the probability of being a zombie, controlling for year and industry fixed effects.

In the second part of the empirical section, chapter 6, we move on to investigating whether zombies contribute to lower employment and capital growth, not only by having low values themselves but more interestingly; through spill-overs on healthy firms. Following McGowan et al. (2017b), we use a model consisting of a dummy variable that takes the value of 1 if the firm is a non-zombie as well as a variable interacting the non-zombie dummy with the capital sunk in zombies in an industry a specific year. In addition we include different firm controls and a fixed effects structure controlling for industry-specific time-varying shocks. Lastly, we investigate whether young firms are particularly affected by the capital sunk in zombie firms in their industry (and region).

5.1 Empirical Framework: Determinants of Being a Zombie Firm

We are interested in investigating which characteristics that are associated with the likelihood of being a zombie firm. In other words, our dependent variable is a dummy variable that takes the value of 1 if the firm is a zombie, and 0 if the firm is a non-zombie. Different researchers have tried to investigate characteristics and their connections to zombies using different methods and models. Hoshi (2006) uses probit models for investigating different characteristics associated with the probability of being a zombie. We will use the linear probability model and take inspiration from Hoshi (2006), other papers and our descriptive statistics when constructing the model.

This part of the thesis is intended to be an introduction to the next section about zombie distortions, taking a closer look at which characteristics that typically increase or decrease the chance of being a zombie firm.

5.1.1 Model Specification

The linear probability model (LPM) is a model that can be used to explain binary outcomes (Wooldridge, 2018); e.g. zombie or non-zombie. As the dependent variable only can take two values (1 or 0), the coefficients cannot be interpreted as the effect on y for a one-unit change in x, ceteris paribus. Instead, the change in x change the probability for "success" ($y = 1$). An important advantage of the LPM is that it allows us to include fixed effects, which we argue are necessary in our model at a later stage. The probit model is a nonlinear model popular to use when predicting binary outcome variables, but are not applicable when working with large numbers of fixed effects (Schivardi, Sette, & Tabellini, 2017).

However, there are some important drawbacks related to using the LPM. First, the fitted probabilities can have values outside the range of [0,1] (Wooldridge, 2018). Related to this, the relationship between all values of the independent variables and a probability cannot be linear. The LPM will in addition suffer from heteroskedasticity, except for the case in which the dependent variable does not depend on any of the independent variables. This problem can be solved using robust standard errors.

Due to its advantages, we use the LPM to identify which factors that increase or decrease the likelihood of being classified as a zombie firm. We use several variables which we believe can be important in determining which firms that end up as zombies; firm size, age, financial structure and two types of ownership categories. We also take a look at whether having a female general manager, female chair person or share of female board members can influence the probability of being a zombie firm. We will later on present our motivation for including these variables.

5.1.2 Fixed Effects Structure

We include fixed effects, as we suspect there are unobservable components in the error term. The fixed effects are included at industry level, using two-digit NACE Rev.2 groups as industry classifications, as before. We also control for unobservable year fixed effects, to control for time shocks such as business cycles. To run regressions with fixed effects, we have used the package *reghdfe* in Stata (Correia, 2016). This package allows us to use a high dimension of fixed effects, without having to use dummies.

5.1.3 Clustering of Standard Errors

Using a panel data set with repeated observations of individuals, serial correlation could be a potential issue (Angrist & Pischke, 2008). Serial correlation does not affect whether the coefficients are biased, but is important for the efficiency of the regression model. In other words, if the model is inefficient, we risk drawing wrong conclusions about inference. To account for potential serial correlation, we cluster standard errors at the firm level.

5.1.4 Regional Dimension

Since Norway covers a wide geographical area, and one could imagine that there are unobservable components in the error term related to this, we also run regressions introducing regions (*landsdel*) to our fixed effects. Our regions are the following (counties in parenthesis): Østviken (Østfold, Oslo, Akershus), Innlandet (Hedmark, Oppland), Vestviken (Buskerud, Vestfold, Telemark), Sørlandet (Aust-Agder, Vest-Agder), Vestlandet (Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal), Trøndelag (Sør-Trøndelag, Nord-Trøndelag), Nord-Norge (Nordland, Troms, Finnmark).

5.1.5 Variable Specification

When choosing variables, we have tried to include characteristics that reasonably could be assumed to affect the likelihood of a firm being classified as a zombie. Hoshi (2006) investigates determinants of zombie firms using a probit model on listed Japanese firms

in large industries. We let us inspire by some of his suggested variables, in addition to adding some more variables, as the database we use consists of a wide range of interesting variables that possibly could contribute in explaining more about which firms that end up as zombies.

The dependent variable is a dummy variable that takes the value of 1 if a firm is classified as a zombie firm, and 0 if not.

Hoshi (2006) suggests the use of two size proxies: number of employees and sum of total assets. The values are included in natural logarithms and squared terms to identify a possible non-monotonic relationship between the variables and zombie classification.

We are interested in investigating whether size makes a firm more or less likely to be a zombie. First, Hoshi (2006) suggests that overall, size in terms of employees and total assets both reduces the likelihood of being a zombie. It is emphasised that this is not the case for small firms. Our sample consists of a high concentration of smaller firms, in contrast to Hoshi (2006). This suggests that size could increase the probability of being a zombie in our sample. This is only partly supported by figure 4.3. In addition, as we saw in the descriptive statistics in table 4.1, the average zombie had fewer employees than the average non-zombie in 2013.

It is also plausible that big firms in terms of total assets have more assets to sell in times of financial distress, and that firms of a certain size could expect to benefit from protective mechanisms from public authorities when faced with financial difficulties ("too big to fail"), making them more likely to be zombies.

In sum, we expect more total assets to increase the likelihood of being a zombie firm, whilst it is more unclear whether number of employees increase or decrease the probability of being a zombie firm.

Given the summary statistics and descriptive statistics in this thesis, in addition to the presented results in McGowan et al. (2017b), we expect older firms to have higher likelihood of being a zombie compared to younger firms, and hence we include age as a variable.

As a measure of financial structure, we will, as suggested by Hoshi (2006), use the ratio of interest-bearing debt over total assets. We calculate an average of the minimum

and maximum interest bearing debt (*rgjeld_min* and *rgjeld_max*) to account for the uncertainty of which accounting figures that are interest-bearing. We expect indebted firms to be more likely to be zombies, given the results in Hoshi (2006) and table 4.1. However, it is not obvious that indebted firms are the same firms as those who cannot fulfil their interest payment obligations. It should also be noted that it is no direct relationship between the level of debt and our definition of a zombie firm.

It could be interesting to take a closer look at whether governmental ownership influences the chance of being a zombie; even though we have intended to remove firms that are made for use by the public sector, there are still firms in the sample that have public sector ownership defined as more than 50% ownership. Some of the firms in the sample, e.g. Vinmonopolet (state-owned alcoholic beverage retailer), holds monopoly imposed by law in their market. One could imagine that firms with public sector ownership e.g. are more likely to receive government subsidies if they experience financial difficulties, and are perhaps therefore more likely to be zombies. The largest financial institution in Norway, DnB NOR (now DNB), where the state holds approximately one-third of the shares, has been estimated to have received NOK 3 billion through supportive initiatives granted by the public authorities during the financial crisis of 2007–2008 (Dagens Næringsliv, 2010). A dummy variable that equals 1 if a firm has public sector ownership, and 0 if not, is included.

A related question is whether foreign ownership influences the probability of being a zombie, as there are different tax regulations across countries, and further as multinational companies can use different strategies to reduce the overall tax burden. Our initial thought is thus that a firm is more likely to be a zombie if it has a foreign owner, as the potential low profitability in the Norwegian registered entity might be a planned transfer pricing strategy. There are also multiple news articles supporting this hypothesis; Eckblad, Johannessen, and Langdal (2018) claim that the revenues of the Norwegian branch of the technology company Google were NOK 3 billion in 2017 while their tax expense to Norway only amounted to NOK 3 million (0.10 percent) in the same year. We include a dummy variable that equals 1 if a firm has foreign ownership, and 0 if not.

The database also include information about female board members, female chairpersons and female general managers. Because there are typically fewer women than men in these

positions in Norway, one could perhaps imagine that the women that actually possess these positions possibly are more hardworking or skilled than their male counterparts. We include female board members as the ratio of female board members to the total number of board members in a firm. Female chairpersons and female general managers are included as dummies, where the dummy variable equals 1 if the position is possessed by a woman, 0 if not. We have also tested if there is any difference if we include a dummy to control for public limited companies, where specifications about gender composition are expressed by law.

All variables are lagged one year, to make our regressions less likely to be influenced by endogeneity problems. It is also important to note that all firms with firm age under ten years are excluded from the sample at this stage, as they, using our definition, cannot be classified as zombies. This way we ensure a fair comparison between the groups of zombies and non-zombies.

5.2 Results

Table 5.1 shows the results without regions in the fixed effects term, and column (1) shows the result of the first regression. The results indicate that, given number of employees as size measure, the probability of being a zombie declines with size, which is in line with the results by Hoshi (2006). The results do not change when including a squared term of employees, as shown in column (2). However, the squared employment coefficient shows a positive sign, without being statistically significant. Note that the regression output suggests that both firm age and foreign ownership increases the probability of being a zombie firm, which is in line with what we expected. However, as the coefficient on firm age is very small, it seems like age has a very limited economic significance.

Columns (3) and (4) show the results when using total assets as proxy for size instead of employment. Column (3) indicates that increased size, using total assets, increases the likelihood of being a zombie firm. This is in line with our expectations. Column (4) includes the squared term of total assets in the model. In this column both the total assets and the squared term of the total assets are significant, but while the linear term shows a negative coefficient, the squared one shows a positive coefficient. This indicates

Table 5.1: Linear Probability Model - Determinants of Zombie Firms Without Regions - Years 1999–2016

	(1)	(2)	(3)	(4)	(5)
log Employment	-0.00540***	-0.00639***			-0.00629***
	(0.0006)	(0.0014)			(0.0016)
$(\log(\text{Employment}))^2$		0.00026			-0.00122***
		(0.0003)			(0.0004)
log Total Assets			0.00138***	-0.01320***	-0.01324***
			(0.0005)	(0.0023)	(0.0027)
$(\log(\text{Total Assets}))^2$				0.00086***	0.00113***
				(0.0001)	(0.0002)
Total Debt / Total Assets	0.00004	0.00004	0.00004*	0.00002	0.00002
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Firm Age	0.00023***	0.00023***	0.00016**	0.00012*	0.00013**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Public Sector Ownership	0.00908	0.00879	-0.00016	-0.00437	-0.00045
	(0.0098)	(0.0099)	(0.0098)	(0.0099)	(0.0100)
Foreign Ownership	0.01757***	0.01712***	0.00668*	0.00361	0.01083***
	(0.0033)	(0.0034)	(0.0034)	(0.0035)	(0.0034)
Year and industry fixed effects	YES	YES	YES	YES	YES
Observations	401,854	401,854	401,854	401,854	401,854
Adjusted R^2	0.012	0.012	0.011	0.011	0.013

	(6)	(7)	(8)
log Employment	-0.00629***	-0.00626***	-0.00634***
	(0.0016)	(0.0016)	(0.0016)
$(\log(\text{Employment}))^2$	-0.00122***	-0.00123***	-0.00124***
	(0.0004)	(0.0004)	(0.0004)
log Total Assets	-0.01325***	-0.01338***	-0.01270***
	(0.0027)	(0.0027)	(0.0028)
$(\log(\text{Total Assets}))^2$	0.00113***	0.00114***	0.00109***
	(0.0002)	(0.0002)	(0.0002)
Total Debt / Total Assets	0.00002	0.00002	0.00002
	(0.0000)	(0.0000)	(0.0000)
Firm Age	0.00013**	0.00013**	0.00013**
	(0.0001)	(0.0001)	(0.0001)
Public Sector Ownership	-0.00044	-0.00020	0.00032
	(0.0100)	(0.0100)	(0.0101)
Foreign Ownership	0.01083***	0.01079***	0.01140***
	(0.0034)	(0.0034)	(0.0035)
Female General Manager	-0.00021		
	(0.0019)		
Female Chairperson		-0.00372**	
		(0.0019)	
Female Board Member Share			-0.00485**
			(0.0021)
Public Limited Company			0.02265
			(0.0167)
Year and industry fixed effects	YES	YES	YES
Observations	401,854	401,854	395,092
Adjusted R^2	0.013	0.013	0.013

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Zombie firm classification (IRCR < 1 for three consecutive years and firm age ≥ 10) is the dependent variable where "1" equals zombie firm. Each line reports variable coefficients with standard error in parenthesis and significance level symbolised by stars (*). Accounting Figures included in NOK '000 and CPI adjusted. Employment is the number of registered employees (*ansatte*). Total Assets is all assets of a firm (*sumeiend*). Total Debt / Total Assets is all interest bearing debt (average of *rgjeld_min* and *rgjeld_max*) divided by total assets (*sumeiend*). Firm Age is the age of firm defined as the accounting year minus year of incorporation ($stiftaar$). Public Sector Ownership is "1" if a firm has > 50 % public sector ownership ($eierstruktur = 5$). Foreign Ownership is "1" if a firm is owned by foreigners ($eierstruktur = 9$). Female General Manager and Chairperson is "1" if the general manager/chairperson of a firm is a female ($daglsex =$ "K" and $stledsex =$ "K"). Female Board Member Share equals the number of females in the board of a firm (*st_kvimdl*) divided by the total number of board members (*st_medl*) in the same firm. Public Limited Company is "1" if the firm is this entity type ($selskf =$ "ASA"). Standard errors are clustered at the firm level.

Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

that up to a certain point of size, the probability of being a zombie decreases, but after this point the probability increases. A reason could be that after a certain point of size, the bigger firms are more likely to be protected.

Column (5) includes all of the suggested variables in column (1) to (4). The overall conclusions remain the same, but the squared term of the employment variable turns significant and has a negative sign.

Columns (6), (7), and (8) include the variables female general manager, female chairperson, and female board member share. We find that the female chairperson and board member share (controlling for public limited company) are significant and have negative coefficients. However, as the coefficients are very small, we would argue that these variables lack economic significance.

Table A0.1 in the appendix shows the results including regions in the fixed effects structure. None of the conclusions changes.

In sum, the likelihood of being a zombie firm tends to be lower with the number of employees. When including a linear and squared term of total assets, we observe that until a certain point of total assets, size reduces the chance of being a zombie. After that point, size increases the chance of being a zombie. We also see indications that foreign ownership increases the likelihood of being a zombie firm.

5.3 Robustness

To further investigate whether our results are sensitive to fixed effects and clustering specifications, we run alternative models. First, we run year-industry fixed effects, and cluster standard errors on the same level. We only test this specifications on the model in column (5). The regression outputs can be found in the appendix, table A0.2. It does not seem like the model used in column (5) is sensitive to this choice of fixed effects.

Moreover, we change our cluster structure, using our original fixed effects structure, and cluster at year-industry level and industry. We only test these specifications on column (5). The regression outputs can be found in the appendix, table A0.2 and A0.3. The results are in limited degree sensitive to these changes, however, it seems to be a sensitivity

related to whether the squared term of the employment and age variables are significant.

6 Zombie Distortions on Healthy Firms

6.1 Empirical Framework: Distortions

In this part of the thesis, we investigate potential distortionary effects of zombie firms on both the average non-zombie and for young firms, within industries. This could be an important topic for policy makers in order to achieve improved insolvency regimes and to ensure productivity growth.

6.1.1 Model Specification

The economic specification used in this part of the thesis builds the framework suggested in Caballero et al. (2008). We follow the application of the framework in McGowan et al. (2017b). Recall that McGowan et al. (2017b) use a harmonised cross-country data set including nine countries in the OECD, whilst we only consider Norwegian firms, and that the data sets differ.

$$Y^k_{ist} = \beta_1 nonZ_{ist} + \beta_2 nonZ_{ist} * Z_{st} + \beta_3 FirmControls_{ist-1} + \delta_{st} + \varepsilon_{ist} \tag{6.1}$$

Following McGowan et al. (2017b)[5], Y refers to a measure of activity in firm i, in industry s, at time t. We use the change in employees (*ansatte*) (using natural logarithms) from one year to another and change in real capital stock (see chapter 3.2.3) (using natural logarithms) as measures of activity. As a measure of capital, recall that we use CPI adjusted tangible assets. As previously mentioned, we use the change in capital stock, while McGowan et al. (2017b) use investment ratio.

Continuing with the rest of the model, $nonZ_{ist}$ is a dummy which equals 1 if a firm is *not* defined as a zombie firm, and 0 otherwise. We expect β_1 to have a negative coefficient, considering previous research from the OECD (McGowan et al., 2017b). However, as McGowan et al. (2017b) point out, this variable can be difficult to interpret. A possible

[5]As McGowan et al. (2017b) use a cross country data set, they also include country in their interacted fixed effects. These are not relevant in our model, and are thus removed.

explanation for a positive sign of the coefficient could be that zombies are more restrictive while spending, while a negative term could e.g. indicate that zombies receive subsidies.

Z_{st} is the share of industry capital sunk in zombie firms for a given year. This is interacted with the $nonZ_{ist}$ dummy variable and indicates whether capital sunk in zombies within industries reduces capital and employment growth amongst healthy firms. We expect this coefficient to have a negative sign, as presented in McGowan et al. (2017b).

Firm controls consist of a dummy $YOUNG$, which takes the value 1 if the firm is younger than six years (firm age), 0 otherwise. McGowan et al. (2017b) include six categories of size of employment, as dummies. However, as the clear majority of firms in our sample belong to the smallest size category, we instead use the number of employees as control variable, which is one of the suggested control variables in Gouveia and Osterhold (2018). The variable is included in natural logarithms. The firm controls are lagged one year.

We also take a closer look at whether young firms are disproportionately affected by potential zombie distortions, which could be reasonable if zombies create entrance barriers. Following McGowan et al. (2017b) we define the following model:

$$Y^k_{ist} = \beta_1 nonZ_{ist} + \beta_2 nonZ_{ist} * YOUNG_{ist} + \beta_3 nonZ_{ist} * Z_{st} + \beta_4 nonZ_{ist} * Z_{st} * YOUNG_{ist} + \beta_3 FirmControls_{ist-1} + \delta_{st} + \varepsilon_{ist} \quad (6.2)$$

Model 6.2 is identical to model 6.1, but include i) the non-zombie dummy interacted with the young dummy, and ii) a triple-interacted term consisting of the non-zombie dummy, the capital sunk in zombies in an industry and the young dummy. We expect the latter variable to have a negative sign, meaning that young firms are disproportionately affected by zombie spillovers.

As underlined by McGowan, Andrews, and Millot (2018) one must be careful in interpreting the results causally, since that would require the zombies to be randomly assigned to industries. Hence, the results should be interpreted as correlations rather than causal relationships.

6.1.2 Fixed Effects Structure

We impose a burdensome fixed effects structure consisting of interacted year-industry fixed effects, following McGowan et al. (2017b). The industry groups are separated using two-digit NACE Rev.2 industry classifications (*bransjek_07_2s*), as before. As Gouveia and Osterhold (2018) explain, this fixed effect structure is necessary because industry-specific shocks can affect both our measures of activity (employment and capital growth), as well as resources sunk in zombies. One cannot estimate the absolute effect of resources sunk, because of the fixed effects structure (Gouveia & Osterhold, 2018). The coefficient of the interacted variables should rather be interpreted as the effect on the average healthy firm in deviation from the effect on zombies.

6.1.3 Regional Dimension

Additionally, we run one more analysis taking into account the regional perspective. We follow the advice given by Schivardi et al. (2017), and include a regional dimension to the analysis as well, using the same regions (*landsdel*) as in the previous chapter: Østviken, Innlandet, Vestviken, Sørlandet, Vestlandet, Trøndelag and Nord-Norge. Gouveia and Osterhold (2018) argue that the relevant labour market possibly is regional. In a country such as Norway with long distances between cities and towns, it is not unlikely that this is an important point for the Norwegian labour market. Thus, in a separate analysis, the interacted fixed effects term consists of region, industry and year. We also change the variable of capital sunk in zombies to include the regional dimension, thus obtaining year-region-industry capital sunk.

6.2 Distortionary Effects on Healthy Firms

Table 6.1 shows the results of the regression outputs. We include robust standard errors clustered at the year-industry level (McGowan et al., 2017b).

We can read from table 6.1 that a non-zombie can expect statistically significant higher employment growth and capital growth than zombies. This is in line with the results in McGowan et al. (2017b).

Table 6.1: Distortionary Effects: Without Regions

	(1) dLog emp		(2) dLog cap	
Variables	Coef.	std. err.	Coef.	std. err.
Non-zombie dummy$_{i,t}$	0.05098***	(0.003)	0.13136***	(0.008)
Non-zombie dummy$_{i,t}\times$ Zombie shares$_{s,t}$	-0.14861**	(0.061)	-0.42938***	(0.138)
Age and size firm controls	YES		YES	
Year-industry fixed effects	YES		YES	
Observations	832,282		634,664	
Adjusted R^2	0.0670		0.0071	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The table shows the distortionary effects on change in employment (dLog emp) and capital (dLog cap). $Non-zombiedummy_{i,t}$ is a dummy variable equal to one if a firm is classified as a non-zombie. $Zombieshares_{s,t}$ refer to the capital within the specific industry invested in zombie firms. Firm age and size (number of employees) act as firm controls. Fixed effects are included by an interaction term of year-industry, where industry follows NACE Rev.2 (*bransjek_07_2s*) codes 10–83, excluding 64–66.
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

The second variable, non-zombie dummy × zombie industry shares, seeks to explain whether zombies reduce labour- and capital growth amongst non-zombies, within industries. The coefficients are negative and statistically significant for both employment and capital growth. One could also note that, as in McGowan et al. (2017b), the negative coefficient for the interacted capital variable is larger than the interacted employment variable, suggesting that the possible distortions could be larger for capital than employment growth when using this model. This point is emphasised in Gouveia and Osterhold (2018). The spillover on employment growth is consistent with the findings in McGowan et al. (2017b). However, Gouveia and Osterhold (2018) do not find significant distortions for employment growth.

We follow the advice given by Schivardi et al. (2017), and include a regional dimension to the analysis as well, using the same regions (*landsdel*) as in the previous chapter: Østviken, Innlandet, Vestviken, Sørlandet, Vestlandet, Trøndelag and Nord-Norge. Gouveia and Osterhold (2018) argue that the relevant labour market possibly is regional. Thus, in a separate analysis, the interacted fixed effects term consists of region, industry and year. We also change the year-industry variable of capital sunk to include the regional dimension. Robust standard errors are clustered at the year-region-industry level. This does not change our overall results. The output can be found in the appendix, table A0.7.

Table 6.2: Distortionary Effects Young Firms: Without Regions

	(1) dLog emp		(2) dLog cap	
Variables	Coef.	std. err.	Coef.	std. err.
Non-zombie dummy$_{i,t}$	0.05071***	(0.003)	0.13000***	(0.008)
Non-zombie dummy$_{i,t}$× Young dummy$_{i,t}$	0.03948***	(0.002)	0.03321***	(0.006)
Non-zombie dummy$_{i,t}$× Industry zombie shares$_{s,t}$	-0.13988**	(0.062)	-0.38864***	(0.142)
Non-zombie dummy$_{i,t}$× Industry zombie shares$_{s,t}$× Young dummy$_{i,t}$	-0.02771	(0.031)	-0.15581**	(0.068)
Age and size firm controls	YES		YES	
Year-industry fixed effects	YES		YES	
Observations	832,282		634,664	
Adjusted R^2	0.0676		0.0072	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The table shows the distortionary effects on change in employment (dLog emp) and capital (dLog cap). $Non-zombiedummy_{i,t}$ is a dummy variable equal to one if a firm is classified as a non-zombie. $Zombieshares_{s,t}$ refer to the capital within the specific industry invested in zombie firms. $Youngdummy_{i,t}$ is a dummy variable equal to one if firm age is less than six years. Firm age and size (number of employees) act as firm controls. Fixed effects are included by an interaction term of year-industry, where industry follows NACE Rev.2 (*bransjek_07_2s*) codes 10–83, excluding 64–66.

Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

Next, we explore whether young firms are disproportionately affected by the zombie congestion. The triple interaction term in the regression output, table 6.2, suggests that young firms are disproportionately affected by zombie distortions concerning capital growth. We do not see this indication for employment growth. McGowan et al. (2017b) find the opposite results: young firms are disproportionately affected concerning employment growth, but not capital growth. However, our measure of capital growth differs from investment ratio, which is the corresponding measure used in (McGowan et al., 2017b). As we suspect that the relevant labour market is the regional one, we also run a regression including the regions.

Table 6.3: Distortionary Effects Young Firms: With Regions

	(1) dLog emp	
Variables	Coef.	std. err.
Non-zombie dummy$_{i,t}$	0.04889***	(0.003)
Non-zombie dummy$_{i,t}$× Young dummy$_{i,t}$	0.03948***	(0.002)
Non-zombie dummy$_{i,t}$× Industry-region zombie shares$_{r,s,t}$	-0.07452**	(0.034)
Non-zombie dummy$_{i,t}$× Industry-region zombie shares$_{r,s,t}$× Young dummy$_{i,t}$	-0.02833**	(0.013)
Age and size firm controls	YES	
Year-region-industry fixed effects	YES	
Observations	824,239	
Adjusted R^2	0.0701	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The table shows the distortionary effects on change in employment (dLog emp) and capital (dLog cap). $Non-zombiedummy_{i,t}$ is a dummy variable equal to one if a firm is classified as a non-zombie. $Zombieshares_{s,t}$ refer to the capital within the specific industry invested in zombie firms. $Youngdummy_{i,t}$ is a dummy variable equal to one if firm age is less than six years. Firm age and size (number of employees) act as firm controls. Fixed effects are included by an interaction term of year-region-industry, where industry follows NACE Rev.2 (*bransjek_07_2s*) codes 10–83, excluding 64–66.
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

Table 6.3 shows the regression including regions; capital sunk is now the capital sunk in zombies in an industry, a region and a year. Fixed effects are interacted at the year-region-industry level, and standard errors are clustered using the same interactions. Interestingly, this model estimates that the employment growth in young firms are particularly affected

by capital sunk in their industry and region.

Our results indicate that zombies distort capital and employment growth within industries. This could potentially imply that zombie congestion hinders productivity-enhancing capital reallocation and thus reduce potential output growth (McGowan et al., 2017b). Zombies also contribute to lower aggregate employment and capital growth by inhabiting lower values of these measures of activity themselves, compared to healthy firms. Additionally, we see indications of capital growth in young firms being disporportionately affected by spillovers from zombies. Assuming that the relevant labour market is the regional one, this also accounts for employment growth.

6.3 Robustness

6.3.1 Changing the Zombie Firm Definition

To investigate the sensitivity of the results above, we are doing the same analyses as the last chapter, but changing the zombie definition; the requirement of age is changed from ten to fifteen years and period of consecutive years with interest coverage ratio less than one from three to four years. The regressions can be found in the appendix, table A0.5 and A0.6. According to Gouveia and Osterhold (2018), a more stringent definition of zombies can contribute in addressing cyclical effects. When doing this, the interaction variable loses its significance for employment growth. This is also the case when increasing the minimum firm age to 15 years. The spillovers on employment growth is thus somewhat sensitive to zombie definition.

6.3.2 Including Fishing and Aquaculture

Fishing is one of Norway's most important export industries, and thus a crucial part of the Norwegian economy. The 03-industries (fishing and aquaculture in NACE Rev.2) are removed during the main analysis, as suggested in McGowan et al. (2017b). We therefore run a regression analysis including 03-industries to test if our results are sensitive to this change. The results are shown in the appendix, table A0.7. Including fishing and aquaculture industries do not change our results.

7 Discussion

We find that the share of zombie firms have increased since 1997, but the growth is not very prevalent. Our analysis suggest that industry capital sunk in zombies lowers capital and employment growth amongst non-zombie firms. We also see indications that this disproportionately affects young firms, in particular when including a regional component in the analysis. In the first section of this chapter we will discuss some limitations of the analysis. Then we move on to a brief section about insolvency regimes, as they could possibly contribute to reduce the zombie firm share and improve market conditions for healthy firms. Lastly, we present possible areas to explore in further research on zombie firms in Norway.

7.1 Limitations of the Analysis

Gouveia and Osterhold (2018) point out that with the current definition, zombies will exit the zombie classification if they experience a single year with interest coverage ratios equal to or more than one. Hence, there is a chance that the prevalence of zombies is underestimated, in particular if many firms have short gaps with interest coverage ratios more than one. A way to address this concern could be to impose a new restriction, where a zombie must have an interest coverage ratio equal to or more than 1 for at least three consecutive years to be "un-classified" as zombies. Another point related to the definition is that our definition does not focus on forbearance lending, which historically has been important in the research field of zombie firms. However, McGowan et al. (2017b) investigate the sensitivity of their results using the modified version of the definition used in Caballero et al. (2008), and only find limited changes in their results. Gouveia and Osterhold (2018) argue that although the share of zombie firms differ using different criteria, the *dynamics* of the zombie prevalence across time and industries are highlighted with either definition.

In the previous analysis, we investigated the effects of zombie distortions on the *average* firm. However, as mentioned the consequences could be even larger depending on which firms that are affected by the zombies (McGowan et al., 2017b). In the case where the

most productive firms are disproportionately affected by the zombie prevalence, we could probably expect even bigger consequences from zombie congestion.

A possible sensitivity is the fact that firms with foreign owners could be a part of a cost- or revenue centre. As we saw in the section about determinants, the firms that are part of foreign-owned groups are more likely to be zombies than those which are not. This could indicate that some of the zombies are cost centres, where the (appearing) low profitability is a planned strategy.

Throughout the analysis we have used NACE Rev.2 classifications (McGowan et al., 2017b). However, in the database we use, this is only available for firms that exist in the database after 2007. Thus, firms that only existed before 2007, do not have this industry classification, but rather NACE Rev.1.1. Whilst the number of firms per year has increased over time, we have also removed a larger share of firms in the early periods of the data set due to this restriction. A consequence could thus be that we remove "young" firms in the early periods of the data set, making young firms underrepresented when we investigate the effects of zombie distortions.

Another drawback with our analysis is related to comparison to the OECD, which could be sensitive to differences in the data set and data cleaning. One of the important differences is related to the calculation of the change in capital stock. As we explained in the Data section, we have not been able to mechanically follow McGowan et al. (2017b) and Gal (2013), as Norwegian accounting standards does not distinguish between depreciation and amortisation. Neither is "change in capital stock" equivalent to investment ratio, which is the suggested measure in McGowan et al. (2017b). Our measure does not account for depreciation and amortisation, making it a simpler, but perhaps less precise measure. This could question the comparability against the OECD.

7.2 Policy Implications

There are different reasons why zombies are kept alive. During the financial crisis of 2007–2008, we saw large financial institutions being "too big to fail". This phenomenon describes the situation where the authorities fear the consequences of bankruptcy and therefore rather choose to save companies by providing grants or guarantees. Banerjee

and Hofmann (2018) argue that the overall shares of zombie firms in fourteen advanced economies have been increasing since the late 1980s and can be linked to reduced financial pressure, possibly affected by the low-interest rate environment of recent years. Reduced financial pressure might also have contributed to the presence of increased possibilities of financing for non-viable firms through roll over of debt, as the alternative use of capital for creditors yields low returns. The question regarding insolvency regimes is related to which parts of the responsibility of the zombie prevalence that can be reasoned to the design of the regimes. Loose regimes can lead to creditors increasing their risk in the hope of short-term profits and give low incentives to terminate bad debt.

Having an economy where, over a six-year period, ten to fifteen percent of the zombies endure as zombies, could lead us to believe that the insolvency regimes have weaknesses, as these zombies are kept alive. Since our results also indicate that increased capital sunk in zombies reduces employment and capital growth at the industry level amongst non-zombies, and that zombies probably create entry barriers for young, innovative firms, there should be incentives for policy makers to address the issue. Given that a reduced amount of resources sunk in zombies could increase growth opportunities for healthy firms, it could possibly be an important step in ensuring productivity growth.

Even though the indicators describing the Norwegian insolvency regime is characterised as medium to high compared to other OECD countries, there is probably room for improvement. The results presented in McGowan and Andrews (2018) show that Norwegian insolvency regimes have limited initiatives concerning prevention and streamlining measures, which includes early warning systems, pre-insolvency regimes, and special insolvency procedures for small and medium-sized enterprises (SMEs). Kapitaltilgangsutvalget (2018) recommends earlier possible initiation of restructuring negotiations as a preventive measure. In addition, they suggest to increase the reporting requirements in the aftermath of bankruptcies since this is important information about why firms fail.

Successfully implementing appropriate additional policy measures could further improve the economic environment, influence the prevalence and resources sunk in zombies, and possible distortions.

7.3 Suggestions for Further Research

The main effort of this masters thesis has been to identify zombies, their distortionary effects on healthy firms, as well as their characteristics. It has also included a brief policy discussion. We have the following suggestions on further research on the field of zombie firms in Norway.

As noted earlier, research on zombie firms has historically placed much of its focus on the channel of bank forbearance. This has not been the focus of this master thesis. However, a contribution to the research would be to investigate the zombie distortions using the definition in Caballero et al. (2008). It could be particularly interesting to examine the link between zombie firms and creditors; the existence of numerous local Norwegian savings banks could lead us to believe that this could be an interesting addition to existing research on the channel of bank forbearance.

An analysis of the features and consequences of insolvency regimes on the share and consequences on zombie firms could also be an interesting research topic. Changes in the insolvency regime throughout the data coverage period could be analysed against the zombie shares, spillovers and similar, to investigate whether they were effective and achieved the preferred outcome.

8 Conclusion

In this masters thesis, we have identified the presence of zombie firms in Norway, in addition to presenting an analysis of characteristics associated with being a zombie firm and possible distortionary effects on healthy firms. We have applied the definition suggested in McGowan et al. (2017b), where a firm is classified as a zombie if firm age is ten years or more, and it has an interest coverage ratio less than one for three consecutive years. The zombie prevalence has, similar to other countries in the OECD area, increased during the past years. While the share of zombies was about 0.97 percent in 1997, it was 2.12 percent in 2016, peaking at 3.44 percent in 2011. However, the trend is not obvious, and the zombie share has declined steadily since 2011. We find that a stable share of between roughly 15–20 percent of the zombies remain zombies after three years.

Only looking at size plots, we observe that there are more zombies amongst the companies with the highest share of employees. We also observe that there are big differences between industries concerning zombie shares and that the prevalence of zombies seems to increase with age. Our results suggest, using measures of size, age, financial structure, and ownership, that increased total assets reduce the likelihood of being a zombie amongst the smaller firms, but for the relatively big firms more total assets increases the likelihood of being a zombie. The results also suggest that increasing number of employees reduces the probability of being a zombie firm. In line with our hypothesis, we find that foreign owned firms have an increased probability of being a zombie firm.

An important question to answer is how resources sunk in zombies affect non-zombies. In particular, it is an important question for policy makers as it provides valuable information about the consequences of the zombie prevalence. We have therefore investigated whether the presence of zombie firms in Norway lowers employment or capital growth amongst non-zombies. We see indications that the zombies distort capital (real tangible assets) and employment growth within industries.

In addition, our results suggest that concerning capital growth, young firms are disproportionately affected of capital sunk in zombies in their industry. Assuming that the relevant labour market is the regional, this is also true for employment growth.

Overall, many of our results are in line with results from other countries in the OECD. We believe the distortions of zombies on healthy firms in Norway could be an important finding for policy makers, whilst ensuring continued economic growth in Norway in the years to come.

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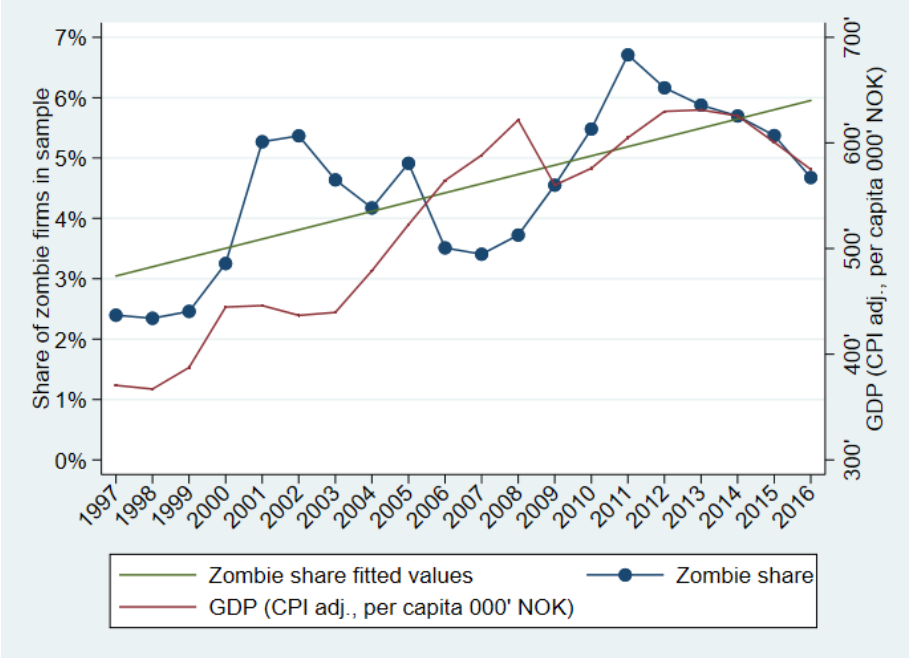
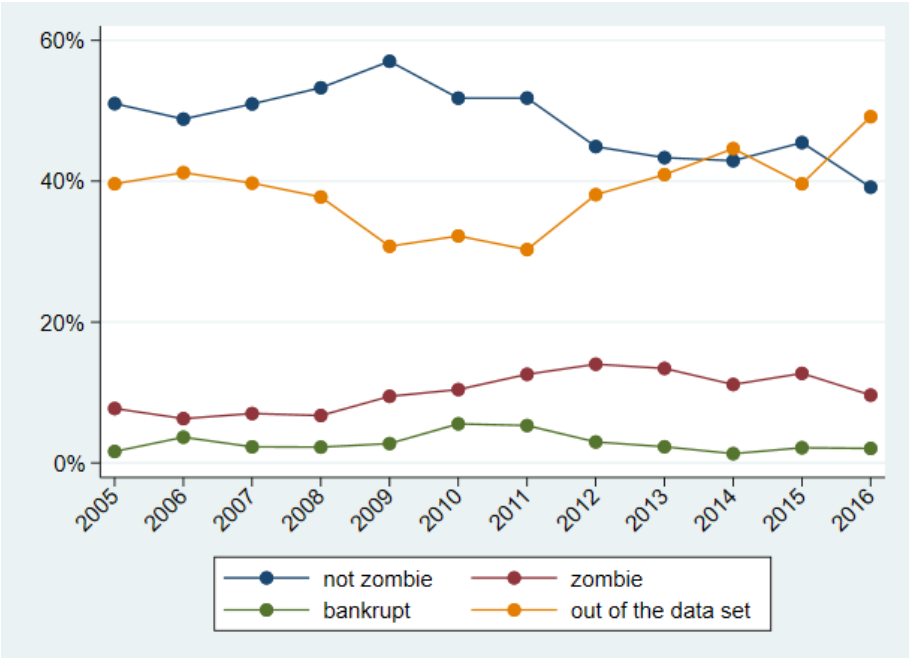
Appendix

Figure A0.1: The share of zombie firms in Norway (1997–2016) - All firms ≥ 10 years



Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

Figure A0.2: Firm classification six years after zombie classification



Note: The status at t_5 for firms which at t_0 were aged ≥ 10 years and had an interest coverage ratio < 1 over three consecutive years. I.e. the firm status six years after being classified as a zombie firm.
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

Table A0.1: Linear Probability Model - Determinants of Zombie Firms With Regions - Years 1999–2016

	(1)	(2)	(3)	(4)	(5)
log Employment	-0.00549***	-0.00663***			-0.00657***
	(0.0006)	(0.0014)			(0.0016)
(log(Employment))^2		0.00030			-0.00118***
		(0.0003)			(0.0004)
log Total Assets			0.00133***	-0.01336***	-0.01331***
			(0.0005)	(0.0023)	(0.0027)
(log(Total Assets))^2				0.00086***	0.00114***
				(0.0001)	(0.0002)
Total Debt / Total Assets	0.00004	0.00004	0.00004*	0.00002	0.00002
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Firm Age	0.00023***	0.00023***	0.00016**	0.00013**	0.00014**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Public Sector Ownership	0.00952	0.00917	0.00037	-0.00395	-0.00009
	(0.0100)	(0.0100)	(0.0100)	(0.0101)	(0.0101)
Foreign Ownership	0.01794***	0.01743***	0.00686**	0.00390	0.01131***
	(0.0034)	(0.0034)	(0.0035)	(0.0035)	(0.0035)
Year, region and industry fixed effects	YES	YES	YES	YES	YES
Observations	398,342	398,342	398,342	398,342	398,342
Adjusted R^2	0.012	0.012	0.011	0.012	0.013

	(6)	(7)	(8)
log Employment	-0.00655***	-0.00654***	-0.00660***
	(0.0016)	(0.0016)	(0.0016)
(log(Employment))^2	-0.00118***	-0.00118***	-0.00119***
	(0.0004)	(0.0004)	(0.0004)
log Total Assets	-0.01333***	-0.01346***	-0.01275***
	(0.0027)	(0.0027)	(0.0028)
(log(Total Assets))^2	0.00114***	0.00114***	0.00109***
	(0.0002)	(0.0002)	(0.0002)
Total Debt / Total Assets	0.00002	0.00002	0.00002
	(0.0000)	(0.0000)	(0.0000)
Firm Age	0.00014**	0.00014**	0.00013**
	(0.0001)	(0.0001)	(0.0001)
Public Sector Ownership	-0.00008	0.00017	0.00082
	(0.0101)	(0.0101)	(0.0102)
Foreign Ownership	0.01131***	0.01126***	0.01186***
	(0.0035)	(0.0035)	(0.0035)
Female General Manager	-0.00042		
	(0.0019)		
Female Chairperson		-0.00393**	
		(0.0019)	
Female Board Member Share			-0.00501**
			(0.0021)
Public Limited Company			0.02348
			(0.0168)
Year, region and industry fixed effects	YES	YES	YES
Observations	398,342	398,342	391,580
Adjusted R^2	0.013	0.013	0.013

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Zombie firm classification (IRCR < 1 for three consecutive years and firm age ≥ 10) is the dependent variable where "1" equals zombie firm. Each line reports variable coefficients with standard error in parenthesis and significance level symbolised by stars (*). Accounting Figures included in NOK '000 and CPI adjusted. Employment is the number of registered employees (*ansatte*). Total Assets is all assets of a firm (*sumeiend*). Total Debt / Total Assets is all interest bearing debt (average of *rgjeld_min* and *rgjeld_max*) divided by total assets (*sumeiend*). Firm Age is the age of firm defined as the accounting year minus year of incorporation (*stiftaar*). Public Sector Ownership is "1" if a firm has $>$ 50 % public sector ownership (*eierstruktur* = 5). Foreign Ownership is "1" if a firm is owned by foreigners (*eierstruktur* = 9). Female General Manager and Chairperson is "1" if the general manager/chairperson of a firm is a female (*daglsex* = "*K*" and *stledsex* = "*K*"). Female Board Member Share equals the number of females in the board of a firm (*st_kvimdl*) divided by the total number of board members (*st_medl*) in the same firm. Public Limited Company is "1" if the firm is this entity type (*selskf* = "*ASA*"). Standard errors are clustered at the firm level.

Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

Table A0.2: Linear Probability Model - Determinants of Zombie Firms Without Regions - Years 1999–2016

	(5-1)	(5-2)	(5-3)	(5-4)
log Employment	-0.00603***	-0.00603**	-0.00629***	-0.00629**
	(0.0011)	(0.0026)	(0.0012)	(0.0025)
$(\log(\text{Employment}))^2$	-0.00125***	-0.00125	-0.00122***	-0.00122
	(0.0003)	(0.0008)	(0.0003)	(0.0008)
log Total Assets	-0.01305***	-0.01305***	-0.01324***	-0.01324***
	(0.0017)	(0.0037)	(0.0017)	(0.0036)
$(\log(\text{Total Assets}))^2$	0.00112***	0.00112***	0.00113***	0.00113***
	(0.0001)	(0.0003)	(0.0001)	(0.0003)
Total Debt / Total Assets	0.00002	0.00002	0.00002	0.00002
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Firm Age	0.00014***	0.00014	0.00013***	0.00013
	(0.0000)	(0.0001)	(0.0000)	(0.0001)
Public Sector Ownership	0.00005	0.00005	-0.00045	-0.00045
	(0.0073)	(0.0067)	(0.0072)	(0.0067)
Foreign Ownership	0.01216***	0.01216*	0.01083***	0.01083*
	(0.0028)	(0.0062)	(0.0028)	(0.0061)
Fixed effects:				
Year-industry	YES	YES		
Year and industry			YES	YES
Clustered robust std.err:				
Year-industry	YES		YES	
Industry		YES		YES
Observations	401,831	401,831	401,854	401,854
Adjusted R^2	0.015	0.015	0.013	0.013

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Zombie firm classification (IRCR < 1 for three consecutive years and firm age ≥ 10) is the dependent variable where "1" equals zombie firm. Each line reports variable coefficients with standard error in parenthesis and significance level symbolised by stars (*). Accounting Figures included in NOK '000 and CPI adjusted. Employment is the number of registered employees (*ansatte*). Total Assets is all assets of a firm (*sumeiend*). Total Debt / Total Assets is all interest bearing debt (average of $rgjeld\_min$ and $rgjeld\_max$) divided by total assets (*sumeiend*). Firm Age is the age of firm defined as the accounting year minus year of incorporation ($stiftaar$). Public Sector Ownership is "1" if a firm has > 50 % public sector ownership ($eierstruktur = 5$). Foreign Ownership is "1" if a firm is owned by foreigners ($eierstruktur = 9$). Female General Manager and Chairperson is "1" if the general manager/chairperson of a firm is a female ($daglsex =$ "K" and $stledsex =$ "K"). Female Board Member Share equals the number of females in the board of a firm (st_kvimdl) divided by the total number of board members (st_medl) in the same firm.

Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

Table A0.3: Linear Probability Model - Determinants of Zombie Firms With Regions - Years 1999–2016

	(5-1)	(5-2)	(5-3)	(5-4)	(5-5)
log Employment	-0.00657***	-0.00657***	-0.00657***	-0.00657***	-0.00657**
	(0.0010)	(0.0020)	(0.0010)	(0.0012)	(0.0025)
$(\log(\text{Employment}))^2$	-0.00118***	-0.00118*	-0.00118***	-0.00118***	-0.00118
	(0.0002)	(0.0006)	(0.0002)	(0.0003)	(0.0008)
log Total Assets	-0.01331***	-0.01331***	-0.01331***	-0.01331***	-0.01331***
	(0.0015)	(0.0032)	(0.0015)	(0.0017)	(0.0036)
$(\log(\text{Total Assets}))^2$	0.00114***	0.00114***	0.00114***	0.00114***	0.00114***
	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0003)
Total Debt / Total Assets	0.00002	0.00002	0.00002	0.00002	0.00002
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Firm Age	0.00014***	0.00014*	0.00014***	0.00014***	0.00014
	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)
Public Sector Ownership	-0.00009	-0.00009	-0.00009	-0.00009	-0.00009
	(0.0064)	(0.0095)	(0.0073)	(0.0073)	(0.0068)
Foreign Ownership	0.01131***	0.01131**	0.01131***	0.01131***	0.01131*
	(0.0025)	(0.0051)	(0.0027)	(0.0028)	(0.0063)
Year, region and industry fixed effects	YES	YES	YES	YES	YES
Clustered robust std.err at:					
Year-region-industry	YES				
Region-industry		YES			
Year-region			YES		
Year-industry				YES	
Industry					YES
Observations	398,342	398,342	398,342	398,342	398,342
Adjusted R^2	0.013	0.013	0.013	0.013	0.013

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Zombie firm classification (IRCR < 1 for three consecutive years and firm age ≥ 10) is the dependent variable where "1" equals zombie firm. Each line reports variable coefficients with standard error in parenthesis and significance level symbolised by stars (*). Accounting Figures included in NOK '000 and CPI adjusted. Employment is the number of registered employees (*ansatte*). Total Assets is all assets of a firm (*sumeiend*). Total Debt / Total Assets is all interest bearing debt (average of $rgjeld\_min$ and $rgjeld\_max$) divided by total assets (*sumeiend*). Firm Age is the age of firm defined as the accounting year minus year of incorporation ($stiftaar$). Public Sector Ownership is "1" if a firm has > 50 % public sector ownership ($eierstruktur = 5$). Foreign Ownership is "1" if a firm is owned by foreigners ($eierstruktur = 9$).

Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

Table A0.4: Distortionary Effects: With Regions

	(1) dLog emp	
Variables	Coef.	std. err.
Non-zombie dummy$_{i,t}$	0.04914***	(0.003)
Non-zombie dummy$_{i,t}\times$ Industry zombie shares$_{r,s,t}$	-0.0893**	(0.034)
Age and size firm controls	YES	
Year-region-industry fixed effects	YES	
Observations	824,239	
Adjusted R^2	0.0695	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The table shows the distortionary effects on change in employment (dLog emp). $Non - zombiedummy_{i,t}$ is a dummy variable equal to one if a firm is classified as a non-zombie. $Zombieshares_{s,t}$ refer to the capital within the specific industry and region invested in zombie firms. Firm age and size (number of employees) act as firm controls. Fixed effects are included by an interaction term of year-region-industry, where region divides Norway into seven areas (*landsdel*) and industry follows NACE Rev.2 (*bransjek_07_2s*) codes 10–83, excluding 64–66. Robust standard errors are clustered at the same interaction as the fixed effects.
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

Table A0.5: Distortionary Effects: Without Regions - 4 years IRCR < 1 & firm age $\geq$ 10

	(1) dLog emp		(2) dLog cap	
Variables	Coef.	std. err.	Coef.	std. err.
Non-zombie dummy$_{i,t}$	0.05156***	(.0004)	0.12734***	(0.010)
Non-zombie dummy$_{i,t}\times$ Industry zombie shares$_{s,t}$	-0.19850	(0.123)	-0.74244***	(0.256)
Age and size firm controls	YES		YES	
Year-industry fixed effects	YES		YES	
Observations	832,282		634,664	
Adjusted R^2	0.0669		0.0068	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The table shows the distortionary effects on change in employment (dLog emp) and capital (dLog cap). $Non - zombiedummy_{i,t}$ is a dummy variable equal to one if a firm is classified as a non-zombie. $Zombieshares_{s,t}$ refer to the capital within the specific industry invested in zombie firms. Firm age and size (number of employees) act as firm controls. Fixed effects are included by an interaction term of year-industry, where industry follows NACE Rev.2 (*bransjek_07_2s*) codes 10–83, excluding 64–66.
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

Table A0.6: Distortionary Effects: Without Regions - 3 years IRCR < 1 & firm age $\geq$ 15

	(1) dLog emp		(2) dLog cap	
Variables	Coef.	std. err.	Coef.	std. err.
Non-zombie dummy$_{i,t}$	0.05116***	(0.004)	0.12020***	(0.009)
Non-zombie dummy$_{i,t}\times$ Industry zombie shares$_{s,t}$	0.11414	(0.091)	-0.64319***	(0.184)
Age and size firm controls	YES		YES	
Year-industry fixed effects	YES		YES	
Observations	832,282		634,664	
Adjusted R^2	0.0669		0.0068	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The table shows the distortionary effects on change in employment (dLog emp) and capital (dLog cap). $Non - zombiedummy_{i,t}$ is a dummy variable equal to one if a firm is classified as a non-zombie. $Zombieshares_{s,t}$ refer to the capital within the specific industry invested in zombie firms. Firm age and size (number of employees) act as firm controls. Fixed effects are included by an interaction term of year-industry, where industry follows NACE Rev.2 (*bransjek_07_2s*) codes 10–83, excluding 64–66. Robust standard errors are clustered at the same interaction as the fixed effects.
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.

Table A0.7: Distortionary Effects: Without Regions - 3 years IRCR < 1 & firm age $\geq$ 10 - Including Fishing and Aquaculture

	(1) dLog emp		(2) dLog cap	
Variables	Coef.	std. err.	Coef.	std. err.
Non-zombie dummy$_{i,t}$	0.05066***	(.003)	0.13189***	(0.008)
Non-zombie dummy$_{i,t}\times$ Industry zombie shares$_{s,t}$	-0.14762**	(0.061)	-0.41911***	(0.134)
Age and size firm controls	YES		YES	
Year-industry fixed effects	YES		YES	
Observations	837,842		639,868	
Adjusted R^2	0.0627		0.0072	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The table shows the distortionary effects on change in employment (dLog emp) and capital (dLog cap). $Non - zombiedummy_{i,t}$ is a dummy variable equal to one if a firm is classified as a non-zombie. $Zombieshares_{s,t}$ refer to the capital within the specific industry invested in zombie firms. Firm age and size (number of employees) act as firm controls. Fixed effects are included by an interaction term of year-industry, where industry follows NACE Rev.2 (*bransjek_07_2s*) codes 03 & 10–83, excluding 64–66.
Source: Our own calculations based on SNF's and NHH's database of accounting and company information for Norwegian companies.