



Staff memo

Zombie Firms in Sweden: Implications for the Real Economy and Financial Stability

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Abstract

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This paper investigates the phenomenon of zombie firms in Sweden using the universe of non-financial firms with limited liability (Aktiebolag) over the period 2002-2016. Following the definition of McGowan et al. (2018), this study shows that the percentage of zombie firms in the Swedish economy consistently decreased over the period 2010-2016. In 2016, only 3% of the total number of firms in the sample could be classified as zombie firms. Collectively, these firms absorbed less than 5% of the total amount lent by financial institutions to all non-financial firms in the same year. Importantly, zombie firms consistently decreased their exposure to financial institutions over the period 2010-2016 and, at the same time, received large contributions from their shareholders. This study also documents that the presence of zombie firms in an industry is mostly uncorrelated with growth in non-zombie firms. Finally, this paper illustrates that over the period when interest rates were consistently lowered, 2011-2016, the probability of a firm becoming a zombie firm did not dramatically increase. Over the same period, however, the probability of a firm being reclassified as a non-zombie firm did increase. Overall, my analysis shows that, in Sweden, zombie firms do not pose a significant threat to either financial stability or economic growth.

Keywords: zombie firms, low interest-rate environment, real economy and financial stability.

JEL classification: D22, D24, E43, G32.

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Abstract in Swedish

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Zombieföretag i Sverige: Betydelse för realekonomin och den finansiella stabiliteten

Synopsis: Denna studie undersöker förekomsten av zombieföretag i Sverige genom att använda hela populationen av icke-finansiella aktiebolag under perioden 2002-2016. Baserat på definitioner av McGowan med flera (2018), visar denna studie att andelen zombieföretag i den svenska ekonomin konsekvent har minskat under perioden 2010-2016. Endast 3 % av det totala antalet företag som undersöks klassificerades som zombieföretag år 2016. Under samma år stod dessa företag tillsammans för ca 5 % av svenska finansinstituts utlåning till icke-finansiella företag. Zombieföretagen har dock minskat sin upplåning från finansiella institutioner under perioden 2010-2016, och har samtidigt tagit in mycket kapital från sina aktieägare. Studien dokumenterar också att förekomsten av zombieföretag inom en viss bransch i de flesta fall är okorrelerad med tillväxten bland icke-zombieföretag inom samma bransch. Slutligen visar studien att sannolikheten för ett företag att klassificeras som ett zombieföretag inte ökade tydligt under perioden med varaktigt fallande räntor, 2011-2016. Under samma period ökade däremot sannolikheten för ett företag att behålla sin status som zombieföretag. Sammantaget visar min analys att zombieföretag i Sverige inte utgör ett betydande hot mot varken finansiell stabilitet eller ekonomisk tillväxt.

Nyckelord: Zombieföretag, låga räntor, realekonomi, finansiell stabilitet

JEL classification: D22, D24, E43, G32

1. Introduction

After the financial crisis in 2008, most central banks around the world, including the Swedish central bank, the Riksbank, lowered interest rates and engaged in large purchases of different assets¹ to support the economy and aid recovery. After more than a decade of stimuli, an intense debate about the real positive and negative effects of the conventional and unconventional monetary policy measures has ensued.

Notably, several economists have pointed out that in most of the developed countries, including Sweden, over the period 2007-2013, there has been a rise of economically weak firms. These firms struggled to repay the interest on their debt for several consecutive years and, in a competitive and well-functioning product market, should have ceased to exist but instead they stayed “alive.”

Commonly referred to as “zombie firms,” financially weak firms, by and large, have been associated with a slow-down in the productivity growth experienced by many developed economies (McGowan et al., 2018). Weak firms may also impair the effectiveness of policy tools aimed at helping economic recovery (Caballero et al., 2008; McGowan et al., 2018; Blattner et al., 2019; Acharya et al., 2019; Fukuda and Nakamura, 2011; Schivardi et al., 2017; Haldane, 2017) and can have important consequences for financial stability (Caballero et al., 2008; and Acharya et al., 2019).

Many studies on this subject have connected the existence of zombie firms to banks engaging in ever-greening of loans² (Caballero et al., 2008 and Acharya et al., 2019). Because this type of lending is done by financial intermediaries to keep unviable firms alive, and because mostly banks struggling to meet their capital requirements engage in this type of lending, this phenomenon is commonly referred to as “zombie lending.” Recently Banerjee and Hofmann (2018) point out that “zombie firms” might have been supported by the availability of cheap funding after the financial crisis in 2008, and in general relate the problem more to persistently low interest rates.³ They suggest that if interest rates had been kept much higher, economies all around the world would not have seen a surge in zombie firms⁴. Moreover, McGowan et al. (2017a) look at bankruptcy codes and argue that, in some countries, it is difficult and costly for companies to exit the market and that is why banks may keep them alive.

What this literature suggests is that zombie firms, and in general weak firms, are undoubtedly interesting for policy makers. For starters, the economic reason for their existence can highlight important problems both for the real economy and for the stability of financial markets. Secondly, the fact that they exist begs the question: what will be the consequences of them?

Given the evidence provided by existing studies and the current economic situation, understanding the evolution and economic importance of zombie firms in the Swedish economy is important not only to develop appropriate policy measures to support growth and productivity, but also to better understand the potential risks they pose to financial stability. Therefore, largely building on the existing work of McGowan et al. (2018), this study tries to paint an accurate picture of the zombie-firm phenomenon in Sweden over the period 2002-2016.

The first challenge that this study undertakes is to define what a zombie firm is. Depending on the question addressed and data availability, the empirical literature has introduced different

¹ The Riksbank only purchased government bonds.

² Bank forbearance or ever-greening refers to banks continuing to extend credit to some insolvent customers in the hope that they will recover and the bank may avoid realizing losses on nonperforming loans. For more details about this topic, please see Appendix A.

³ All else equal, low interest rates may help firms improve their interest coverage ratio because, keeping the amount fixed, they may be able to renegotiate a lower interest rate. However, Banerjee and Hoffman argue (but do not directly show) that firms instead increased the amount borrowed and thus many of them ended up as zombie firms.

⁴ Recently, Ulrich Bindseil and Jürgen Schaaf from the ECB have strongly disputed this argument: <https://voxeu.org/content/zombification-real-not-monetary-phenomenon-exorcising-bogeyman-low-interest-rates>.

methodologies to identify zombie firms.⁵ Given the nature and limitations of my data (see section 3 for details), I follow McGowan et al. (2018) and rely on firms' operating characteristics to identify zombie firms in my dataset.⁶

Accordingly, a firm is classified as a zombie firm if (1) its interest coverage ratio (earnings before interest and taxes over interest paid) has been below one for at least three consecutive years⁷ and (2) the firm is more than ten years old^{8,9}. Hence, zombie firms are companies that for several consecutive years are unable to service the cost of their debt from current profits but continue to be in business.¹⁰

This study utilizes data for the universe of limited liability firms (*aktiebolag* in Swedish) in Sweden over the period 2002-2016 and compares the results with those found by studies at the OECD and BIS. It describes the financial situation of these firms and provides some comparison with aggregate data from the National Accounts. This study also looks at profitability and productivity of zombie firms and, following Schivardi et al. (2017), investigates how zombie firms affect the input and output growth of non-zombie firms.

This paper also explores the two possible effects that low interest rates might have had on this phenomenon. On the one hand, low interest rates have supported demand for goods and services, and thus might have helped all firms, including zombie firms, to improve their profit margins. This would suggest that low interest rates might even have helped some firms to get out of the zombie state. On the other hand, low interest rates have also had relevant effects on the financing side of firms; while some firms might have been able to restructure their debt and improve their interest coverage ratios, other might have taken this opportunity to further increase their leverage. As a consequence, some of the firms might have fallen into the zombie state, despite a positive product market demand. I finally conclude my analysis by tracking the evolution of zombie firms over the period 2002-2016 to identify how many, by the end of 2016, had exited my sample or been reclassified as healthier firms. I also study how the probability of a firm becoming a zombie firm and of a zombie firm being reclassified as a non-zombie firm has changed over time.

The rest of the paper is organized as follows. Section 2 reviews the existing literature and describes how zombie firms are identified in the data. Section 3 discusses some of the shortcomings of the definition used to identify zombie firms in the data. Section 4 describes the data. Section 5 describes the evolution of zombie firms in Sweden. Section 6 looks at their financial strength, and Section 7 elaborates on the potential economic consequences. Section

⁵ Depending on the research questions, different methodologies to identify zombie firms have been employed. For more details about this topic, please see Appendix B.

⁶ The main scope of this paper is to understand and further investigate results shown by existing studies at the OECD and BIS. In order to allow comparability, I then rely on the same definition of zombie firms employed by those studies. However, being sceptical about the definition that empirically allows us to identify zombie firms is an important issue that this study also wants to highlight. To fully understand the phenomenon of zombie firms, one should look beyond a firm's accounting ratios. Hence, it is important to keep in mind that, while I will refer to these firms as zombie firms, their existence may not necessarily indicate either so-called zombie lending (i.e. weak banks lending to weak firms) or structural weaknesses in the financial markets. For now, a thorough discussion of potential reasons for why I observe these firms (or why I misclassify firms as zombie firms when they are not) in the Swedish economy is left for future analysis.

⁷ This methodology to classify firms was originally proposed by Bank of Korea (2013). Notice that the Bank of Korea doesn't use the term zombie firms in their study but instead refers to them as "marginal firms".

⁸ This additional criterion was proposed by McGowan et al. (2018) in order to avoid erroneously classifying start-ups as zombies. Nevertheless, focusing only on firms older than ten years may ignore younger firms that may also keep receiving financing even if insolvent. In robustness checks, I extend the definition of zombie firms to address this concern.

⁹ Notice that the recent paper of Banerjee and Hofmann (2018) focuses only on listed firms and adds to these two key variables an additional variable to capture a firm's investment opportunities. Specifically, a zombie firm classified according to their definition is a firm older than ten years that has had an interest coverage ratio below one for three consecutive years and has a Tobin's Q (calculated as the sum of the market value of equity and liabilities divided by the sum of the book value of equity and debt) that is below the median within their sector in any given year.

¹⁰ The reasons why these firms may not exit the market do not necessarily all point to a market failure. It may be that, despite the fact that they cannot organically pay the interest on their debt, these firms are still worthy borrowers and, therefore, banks and other financial institutions may still lend them money. For example, their problems may be only considered temporary (maybe related to a demand shock), or they can provide enough information (hard and soft) to reassure their financiers. In these cases, these firms could have taken different actions, for example: 1. they could have restructured the terms of their debt; 2. they could have reduced their exposure to financial institutions. 3. they could have received a fresh injection of capital from their shareholders. Nevertheless, the literature most commonly points to banks keeping zombie firms artificially alive to avoid (or at least defer) realizing immediate loan losses (Acharya et al. 2019). In this last scenario, one should observe a crowding-out of credit to productive firms, and distortions in market competition that will negatively affect non-zombie firms competing in the same industries (for the same inputs and outputs).

8 describes the potential link between low interest rates and the changes in the amount of zombie firms. Section 9 concludes.

2. Literature review

2.1 Why do we observe zombie firms?

To understand why zombie firms are important for both monetary policy and financial stability, one needs to ask why weak firms do not exit the market as they probably should. In general, weak firms thrive in poorly functioning markets, and several distortions can contribute to making the market place less competitive than it should be or impair firms' natural exit.

Some recent empirical evidence suggests that ineffective insolvency regimes are associated with the rise in zombie firms in many economies since they impair firms' exit (McGowan et al., 2017b; McGowan et al., 2017c). Other papers discuss financial constraints, and suggest that banks' lending to weak firms creates conditions for such firms to keep competing with more productive firms, even if they should have instead exited the market (Duval et al., 2020, Blattner et al., 2019; Storz et al., 2017; Schivardi et al., 2017; Acharya et al., 2019; Arrowsmith et al., 2013; Peek and Rosengren, 2005).

Government support to economic activity is also a relevant factor that may explain the rise in zombie firms. For example, Lam et al. (2017) show that, in China, there is a large number of zombie firms among state-owned firms, and Banerjee and Hofmann (2018) directly connect the rise in zombie firms in advanced economies after the financial crisis in 2008 with accommodative monetary policies.

2.2 How could zombie firms affect the economy and financial stability?

From a policy perspective, the potential reasons why I observe zombie firms in the economy are as important as the consequences of the existence of such firms. Despite being, on average, less productive than non-zombie firms, zombie firms crowd-out funds and absorb resources that could be allocated to healthier firms. This latter argument would suggest that the existence of zombie firms may impair the effort made by financial authorities to support economic recovery (Caballero et al., 2008, Acharya et al., 2019, McGowan et al., 2017a, Blattner et al., 2019). Nevertheless, several studies suggest that zombie firms are not necessarily bad for the economy.

Fukuda and Nakamura (2011) show that, in Japan, most of the zombie firms arising during the "lost decade" recovered by the turn of the century, suggesting that supporting them was not completely inefficient. Schivardi et al. (2017) show that, in Italy, the rise of zombie firms did not negatively affect the growth rate of healthier firms and thus their presence did not necessarily damage the economy. Finally, Haldane (2017) suggests that keeping zombie firms alive prevents an increase in unemployment and has the effect of mitigating aggregate demand externalities.

Other authors suggest that the losses of Total Factor Productivity (TFP) are mostly driven by the fact that credit frictions inefficiently affect the entry and exit of firms (Midrigan and Xu, 2014; and Yang, 2011). Different studies also document a large negative effect of resource misallocation on GDP and TFP growth after financial crises (Barnett et al., 2014; Di Nola, 2016).

Gopinath et al. (2017) document that, in southern Europe, after the drop in real interest rates following the introduction of the euro, resources were allocated to firms that had higher net worth but were not necessarily more productive. Finally, Gamberoni et al. (2016) show that before the Great Recession, restrictive bank lending, demand uncertainty and rigidities in the

product and labor market led to capital misallocations in five European countries, while the Great Recession helped regain some allocative efficiency of both capital and labor.

Given the discussion above, it should then appear clear that the existence of zombie firms is relevant from the perspective of both monetary policy and financial stability. To begin with, the concern from central banks is, of course, that the existence of these firms diverts resources away from more profitable firms, damaging the overall economy and squandering the effort to sustain economic growth when the economy slows down. Moreover, one can also wonder whether zombie firms survive longer because cheap funding is more readily available.

Yet again, the presence of zombie firms may not necessarily be damaging to the economy. First, it is not clear whether the presence of these firms has a negative effect on the growth of other firms within the same industry. Second, if these firms eventually recover or exit the market, keeping them alive may only incur limited costs for the rest of the economy. Importantly, the fact that they exist is not necessarily bad even during a downturn since, as explained above, keeping them alive may at least help support employment.

From a financial stability perspective, the main worry is the negative consequences that zombie lending may have for the financial system. If banks are highly exposed to zombie firms and these do not recover but rather start going bankrupt in large numbers, then banks risk incurring large losses that can spread to the entire financial system.

The general worry is that the availability of cheap financing might in the past have helped zombie firms to build up debt and survive for longer than otherwise expected. Given that, even with low interest rates, these firms do not generate enough earnings to pay the interest on their debt, if availability of credit keeps them artificially alive when interest rates start increasing, one could expect a spike in bankruptcies among these firms.

Finally, it may be that not just banks are exposed to these firms. Because of low interest rates, (bank and non-bank) financial institutions have searched for yields in different ways (Becker and Ivashina, 2015; among others). One cannot exclude the possibility of these institutions also exposing themselves to securities issued (both shares and bonds) by zombie firms since these should bear larger returns than less risky securities. Again, if this is true, then an increase in the bankruptcy rate among these firms may spread financial risk in the system.

3. Potential biases in the identification of zombie firms

While the economics behind the existence of zombie firms is straightforward, identifying them in the data is quite challenging. Whereas some studies try to use data that allow a direct link between weak firms and weak banks, many other existing studies classify zombie firms using ratios based on accounting data only. In the latter case, any bias that affects the input variables used to classify firms also induces a bias (over-estimation/under-estimation) in the number of firms classified as zombie firms. This bias could be small or large depending on the definition used, on the quality of the data employed and on the country analyzed. Such a bias may be introduced, for example, by the extensive use of tax optimization schemes.

As mentioned before, following McGowan et al., 2018, I identify zombie firms using a firm's interest coverage ratio calculated as earnings before interest and taxes (EBIT) divided by interest paid. This suggests that, all else equal and keeping debt constant, any scheme that helps a firm to reduce its taxable earnings over several consecutive years will increase the probability of such a firm being classified as a zombie firm. Since the accounting data used in this and any other study are self-reported by the firms to the tax authorities, the possibility of such bias cannot be completely ruled out.

The use of several tax optimization schemes is quite well-documented among Swedish firms.¹¹ Swedish firms have been optimizing their tax bill by creating groups to move taxable income to more favorable tax jurisdictions. While moving profits to tax-friendly locations is quite a common practice around the world, the Swedish system allows some interesting additional practices such as the use of *räntesnurror*¹², for example. This practice had become so widely used and controversial that the law was changed in 2009 making its use much less attractive.

For this study, two more schemes are also important to mention: the closely held private firms set up with the 3:12-rules,¹³ and the participation exemption rule that gives a tax exemption to Swedish resident corporates on gains obtained on shares held for business reasons.¹⁴ For example, because of this latter rule, a firm in the real estate or construction industry, even a retail firm owning warehouses, may register each building they own as an independent subsidiary to avoid future taxes on the sale of such units.

For this study, the use of the rules described above (among others) has different implications. For example, in the case of the participation exemption rule, where each subsidiary has no income or zero sales, and depending on how financing is obtained, such subsidiaries may have large interest-bearing liabilities making them likely to be mistaken for zombie firms. The same is true for firms set up with the 3:12 rule and all the subsidiaries belonging to groups registered in other countries that employ or do not employ the practice of *räntesnurror*. Unfortunately, I do not have the data to further study whether the use of tax optimization schemes is associated with zombie firms, but overall it is important to keep in mind how these may bias the results found in this and other studies.¹⁵

4. Data

For this study I use the *unidentified*¹⁶ Serrano database by Bisnode. This database contains detailed financial statement information for all Swedish limited liability companies (AB) that have reported to the Swedish Companies Registration Agency (Bolagsverket) over the period 2002-2016.

Accounting items include total workforce, total assets, profits and losses (earnings before interest and taxes), interest paid every year and value added. I also know the registration date of each firm and whether it belongs to a group or not. I employ 2017 SNI industry codes to identify the industry to which each firm belongs and to identify non-financial firms.

To be able to have a robust analysis and to ensure data quality¹⁷, I follow the methodology employed by Kalemli-Ozcan et al. (2015) as closely as possible. Therefore, I drop company-years with (joint) missing information on all of the following variables: total assets and operating revenue, sales and workforce, and equity. I check that there is no company that only

¹¹ For an overview of the topic and more specific definitions, please see Lodin, Lindencrona, Melz, Silfverberg, Simon-Almendal (2019).

¹² Companies employing the practice of *räntesnurror* are firms registered in countries with favourable tax systems that lend (at a high interest rate) to companies registered for tax purposes in Sweden. For a detailed description of these practices, see Bjurman and Brohlin (2012). Also see: <https://www4.skatteverket.se/rattsligvagledning/323746.html>.

¹³ This rule allows the owners of the closely held firm to pay themselves a dividend rather than income. For more details: <https://www.skatteverket.se/foretagochorganisationer/drivaforetag/famansforetag/reglerforfamansforetagensoversikt.4.41f1c61d16193087d7f4d82.html>.

¹⁴ For more details see for example:

<https://taxsummaries.pwc.com/sweden/corporate/income-determination>;

<https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Tax/dttl-tax-swedenhighlights-2020.pdf>.

¹⁵ Importantly, even if only a small proportion of the zombie firms in this study employ tax optimization schemes, this would suggest that the actual amount of zombie firms may be even smaller than the number I found. Moreover, it is important to highlight that part of the Swedish tax code has been modified in the last decade resulting in stricter rules and reducing the tax benefits of certain type of schemes. Some of these changes happened at the same time as interest rates were being cut, hence, I cannot exclude the possibility that some of my findings over the period 2010-2016 could also be driven by changes in the tax code and not only by a better economic climate or lower interest rates.

¹⁶ The dataset is anonymized. Each company in the dataset has a fake identification number that cannot be matched with other sources of data and does not allow the company name to be identified.

¹⁷ Note that Kalemli-Ozcan et al. 2018 employ Orbis data not Serrano data in their analysis. However, their methodology to insure data quality is consistent and can be easily applied to Serrano.

reports negative total assets or negative number of employees or negative sales or negative tangible fixed assets (such as buildings, machinery, etc.) in any year.

In addition to the screenings above, I also keep firm-year observations for which the firms have reported 12 months of accounting data to avoid using data processed by Bisnode. I then start with an original number of firm-year observation of 6,098,190 and after keeping only firms with 12 months of accounting records, I am left with a total of 5,383,792 firm-year observations.

While no company in the Serrano data reports negative total assets or employees, many firms do report zero sales and a few report negative sales. While young firms may well start out with zero sales, I assume it is impossible for an older company never to make a sale. Therefore, I drop all companies with negative sales and those with zero sales over their entire life in the data and older than five years. This additional step leaves us with a total of 4,869,975 firm-year observations.¹⁸

5. The evolution of zombie firms in Sweden

In this section, I start my empirical exploration of the zombie firm phenomenon. First, I classify all firms in my dataset as either zombie firms or non-zombie firms. Then, I look at how the number of zombie firms and their economic importance (captured by how the amount of assets and employees) has changed over time over the period 2002-2016. In this analysis, I follow McGowan et al. (2018) as closely as possible so that I can draw some comparisons with their results about Sweden.

I start by classifying firms. Regardless of whether they belong to a group or not, I begin by considering all firms as standalone and employ the definition of McGowan et al. (2018) to categorize the *zombie firms* in the data. I identify a zombie firm as an old firm (ten years or older since incorporation) that, for three consecutive years, has been unable to make enough earnings to pay interest expenses on its outstanding debt.¹⁹

I capture a firm's ability to repay its interest expenses using the ratio between its profits before interest and taxes (EBIT)^{20,21} and interest expenses every year (the firm's interest coverage ratio, henceforth ICR).

Importantly, companies in the Serrano database often report missing data or zeros for interest expenses while their debt outstanding is different from zero. Therefore, the company may end up with a missing ICR. To minimize data loss for this key variable, I follow Gouveia and Osterhold (2018) and interpolate the ICR for companies with ICR in year t-1 and t+1 but missing in year t.

Once the ICR is calculated, I define a set of firms as *zombie firms* but I also identify two additional set of companies. First, *non-zombie* firms which are all firms that cannot be classified as zombie firms and for which I have non-missing information on both profits before interest and taxes (EBIT) and interest expenses. Second, I categorize as *non-classifiable firms*²² those

¹⁸ Consistent with the most common practices, I winsorize all of the relevant variables at the 5% level by year and sector.

¹⁹ A natural question is why these firms are not forced into bankruptcy. While I do not have enough data to investigate this question, I refer to existing studies suggesting that these firms do not enter bankruptcy proceedings because of ineffective bankruptcy codes (McGowan et al. (2017a)) and, because banks try to keep them alive (see literature on bank ever-greening led by Caballero al. 2008).

²⁰ If the firm belongs to a group, this variable is calculated using "external interest" which is the interest the firm pays on the debt obtained from financial institutions not belonging to the group.

²¹ The interest coverage ratio measures a firm's ability to pay interest expenses on its outstanding liabilities, while a firm's leverage measures the company's ability to meet obligations over the long run. Importantly, to calculate the interest coverage ratio, some studies use EBITDA, which is earnings before interest, taxes, depreciation (of physical assets) and amortization (of intangible assets), rather than EBIT, which captures earnings before interest and taxes. EBITDA represent the revenues left in a firm after paying labour and intermediaries, while EBIT is what is left not only after paying labour and intermediaries but also after re-placing capital. Hence, when I calculate the interest coverage ratio as earnings before interest and taxes over interest expenses, I assume that the firm will also use the money that should be used to replace worn assets to meet its interest payments. Since most firms cannot compete effectively without replacing worn assets, using EBIT suggests a more severe scenario than using EBITDA.

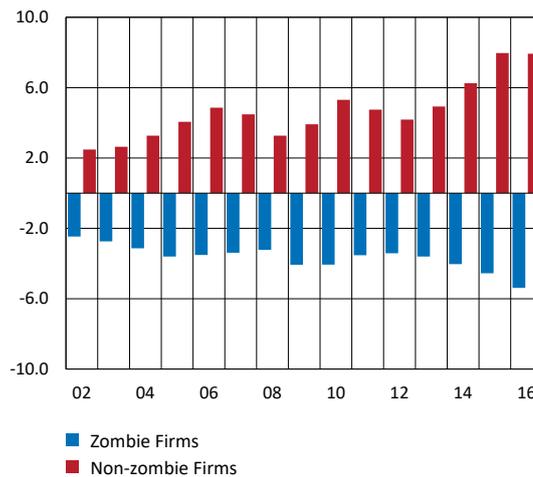
²² The fact that these firms cannot be classified does not mean that they are of no interest to policy makers. However, since this study focuses on zombie firms, I will disregard them.

firms that, because of missing data, cannot be classified as either zombie firms or non-zombie firms.

Figure 1 shows the median interest coverage ratio (ICR)²³ each year over the period 2002-2016 for companies that are classified as zombie firms and non-zombie firms, respectively. As expected, because it is defined using this characteristic, even before taxes, the median zombie firm has a hard time producing profits to meet its interest payments. Looking at Figure 1, over the sample, the median ICR for zombie firms is -3.69 (unreported), which suggests that the median zombie firm in the sample makes losses almost four times larger than the interest on its outstanding debt. On the other hand, non-zombie firms look quite healthy with a median interest coverage ratio of 4 over the sample period. This latter number suggests that the median non-zombie firm would have been able to repay the interest on its outstanding debt four times over just by using its profits before taxes. I also use age to identify zombie firms (they must be ten years or older from registration). Looking at statistics for this characteristic (not reported here), I see that the average zombie firm is about 23 years old while the average non-zombie firm has been registered for about 14 years. This suggests that zombie firms tend to be some of the oldest firms in the sample.

Figure 1. Median interest coverage ratio (ICR)

Number



Note. The Figure reports the median interest coverage ratio (ICR) for the zombie (blue bars) and non-zombie (red bars) firms in the sample over the period 2002-2016. The interest coverage ratio is calculated as the ratio between a firm's earnings before interest and taxes (EBIT) and interest expenses. An ICR above one indicates that the firm can cover its interest expenses in full just relying on its operating income. An ICR between zero and one suggests that the firm does not generate enough earnings to cover all of the interest payments due on its debt outstanding. A negative ICR means that the firm generates losses much bigger than the amount of interest to be paid.

In order to understand whether zombie firms are very different from non-zombie firms, I look at other firm characteristics that have not been used to classify them. Statistics on these characteristics show that the median zombie firm appears to be smaller than the median non-zombie firm, both in terms of assets and number of employees. The median zombie firm also has less tangible fixed assets than the median non-zombie firm, but its leverage is about the same.²⁴ Moreover, consistent with the existing findings, zombie firms are much less profitable (ROA) and productive (Value Added per Employee) than non-zombie firms.

It is also interesting to notice that, on average, a zombie firm is classified as such for almost three consecutive years. This suggests that such a firm has not been generating enough profits

²³ As is common in this literature, I report the median interest coverage ratio. This is due to the fact that the average interest coverage ratio in the distribution is affected by extreme outliers. The median interest coverage ratio is instead the ICR of the firm exactly in the middle of the distribution and is therefore not affected by outliers.

²⁴ Results are unchanged if I compare the average zombie firm with the average non-zombie firm. I report the medians rather than the averages for consistency with the statistics in the previous paragraph.

to fully meet its interest payments for at least five consecutive years.²⁵ Interestingly, in Section 7, I will show that after a period as zombie firms, most firms either exit my sample or are reclassified as non-zombie firms. This suggests that keeping track of zombie firms in the economy is important to improve understanding of the real economy and its dynamics.

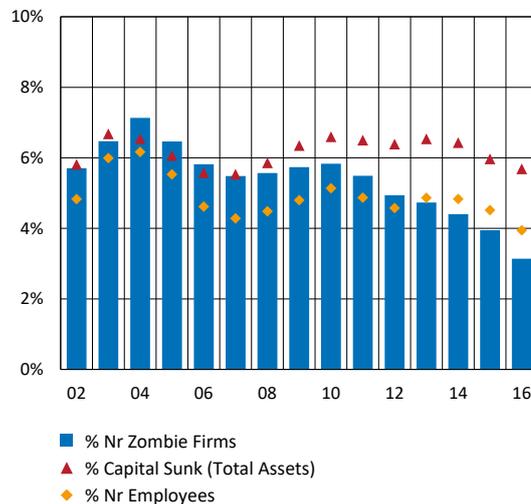
Consistent with the findings above, I document that, over the sample period, the probability of a firm classified as a zombie firm in year t being again classified as a zombie firm in year $t+1$ is above 60%. This statistic illustrates that once a firm enters the zombie state, it has a hard time getting back on its feet.

Next, Figure 2 shows how the number and economic significance of zombie firms have changed over time in Sweden. The figure contains four panels. Figure 2.a describes the evolution of zombie firms in the economy, while Figure 2.b and Figure 2.c focus on size quintiles and illustrate the number and economic significance of zombie firms among the smallest and largest firms in the economy, respectively.

Each figure shows three different variables of interest: the percent of zombie firms, the percentage of capital (total assets) and the percentage of employees absorbed by zombie firms. The percentage of zombie firms is calculated as the number of zombie firms divided by the total number of firms (zombie firms, non-zombie firms and non-classifiable firms) in the economy any given year. The percentage of capital sunk into zombie firms is calculated as the total amount of total assets collected in zombie firms divided by the total amount of total assets in all firms in any given year. The percentage of employees absorbed by zombie firms is calculated as the total number of employees in zombie firms divided by the total number of employees in all firms in my dataset each year.

Figure 2a. Zombie firms in Sweden

Per cent



Note. This Figure shows the evolution of zombie firms over the period 2002-2016. A firm is classified as a zombie firm if it is at least 10 years old (from registration year) and has had an interest coverage ratio below one for, at least, three consecutive years. The blue bars represent the percentage of firms that are classified as zombie firms each year. The yellow squares capture the percentage of employees employed by zombie firms. The red triangles depict the percentage amount of total assets that are accumulated in zombie firms.

The blue bars in Figure 2.a show several important facts. First, zombie firms in Sweden, as in the rest of the world, are not new. They existed long before the financial crisis of 2008 struck. In numbers, the percentage of zombie firms in the economy increased in the period immediately after the burst of the dot-com bubble, reaching a peak in 2004 of around 7%.

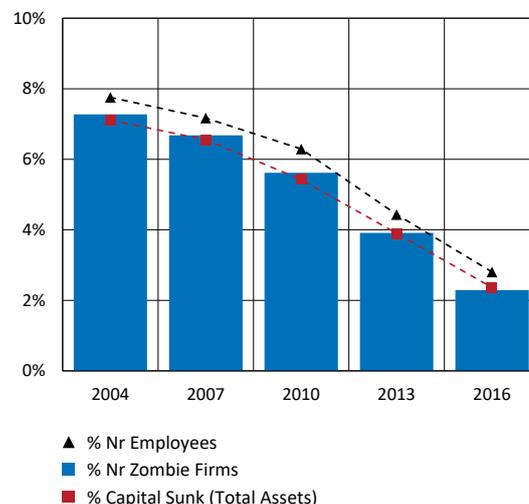
²⁵ A firm (at least 10 years old) is classified as a zombie firm after three years of its interest coverage ratio (ICR) being below one. Assume that the firm is classified in year t , this means that its ICR has been below 1 in year $t-2$, $t-1$ and t . Now, if a zombie firm is in this state for at least three consecutive year, including the year it is classified as a zombie firm, then the firm has had a ICR below 1 from $t-2$, $t-1$, t , $t+1$ and $t+2$ - a total of five years.

Thereafter, Figure 2.a shows a small decline in zombie firms and illustrates that, from 2006 till 2010, the percentage of zombie firms in the economy was stable at around 6%. Then there was a sharper and continuous decline from 2011 to 2016, when the number of zombie firms reached its minimum of around 3%.

If I look at the economic significance of zombie firms, starting in 2007, I notice a slightly different pattern than the one I just described. The total amount of capital sunk into zombie firms (the red triangles in the figure) first increased between 2007 and 2010, then remained almost constant up to 2014, whereupon it started to decrease back down to a similar level as in 2002 (about 6%). A similar pattern also appears when I compare the number of employees (the yellow dots in the figure).

Next, I compare the patterns highlighted in this study with the results about Sweden described in McGowan et al. (2017a)²⁶. McGowan et al. (2017a) use ORBIS data²⁷ to study the evolution of zombie firms in several developed economies between 2005 and 2013. The results most relevant to Sweden are included in Figure 5, on page 17. This figure shows (size-weighted) statistics for the number and economic importance of zombie firms between 2007 and 2013, and shows that, both in numbers and economic power, zombie firms have increased after the financial crisis. My Figure 2.a shows instead that there has been a decrease in the number and economic power of zombie firms in Sweden. The main difference between the two figures is that the figure in this study shows simple statistics, not size-weighted. Therefore, I further investigate the importance of firm size in the next section where Figure 2.b and Figure 2.c show results for firms that are classified based on their size.

Figure 2.b. Zombie firms in Sweden, small firms category
Per cent



Note. Figure shows the evolution of small zombie firms over the period 2002-2016. Each year, firms are classified in size quintiles using the total assets reported at the end of the year. Small firms belong to the first quintile of the distribution of total assets. A firm is classified as a zombie firm if it is at least 10 years old (from registration year) and has had an interest coverage ratio below one for, at least, three consecutive years. The blue bars represent the percent number of firms that each year are classified as zombie firms. The black dotted line captures the percentage number of employees employed by zombie firms. The red dotted line depicts the percentage amount of total assets accumulated in zombie firms.

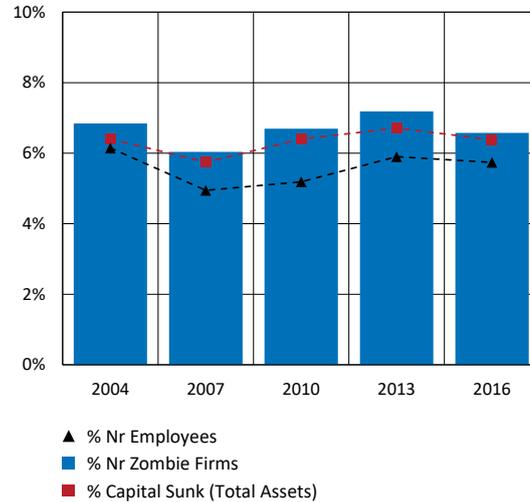
At the end of each year, I classify all firms in five size quintiles based on total assets. For the sake of space, I am only showing results for the first and fifth quintile. The first quintile contains the smallest firms in terms of assets, while the fifth quintile collects the largest ones. Figure 2.b

²⁶ This study is now published in the journal "Economic Policy," but since I do not have access to the published version, I will refer to the older version to discuss results relevant for the Swedish case.

²⁷ Wordscope data (Orbis and Amadeus) is a harmonized worldwide (150 million+ companies in 90+ countries) dataset. AMADEUS is the European subset of ORBIS (from 1996-). Collected from official business registers, annual reports, newswires, and webpages. It contains ownership data and can largely be matched with bank-level data.

shows the economic significance of zombie firms within the group of the smallest firms in the economy (the average total asset for these firms is about 0.18 million Swedish kronor).

Figure 2.c. Zombie firms in Sweden, large firms category
Per cent



Note. This Figure shows the evolution of large zombie firms over the period 2002-2016. Each year, firms are classified in size quintiles using the total assets reported at the end of the year. Large firms belong to the fifth quintile of the distribution of total assets. A firm is classified as a zombie firm if it is at least 10 years old (from registration year) and has had a interest coverage ratio below one for, at least, three consecutive years. The blue bars represent the percent number of firms that each year are classified as zombie firms. The black dotted line captures the percentage number of employees employed by zombie firms. The red dotted line depicts the percentage amount of total assets accumulated in zombie firms.

Figure 2.c illustrates the evolution and economic significance of zombie firms in the group belonging to the largest quintile (the average total asset for these firms is about 30 million Swedish kronor). From Figure 2.b, it immediately appears that in the quintile of the smallest firms (quintile one) in each industry, there has been a substantial decrease in both the number and economic significance of zombie firms. The number of zombie firms between 2004 and 2013 decreased by almost five percentage points, moving from about 7% to about 2%. Similar patterns can be observed in the amount of total assets and employees absorbed in these firms. Importantly though, Figure 2.c shows that while the general trend in the economy is for zombie firms to decrease in magnitude, if one zooms in on the largest firms in the economy, the picture is quite different.

Between 2007 and 2013, the number of zombie firms within the group of largest firms in the economy did indeed increase, even if only marginally, but then the number dropped slightly between 2013 and 2016. This would suggest that, while small firms in the economy may struggle to get financing when insolvent, large firms may have more power at the contracting table and/or less financial constraints, and this may allow them to survive longer even if insolvent.

Importantly, between 2005 and 2013, my study suggests similar results to those presented by McGowan et al. (2017a) once I distinguish firms by size and focus on the largest firms in the economy. Nevertheless, the Swedish economy is more than its largest firms, so I will continue investigating all the firms in the economy while keeping in mind the issue of size when discussing policy implications.

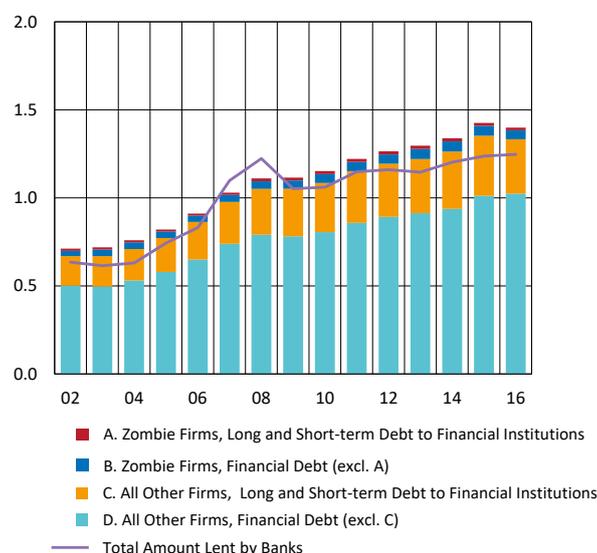
To conclude, Figure 2.a and Figure 2.b show that the number of zombie firms has decreased in recent years in Sweden, especially among small firms. However, Figure 2.a suggests that overall, their economic power (assets-wise) has not significantly decreased with respect to the period right before the crisis. Nevertheless, this suggests that there is probably no, or very low,

correlation between the policies implemented after the financial crisis and the rise of zombie firms, as also suggested by Bindseil and Schaaf (2020).

6. Zombie firms and financial institutions

In this section, I describe how my data compares with the aggregated data provided by the National Accounts (Statistics Sweden). I then proceed by illustrating zombie firms' debt exposure to financial institutions, and how this exposure has changed over time. To begin with, Figure 3 compares the total amount of debt in zombie firms (broken down into debt to financial institutions and other debt) with respect to the total amount lent by (Swedish and non-Swedish) banks to Swedish non-financial corporates as reported by Statistics Sweden at the end of every year (fourth quarter).

Figure 3. Debt in Swedish firms w.r.t. the total amount lent by banks
Trillion SEK



Note. This Figure shows the total amount of debt in zombie firms and the total amount lent by (Swedish and non-Swedish) banks to Swedish non-financial corporates as reported by Statistics Sweden at the end of every year (fourth quarter). I calculate a firm's financial debt as the sum of all long-term debt (excluding "other non-current liabilities") and all short-term loans. For each year, I add up the variable financial debt for all of the firms reporting that year. I then break this figure down in several pieces. The red portion of each bar reports the amount of debt, both with long and short-term maturity, that zombie firms report as debt to financial institutions. The blue portion of each bar illustrates the part of the financial debt that zombie firms do not explicitly report as debt to financial institutions. The orange portion of each bar reports the amount of debt to financial institutions, both with long and short-term maturity, reported in a given year by all firms not classified as zombie firms. The clear blue portion of each bar illustrates the part of the financial debt that all firms not classified as zombie firms do not explicitly report as debt to financial institutions.

Although from Serrano I do not know either what institutions are actually lending to firms or whether the lending institutions are registered in Sweden, this figure helps us better understand the quality of the data.

Figure 3 shows several variables. First, it reports the total amount of long-term and short-term debt to financial institutions in zombie firms (the red portion of each bar). Then, it shows the total amount of financial debt,²⁸ excluding debt to financial institutions, in zombie firms (the dark blue part of each bar). Next, it illustrates the total amount of long-term and short-term debt to financial institutions in all non-zombie firms (the orange part of each bar). Finally, it

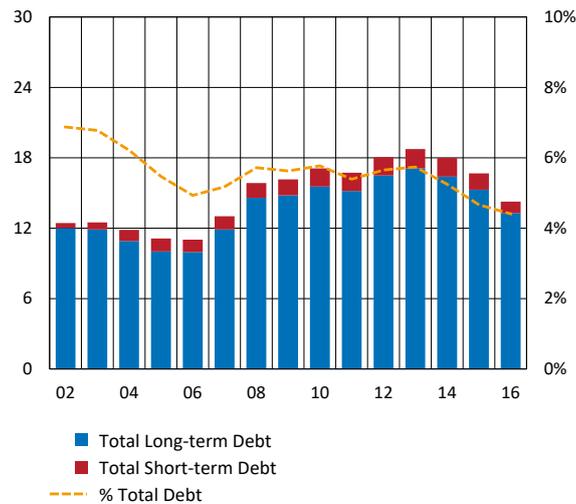
²⁸Total financial debt is calculated as long-term debt (excluding other non-current liabilities) plus all short-term loans. This includes not only debt to banks and other financial institutions but also non-current liabilities or long-term liabilities which are debts or obligations due in more than one year. These type of liabilities usually include bonds payable, long-term notes payable, deferred tax liabilities and capital leases.

shows the total amount of financial debt, excluding debt to financial institutions, in all non-zombie firms (the clear blue part of each bar). Finally, the violet line reports the total amount of lending from Swedish and non-Swedish banks to non-financial corporates as reported by the National Accounts.

While Figure 3 purely has the purpose to illustrate the data, and thus should be interpreted and used carefully, Figure 4 aims at gauging more directly the importance of zombie firms for the financial system.

Figure 4. Financial institutions' debt in zombie firms

Billion SEK, per cent



Note. Figure 4 shows the total amount borrowed by zombie firms from financial institutions. The bars represent the total nominal amount of debt outstanding in SEK billion and are reported on the left axis of the graph. Each bar is composed of two parts. The blue part refers to the total long-term amount of debt. The red portion of each bar captures the short-term part of the total amount of debt outstanding. The right axis of the graphs captures instead the percentage amount of debt in zombie firms with respect to all debt reported in each given year by all of the firms in the dataset.

Figure 4 zooms in on zombie firms and shows how much these have been borrowing from financial institutions²⁹ over the years. The graph shows three variables: a. The total nominal amount of SEK reported from the firms as long-term debt; b. the total nominal amount of SEK reported from the firms as short-term debt and c. the percentage of total outstanding debt in zombie firms with respect to the total outstanding debt that all firms in the data report as borrowed from financial institutions.

Figure 4 shows that zombie firms mostly finance themselves with long-term debt which is surprising given that these firms are small and almost bankrupt.³⁰ It also shows that while the total nominal amount borrowed by zombie firms increased between 2007 and 2013, their relative borrowing stayed quite constant over this period. Interestingly, the total amount borrowed by zombie firms decreased substantially between 2013 and 2016, both in relative and absolute terms. This dynamic is consistent with the previous decrease in the number of zombie firms between 2013 and 2016. Nevertheless, at the end of the year 2016, more than 4% (circa SEK 15 billion) of the credit given by financial institutions to Swedish firms in my sample went to zombie firms. Importantly, unreported statistics show that on average almost 78% of all lending to zombie firms is concentrated in the largest ones in each industry.

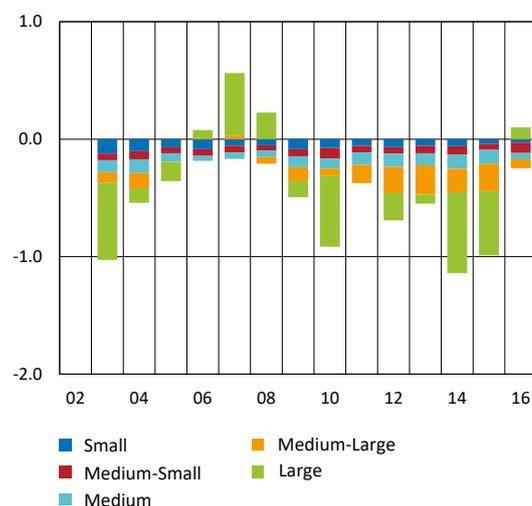
²⁹ Notice that I do not know whether these institutions are all banks. I also do not know whether they are domestic or foreign institutions.

³⁰ One should note that these are all bonds with maturities longer than one year. I know neither when the firm initiated the debt contract, nor the original maturity of the debt, nor the remaining time to maturity. Hence, it is possible that debt was locked before revenues from operations gave signs of any potential distress.

Next, I try to understand how debt has changed among zombie firms. I report these results in Figure 5. The figure shows how the debt to financial institutions changed over time among zombie firms, and breaks down this change by firm size.

Figure 5. Year-on-year change in debt to financial institutions, zombie firms by size

Billion SEK



Note. This picture shows the aggregated year on year change in debt owed by zombie firms to financial institutions. For each year t , I calculated the total nominal amount of debt to financial institutions accumulated by zombie firms. Each bar then reports the change in the total amount obtained as the difference between the total nominal amount of debt to financial institutions accumulated by zombie firms in year t with respect to year $t-1$. Each bar is divided further in 5 parts. Each part captures a different group of zombie firms divided based on size. To divide firms in size categories, I divide all firms in the sample in quintiles based on total assets each year. The blue portion of each bar depicts the smallest firms (those in the bottom quintile of the size distribution). The red portion of each bar represents the medium-to-small firms in the distribution (those in the second quintile of the size distribution). The light blue portion of each bar captures the medium firms in the distribution (those in the third quintile of the size distribution). The orange portion of each bar represents the medium firms in the distribution (those in the fourth quintile of the size distribution). The green portion of each bar depicts the large firms in the distribution (those in the fifth quintile of the size distribution).

Each bar in Figure 5 shows the total nominal change in debt to financial institutions between the current year (year t) and the previous year ($t-1$). The figure shows that after the financial crisis, zombie firms have largely diminished their exposure to financial institutions. This could be the result of these firms not taking on more debt, or repaying their existing debts, so that the total debt has decreased. Of course, one cannot exclude that part of the result is also driven by zombie firms' exit, as confirmed by Figure 3, since most of the exits occurred among smaller firms. To investigate this issue, Figure 5 also shows the total change in debt to financial institutions broken down by firm size. If the results are only driven by smaller firms leaving the sub-sample of zombie firms, then one should not see any big change in the exposure of large firms. This does not seem to be the case since Figure 5 shows a clear decreasing path also among large firms (depicted in green).

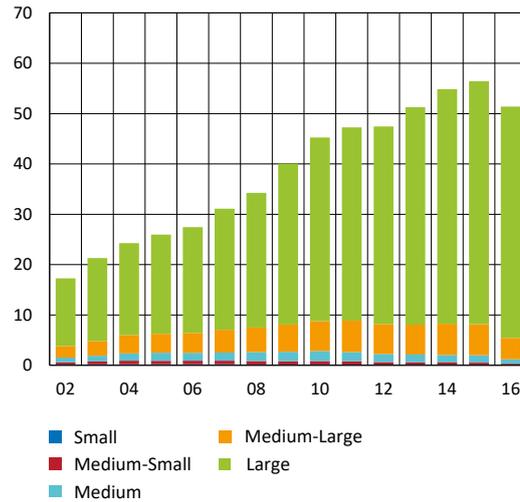
Overall, Figure 5 confirms that the exposure of financial institutions to zombie firms clearly decreased over the period 2008-2016. Unreported results also confirm that, even if largely driven by a reduction in debt to financial institutions, the overall financial exposure of zombie firms decreased over the period 2010-2016. This further confirms that zombie firms can hardly be interpreted as the result of the availability of cheap funds.

I next look at how zombie firms can continue borrowing despite the fact that they do not produce enough earnings to repay the interest of the accumulated debt. Excluding for the moment banks' willingness to keep these firms financed to avoid acknowledging potential losses, I look into the total equity invested in these firms (Figure 6.a) and into shareholders' direct contributions (Figure 6.b).

Figure 6.a reports the collective amount of total equity reported by all firms classified as zombie firms each year from 2002 to 2016. To compile this figure, I use the variable Total Equity as reported in Serrano. This variable refers to the capital that the owners have invested in the business in the form of share capital at the time the business was instituted and at the time of new share issues, and to accumulated retained earning profits minus dividends paid to owners.

Figure 6.a. Total equity in zombie firms, by firm size

Billion SEK



Note. This graph reports the total nominal amount of equity held in zombie firms each year. A firm's equity includes the original value of common stocks, additional paid-in capital, retained earnings, retained earnings and accumulated other comprehensive income (OCI). Each bar is divided further in 5 parts. Each part captures a different group of zombie firms divided based on size. To divide firms in size categories, each year I divide all firms in the sample in quintiles based on total assets. The blue portion of each bar depicts the smallest firms (those in the bottom quintile of the size distribution). The red portion of each bar represents the medium-to-small firms in the distribution (those in the second quintile of the size distribution). The light blue portion of each bar captures the medium firms in the distribution (those in the third quintile of the size distribution). The orange portion of each bar represents the medium firms in the distribution (those in the fourth quintile of the size distribution). The green portion of each bar depict the large firms in the distribution (those in the fifth quintile of the size distribution).

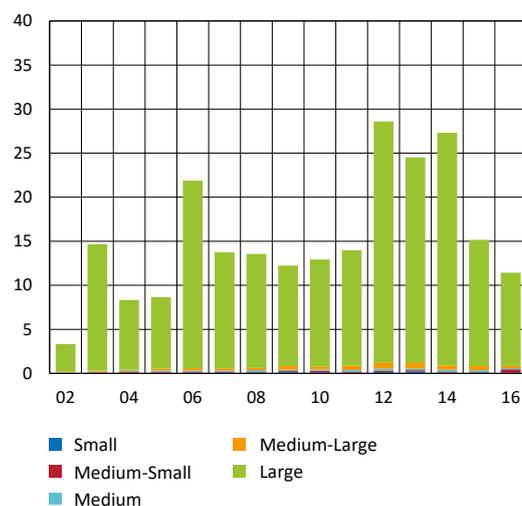
Figure 6.a clearly shows that equity in zombie firms has been building up, especially in the one fifth of them classified as large firms. This is despite the fact that most of these firms have consistently made losses over time. Importantly, the number of zombie firms did not increase dramatically over this period, as shown in Figure 2.a and Figure 8 on page 24. Therefore, the increase in equity cannot be driven by an increase in the number of firms. Hence, this figure should mostly reflect the original contributions from shareholders and the value of new equity issuances. However, not knowing the original amount of equity invested and being unable to assess whether any of the firms in the sample were indeed able to issue new shares, I also look directly at equity contributions by shareholders, recorded by Serrano as "shareholders' contributions."³¹

The variable shareholders' contributions shows the value of money or other assets (i.e. buildings or equipment) brought into the company by shareholders. Shareholders stand to lose these contributions if the business goes into bankruptcy and therefore these type of contributions are similar to a "last resort" type of injection of funds to help ease the financial constraint of a business that has become insolvent, or risks becoming insolvent. Results are reported in Figure 6.b.

³¹ Shareholders' contributions can be used for a variety of purposes for example to offset losses. Contributing shareholders usually receive shares corresponding to the additional amount invested.

Figure 6.b. Shareholders' contributions in zombie firms, by firm size

Billion SEK



Note. This graph reports the total nominal amount of contributions made by shareholders to zombie firms each year. Shareholders' contributions are usually made in cash (or other assets) in exchange for more stocks and can be used to support the business. These contributions are different than other equity items generated by the business itself (for example, retained earnings) and can be made ad-hoc. Each bar is divided further in 5 parts. Each part captures a different group of zombie firms divided based on size. To divide firms in size categories, each year I divide all firms in the sample in quintiles based on total assets. The blue portion of each bar depicts the smallest firms (those in the bottom quintile of the size distribution). The red portion of each bar represents the medium-to-small firms in the distribution (those in the second quintile of the size distribution). The light blue portion of each bar captures the medium firms in the distribution (those in the third quintile of the size distribution). The orange portion of each bar represents the medium firms in the distribution (those in the fourth quintile of the size distribution). The green portion of each bar depict the large firms in the distribution (those in the fifth quintile of the size distribution).

Figure 6.b shows that, collectively, zombie firms have received significant contributions from their shareholders, this being evident especially in large firms. Over the years 2012, 2013 and 2014, almost SEK 30 billion each year were collected by zombie firms as shareholders contributions, almost twice as much as was injected into these firms in the years immediately before and after. This would suggest that this injection of money may have helped firms to repay the interest on their debt and even get more funding.

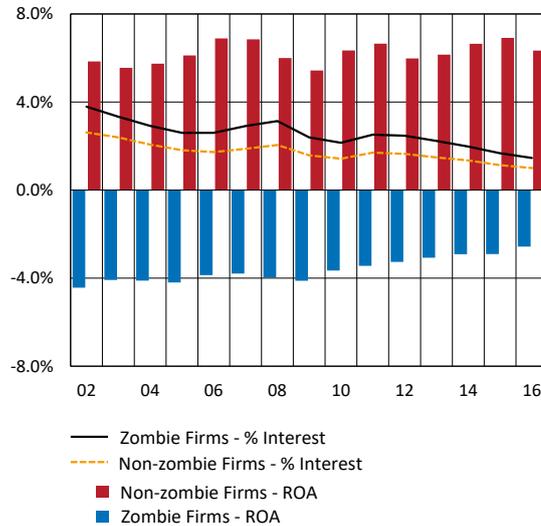
To complete my analysis, I finally look at the implied interest rate³² that the median zombie firm and the median non-zombie firm pay each year. Results are reported in Figure 7 where the black solid line shows the implied interest rate for the median zombie firm while the yellow dotted line show results for the non-zombie firm. To help put things into perspective, Figure 7 also shows the return on assets (ROA) of the median zombie firm (blue bar) and the median non-zombie firm (red bars).³³

³² The firms in the dataset do not report the interest rate they are charged on their debt, hence I calculate a firm's implied interest rate using the data available on the interest paid and the total financial debt. The interest rate is calculated (very broadly) as the percentage of the interest paid by a firm with respect to the firm's financial debt. Financial debt is calculated as long-term debt (excluding other non-current liabilities) plus all short-term loans. Return on assets (ROA) is calculated as earnings before interests and taxes divided by total assets. The distribution of interest payments is highly skewed. Hence, Figure 4 reports medians rather than averages since the average will be highly affected by extreme values.

³³ All unclassifiable firms are not included since they do not report any interest payment.

Figure 7. (Implied) interest rate and return on assets (ROA)

Per cent



Note. This picture shows the median (implied) interest rate paid by zombie firms (the black line) and non-zombie firms (the orange dotted line) on their debt outstanding. The implied interest rate is calculated by dividing the amount of interest that companies report pay each year by the amount of debt outstanding to all financial institutions for that year. The blue bars show the return on assets of the median zombie firm, and the red bars show the return on assets of the median non-zombie firm, each year. Return on assets is calculated as net income over total assets.

Figure 7 clearly shows that even though the median zombie firm had a widely negative return on assets (-3.62% on average between 2002 and 2016 compared to 6% on average for the median non-zombie firm), I find only a slightly larger implied interest rate for this firm over my sample period. For the median zombie firm, I calculate an average implied interest rate on its financial debt of 3.18% over the period, while for the median non-zombie firm the average implied interest rate is around 2.16%. While interest rates are implied and the analysis does not correct for any heterogeneity across firms, one should ask whether the premium paid by zombie firms is large enough given that they are unprofitable and have issues making their interest payments. Nevertheless, from the previous analysis, I have learned that zombie firms rely on decreasing their debt exposure and also on a large influx of capital by their shareholders. All of these elements may help ease their financial constraints despite the fact that they show low profitability and are unable to repay organically the interest on their outstanding commitments.

Overall, this analysis shows that zombie firms may not be a large threat to financial stability in Sweden. First, the number and economic significance of zombie firms have not dramatically increased over the years when financing conditions have been eased. In fact, the share of zombie firms has decreased somewhat. Second, debt exposure in zombie firms has been decreasing over time. Third, even if helped by generally good macro conditions, zombie firms may exist and survive because they are supported by shareholders' recapitalizations which reduce the risk to the financial system.

Next, I turn to the economic consequences of zombie firms. In particular, I investigate whether the existence of zombie firms in Sweden in any given industry impairs the growth and productivity of the other firms in the same industry.

7. The economic consequences of zombie lending

In this section, I start exploring how the presence of zombie lending affects other firms operating in the same industry. This question is difficult to answer clearly because zombie firms and non-zombie firms are affected by the same industry shocks, for example a demand shock. In other words, the share of zombie firms in a given industry is correlated with shocks affecting the performance of non-zombie firms. In order to explore how zombie lending affects other firms I follow the methodology of Schivardi et al. (2017), and simplify it to adapt it to the data I have available.

Assume I want to estimate the following regression (equation 2, p. 28 of Schivardi et al.):

$$\Delta y_{ipt} = \beta_0 + \beta_1 ShZ_{pt} + \beta_2 (1 - Z_{ipt}) * ShZ_{pt} + \beta_3 Z_{ipt} + D_{ipt} + \mu_{ipt} \quad (1)$$

In this equation, i denotes the firm, p denotes a firm's sector defined using the SNI2007 codes, and t the year. The dependent variable Δy_{ipt} captures a firm's performance or growth. Z_{ipt} is a dummy variable equal to one if a firm in a given industry in a given year is classified as a zombie firm. ShZ_{pt} is the share of zombie firms in sector p at t . D_{ipt} is a vector of dummy variables and μ_{ipt} is the error term.

The coefficient β_1 captures the average effect of the share of zombie firms in a given industry in a given year (ShZ_{pt}) on the performance of zombie firms. The coefficient β_2 captures the average effect of the share of zombie firms in a given industry in a given year (ShZ_{pt}) on non-zombie firms captured as a deviation from the effect on zombies ($1 - Z_{ipt}$).

If the presence of zombie firms has a negative effect on non-zombies, then one should find that the coefficient β_2 is negative and statistically significant. Importantly, when the dependent variable measures the growth rate of inputs (assets and labour, for example), the coefficient β_2 tells something about two important channels. First, the coefficient β_2 captures the fact that zombie firms' access to financing allows them to compete for resources, thus crowding out non-zombie firms, which in the same industry compete for the same resources. Second, when zombie firms receive credit despite the fact that they cannot organically repay it, they implicitly receive a form of "financial support" from their creditors. This implicit subsidy de facto allows zombie firms to compete with their competitors hurting them both on the input market and the product market (i.e. it affects their sales and thus they have less resources to grow). Both channels reinforce each other and slow down input growth.

When the dependent variable measures the growth of output (total assets, sales, and investment) instead, the coefficient β_2 mainly reflects the implicit subsidy channel and its expected sign is still negative.

If the demand for products or services provided by firms in the same industry weakens for a few consecutive years, all else equal, some firms may be classified as zombie firms (increasing the share of zombie firms in that industry) and at the same time the non-zombie firms ($ICR \geq 1$) may also see less revenues and growth. However, the poor performance of non-zombie firms is clearly not related to the increase in the share of zombie firms and it would be wrong to assert the contrary.

To solve the above identification issue, Caballero et al. (2008), Acharya et al. (2016), McGowan et al. (2018) and Schivardi et al. (2017) focus on the relative performance of non-zombie firms versus zombie firms using a dummy variable approach. In particular, they control for country-industry-year dummies (in my setting this is a set of sector-year dummies). In this regression, the sector-year dummies control for any aggregate shock. However, the variable capturing the share of zombie firms in each industry each year will be dropped since it is absorbed by the industry-year dummy.

Nevertheless, the coefficient β_2 will be estimated and can be interpreted as the effect of increasing the share of zombie firms on non-zombies in the same industry in the same year, in deviation from the effect on zombies themselves.³⁴

Using data for the period 2009-2016, I estimate the regression in equation (1) and report the results in Table 1. In Table 1, column (1) uses as the dependent variable the log growth in total assets, while column (2) shows results using the log growth of capital expenditure. Column (3) uses as the dependent variable the log growth in the number of employees and column (4) shows results using the log growth of sales. I employ the most stringent possible specifications so all regressions include industry-year fixed effects, together with robust standard errors clustered at the industry-year level. This multivariate approach controls for firms' time-varying characteristics (since firms seldom change industry), and reduces omitted variables biases at the industry-year level by including time, industry and time-industry dummy variables that capture firm time-invariant characteristics (industry dummies), the influence of aggregate trends (year dummies) and the influence of industry-specific time trends (industry-year dummies).³⁵

Table 1: Correlation between the share of zombie firms in an industry and the growth of non-zombie firms' in that industry

	(1)	(2)	(3)	(4)
	Total Assets	Capex	Employees	Sales
(1- Z)* ShZ	-0.576** (0.037)	1.490 (0.152)	0.152 (0.381)	-0.310 (0.398)
Z	-0.158*** (0.000)	0.003 (0.963)	-0.052*** (0.000)	-0.158*** (0.000)
Observations	1,624,974	581,588	1,211,849	1,497,018
Adj. R ²	0.00854	0.00696	0.00502	0.00640

Table 1 shows the results of estimating the following regression on the full sample from 2009 to 2016: $\Delta y_{ipt} = \beta_0 + \beta_1 ShZ_{pt} + \beta_2 (1 - Z_{ipt}) * ShZ_{pt} + \beta_3 Z_{ipt} + D_{ipt} + \mu_{ipt}$ (1). In this equation, i denotes the firm, p the area-sector, and t the year. The dependent variable Δy_{ipt} captures a firm's performance or growth. Z_{ipt} is a dummy variable equal to one if a firm in a given industry in a given year is classified as a zombie firm. ShZ_{pt} is the share of zombie firms in sector p at t . D_{ipt} is a vector of dummy variables and μ_{ipt} is the error term. The coefficient β_1 captures the average effect of the share of zombie firms in a given industry in a given year (ShZ_{pt}) on the performance of zombie firms. The coefficient β_2 captures the average effect of the share of zombie firms in a given industry in a given year (ShZ_{pt}) on non-zombie firms captured as a deviation from that on zombies ($1 - Z_{ipt}$). Column (1) uses log growth in total assets as the dependent variable. Column (2) shows results using the log growth of capital expenditure as the dependent variable. Column (3) uses the log growth in the number of employees as the dependent variable and column (4) shows results using the log growth of sales. All regressions include industry-year fixed effects, together with robust standard errors clustered at the industry-year level. Robust p-values are reported in the parentheses underneath the coefficients and should be interpreted as follows *** p<0.01, ** p<0.05, * p<0.1.

³⁴ Schivardi et al. (2017) suggest that this estimation approach is far from perfect, and argue that one should identify a variable that moves the shares of zombies in a province-sector-year but that is orthogonal to local sectoral shocks. Thus, in their analysis they replace the share of zombie firms with a measure of under-capitalization of the banks that lend in a given province-sector. Please, see the paper for more details. Unfortunately, I do not have the data to use this additional methodology so I use the traditional one employed by the rest of the literature. However, I fully share the concerns put forward by the authors and interpret the regression results simply as correlations.

³⁵ Notice that the coefficient of the variable ShZ is not identified because I include industry-year fixed effects.

Looking at the estimates for the interaction term, β_2 , Table 1 shows a negative association between an increase in the share of zombie firms and the growth in total assets in non-zombie firms, but in the rest of the regressions, the estimates of the coefficient β_2 are insignificant. Hence, there does not seem to be any correlation with the ability of non-zombie firms to invest in capital expenditure or attract employees, and neither seem to have any correlation with their ability to compete on the product market.

Table 1 then suggests that despite the fact that zombie firms can be highly unproductive (McGowan et al., 2018), their presence in Sweden may not have a significant effect on the ability of other firms to compete. Hence, their overall impact on the economy should be quite contained.

8. Zombie firms in the low interest environment

So far, this study shows several important facts: First, the number of zombie firms decreased in Sweden over the period 2010-2016. Second, zombie firms' total debt to financial institutions has decreased while shareholders contributions have increased. Third, the presence of zombie firms, overall, does not have a significant negative correlation with the input and output growth of non-zombie firms in the same industry. This last section will now address a final question: how did zombie firms change over the period after the global financial crisis in 2008?

Low interest rates have been a key ingredient for the economic recovery after the global financial crisis in 2008. They have helped support demand for goods and services, and thus might have helped all firms, including zombie firms, to improve their profit margins. This would suggest that low interest rates might even have helped some firms to get out of the zombie state. However, low interest rates have also affected the supply of credit to firms and, in general, the way firms finance themselves. While some firms might have been able to restructure their debt and improve their interest coverage ratios, other might have taken this opportunity to further increase their leverage. As a consequence, some of the firms might have fallen into the zombie state, despite a positive product market demand.

In light of the discussion above, I begin my analysis by investigating whether, after the financial crisis in 2008 and, in particular, over the period of low interest rates, more firms have been classified as zombies. The idea behind this investigation is that over the period of low interest rates, or in general after the financial crisis in 2008, more firms should be categorized as zombie firms with respect to the years before the financial crisis. In Figure 8, I then look at how many new zombie firms are classified each year with respect to how many are "inherited" each year.

Figure 8. Newly originated zombie firms
Number, per cent



Note. The left axis of this graph shows the total amount of zombie firms each year. This total is then divided in newly originated zombie firms (the red portion of each bars) and zombie firms coming from the previous year (the light blue part of the bar). The right axis instead shows the percentage of newly originated zombie firms over the total amount of firms classified as zombie firms each year.

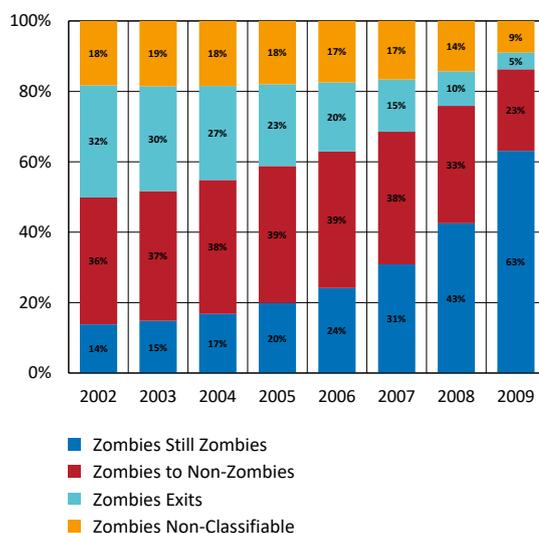
Figure 8 shows clearly that most of the firms classified as zombie firms in the years after the financial crisis come from previous years (as captured by the light blue portion of each bar). This latter result is consistent with the fact that zombie firms on average stay in the zombie state for about 3 years. Apart from a spike in 2009 and 2010, the number of firms classified for the first time as zombie firms (captured by the red portion of each bar) is in fact no larger than the number classified in the period before the global financial crisis in 2008, and decreases sharply between the year 2015 and 2016. This dynamic is also illustrated by the blue line, which captures the percent of new zombie firms with respect to all zombie firms each year.

However, while Figure 8 shows that each year almost 60% of zombie firms are classified as such in the previous year too (consistent with previous results on the persistency of the zombie state), this figure does not tell us anything about what happens to zombie firms over time. Figure 9 addresses this issue.

Figure 9.a shows what happened to firms classified as zombie firms each year from 2002 to 2009 by the year 2010, while Figure 9.b focuses on the period after the global financial crisis and shows what happened to firms classified as zombie firms each year from 2010 to 2015 by the year 2010.

Figure 9.a. Zombie firm transition to other states by the year 2010

Per cent



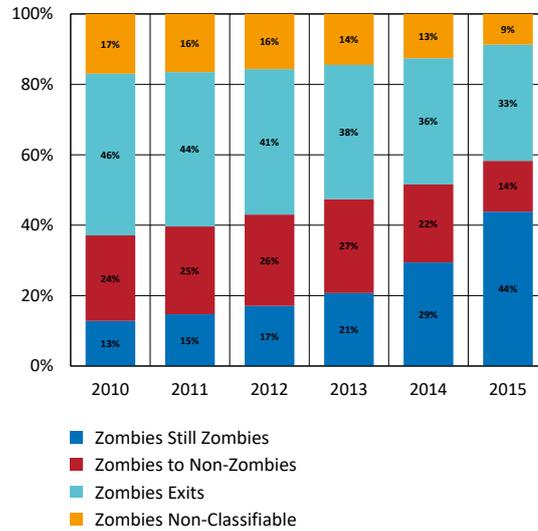
Note. This graph shows how zombie firms classified each year from 2002 to 2009 are classified at the end of 2010. Each year, I identify zombie firms and then I look at what happened to them in 2010. In 2010, I classify all zombie firms in four different categories: a. zombie still zombie: zombie firms still zombie firms (the blue portion of each bar), b. zombies to non-zombies: zombie firms that become non-zombie firms (the red portion of each bar), c. zombies exits: zombie firms that exited the sample (the light blue portion of each bar), d. zombies non-classifiable: zombie firms that are still in the sample but do not report any interest payment or debt outstanding (the orange portion of each bar).

Each year, I focus on the group of firms classified as zombie firms and follow their evolution either until year 2010 or until year 2016. For example, the first bar in Figure 9.a follows the evolution of all zombie firms classified in 2002. This bar shows all the zombie firms classified in 2002. Of these firms, 14% were still classified as zombie firms in 2010 (the blue portion of each bar), 36% of the firms were still in the sample but had been reclassified as non-zombie firms (the red portion of each bar), 32% of the firms exited the sample³⁶ (the light blue portion of each bar), and 18% had missing ICR and therefore could not be classified (the orange portion of each bar). Interestingly, this Figure shows that by 2010, of all the firms classified as zombie firms in 2007, right before the financial crisis, 31% were still classified as zombie firms and only 38% of them were reclassified as non-zombie firms but only 15% left the sample. This number drops to 5% if I focus on the year 2009, captured in the last bar of Figure 9.a. Importantly, this figure clearly shows that by the year 2010, the amount of accumulated zombie firms was indeed quite large (63% of the zombie firms in 2009 were still zombie firms in 2010). This is consistent with the idea that zombie firms struggle the most when the economy slows down, yet they stay alive.

Figure 9.b shows the same exercise as in Figure 9.a but for the years after the global financial crisis of 2008. Figure 9.b shows that after the financial crisis more firms left the sample. Of all of the zombie firms in 2010, 46% had exited the sample by 2016 and 24% had been reclassified as non-zombie firms.

³⁶ I do not know the reason why the companies left the sample. However, since Serrano follows all firms that file accounting records with the Swedish authorities, these firms most likely stopped reporting and possibly exited the market without necessarily going bankrupt.

Figure 9.b. Zombie firm transition to other states by the year 2016
Per cent



Note. This graph shows how zombie firms classified each year from 2010 to 2016 are classified at the end of 2016. Each year, I identify zombie firms and then I look at what happened to them in 2016. In 2016, I classify all zombie firms in four different categories: a. zombie still zombies: zombie firms still zombie firms (the blue portion of each bar), b. zombies to non-zombies: zombie firms that become non-zombie firms (the red portion of each bar), c. zombies exits: zombie firms that exited the sample (the light blue portion of each bar), d. zombies non-classifiable: zombie firms that are still in the sample but do not report any interest payment or debt outstanding (the orange portion of each bar).

Results in Figure 9.a and Figure 9.b suggest that, at least in Sweden, over the period of low interest rates, firms were not reclassified to a large extent as zombie firms and actually the existing zombie firms were either reclassified as non-zombie firms or exited the sample. I further investigate the probability of a firm becoming a zombie firm and the probability of a firm exiting the zombie state in Table 2.

In Table 2, I employ a multivariate setting that controls for firms’ time-varying characteristics. To reduce omitted variables bias, I also include fixed effects at the firm and year level to control for firms’ time-invariant characteristics and capture the influence of aggregate (time-series) trends. In Table 2, I compare how the probability of a zombie firm being reclassified as a non-zombie firm and the probability of a non-zombie firm becoming a zombie firm changed over the period in which interest rates were constantly lowered in Sweden, 2011-2016,³⁷ compared to the period 2002-2010.

³⁷ I focus on the period 2011-2016 because over this period interest rates were consistently lower in Sweden compared to the period 2002-2010.

Table 2: Zombie firms transition probabilities

	(1)	(2)	(3)	(4)
	Probability of being Reclassified as a Non-zombie Firm Next Year	Probability of being Reclassified as a Non-zombie Firms within Three Years	Probability of Becoming a Zombie Firm Next Year	Probability of Becoming a Zombie Firm within Three Years
D2011_2016	0.061*** (0.000)	0.066*** (0.000)	-0.007*** (0.000)	-0.012*** (0.000)
ICR	0.000 (0.167)	-0.000 (0.894)	-0.000*** (0.000)	-0.000** (0.047)
Control Variables	YES	YES	YES	YES
Observations	164,633	95,204	1,700,806	1,090,759
Adj. R ²	0.266	0.643	0.0833	0.160

Table 2 shows the results of estimating a Linear Probability Model (LPM) with year- and firm-fixed effects on the full sample from 2002 to 2016. Column (1) uses the probability that a zombie firm in year t will be reclassified as non-zombie firm in year $t+1$ as the dependent variable. Column (2) uses the probability that a zombie firm in year t will be reclassified as non-zombie firm in year $t+2$ or year $t+3$ as the dependent variable. Column (3) uses the probability that a firm in year t will be classified as zombie firm year in year $t+1$ as the dependent variable while (4) shows results using the probability that a firm in year t will be classified as zombie firm year in year $t+2$ or year $t+3$ as the dependent variable. The dependent variables are as follows: D2011_2016 is a dummy variable equal to 1 over the years 2011-2016 and equal to zero over the period 2002-2008. The following control variables are included: ICR, firm age, change in outstanding debt (Δ Debt) and firm size. ICR is a firm's one-year lagged interest coverage ratio, Firm Age is the one-year lag of a firm's age (measured as the natural logarithm of the number of years since registration), Δ Debt is the change in the firm's total amount of outstanding debt with financial institutions between year $t-2$ and $t-1$. Firm Size is the one-year lag of a firm's age (captured as the natural logarithm of a firm's total assets). All regressions include firm- and year-fixed effects, together with robust standard errors clustered at the firm level. Robust p-values are reported in the parentheses underneath the coefficients and should be interpreted as follows *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. For the sake of brevity, control variables are not shown in the Table. The complete table can be obtained directly from the author.

Table 2 shows the results of a linear probability model³⁸ with firm and year fixed effects and robust standard errors. In Table 2, column (1) uses the probability that a zombie firm in year t will be reclassified as non-zombie firm in year $t+1$ as the dependent variable. Column (2) uses the probability that a zombie firm in year t will be reclassified as non-zombie firm in year $t+2$ or year $t+3$ as the dependent variable. Column (3) uses the probability that a firm in year t will be classified as zombie firm in year $t+1$ as the dependent variable while (4) shows results using the probability that a firm in year t will be classified as zombie firm in year $t+2$ or year $t+3$ as the dependent variable. The independent variable of interest is D2011_2016 which is a dummy variable equal to 1 over the years 2011-2016 and equal to zero over the period 2002-2010. I also control for a firm's interest coverage ratio, age, size, and the change in total amount of outstanding debt with financial institutions.

³⁸ In the interest of keeping the analysis as simple as possible, I employ LPM. However, I acknowledge that other models could be more appropriate and refer readers to Wooldridge (2010) for more details.

Column (1) and (2) of Table 2 show that the probability that a firm is reclassified as a non-zombie firm is statistically higher over the period 2011-2016 than it was before. This suggests that, after the financial crisis, the probability that a firm could be reclassified as a non-zombie firm within three years was larger than what it was before the financial crisis. The sign of the control variables also makes economic sense. For example, looking at the coefficient statistically different from zero in column (2), firms that are more likely to be reclassified as non-zombie firms within three years are older and smaller.

Next, I also further investigate whether the probability of becoming a zombie firm has increased in Sweden over the period when interest rates were consistently cut. These results are shown in column (3) and column (4). These columns show that both the probability at a one-year horizon and that within three years has significantly decreased over this period, consistent with what figure 9.b showed. In fact, the coefficient of the variable D2011_2016 is negative and highly statistically significant in both columns and even more so in column (4). Moreover, even in these columns, all of the control variables have signs consistent with economic intuition. Results in column (3) indicate that non-zombie firms with higher (better) interest coverage ratio and larger size are less likely to become zombie firms in the next year. While older non-zombie firms and firms that have increased their outstanding debt in the previous two years have a higher probability of being classified as zombie firms in the next year.

In conclusion, the analysis in this section shows that the phenomenon of zombie firms, at least in Sweden, is not necessarily related to low interest rates. Even more interestingly, if anything, this section suggests that after the great financial crisis in 2008, and more so over the period 2011-2016, many zombie firms were reclassified as non-zombie firms or exited the sample, while the probability of firms being classified as zombie firm decreased. Together with the results presented in the rest of this study, zombie firms in Sweden are a contained phenomenon and do not seem to set off alarm bells neither for financial stability nor for the real economy. These results are at odds with the conclusions of Banerjee and Hoffman (2018).

9. Conclusions

This paper investigates the relevance of zombie firms in Sweden and their impact on economic activity and financial stability. Using the universe of Swedish non-financial limited liability firms (aktiebolag) over the period 2002-2016 and the standard definition employed by McGowan et al. (2018), this study documents three main results. First, the percentage of firms classified as zombie firms consistently *decreased* over the period 2010-2016. Second, the presence of zombie firms in an industry is mostly uncorrelated with the growth of firms classified as non-zombie firms. Third, over the period 2011-2016, when interest rates were consistently cut, the probability of a firm becoming a zombie firm did not dramatically increase while the probability of a firm being reclassified as a non-zombie firm did.

This study mostly aims to assess the zombie firm situation in Sweden and its take-away is simple: while zombie firms can be identified in Sweden too, these firms do not pose a significant threat to the real economy or to financial stability. However, this paper does not address a very relevant question: what are the drivers behind the existence of zombie firms? While the drivers of the existence of zombie firms are beyond the scope of this paper, the question is interesting and thought-provoking, and more research in this area could be quite valuable for both academics and policy makers.

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Appendix A – What is bank forbearance?

Bank forbearance, or ever-greening, is when banks continue to extend credit to some insolvent customers in the hope that they will recover and the bank can avoid realizing losses on non-performing loans. Banks engage in this practice for several reasons. First, because of concerns about their minimum capital requirements. Banks need to identify non-performing loans (or generally, loans that the borrowers may not be able to repay in accordance with the details of their contracts) and immediately write-off the value of the expected credit losses against their capital with immediate consequences for their minimum capital levels. The willingness to avoid raising more capital may lead many banks to continue to extend credit to insolvent borrowers in the hope that they will somehow recover or survive. Secondly, during economic downturns, banks receive some pressure to help spark economic recovery by increasing their lending to small and medium-sized firms. In this contest, banks can then easily justify not cutting funds to insolvent firms that may have a chance of recovery. Finally, in some judicial systems, banks may recover more of their investment by keeping insolvent firms alive than by pushing them into bankruptcy (Andrews and Petroulakis, 2019). Importantly, by keeping weak firms alive, banks may crowd out credit to more productive firms. Moreover, since there is no guarantee that zombie firms will indeed recover, by extending credit to them, banks may even increase their own risk of default. This is particularly true when the economic significance of zombie firms in banks' portfolios becomes substantial.

Appendix B – How is a zombie firm identified in the data?

Depending on the research question, different methodologies to identify zombie firms have been employed. For example, Caballero et al. (2008) study zombie firms in Japan in relation to bank forbearance, and identify zombie firms by comparing the interest rate paid by the highest quality borrowers (firms with AAA-ratings) with the interest paid by other firms (firms with public information about their bank loans and debt issuance available). Firms that pay an interest rate below that of the best borrowers are then classified as receiving subsidized credit and labeled as zombie firms. The main methodology employed by Caballero et al. (2008), by focusing completely on comparing interest rates, does not necessarily capture firms that should exit the market but are kept alive by subsidized lending. Therefore, other authors have developed empirical methodologies that instead rely on firms' operating characteristics. Nevertheless, the specific methodology used to identify a zombie firm does not seem to make a substantial difference for many studies, since results usually hold using different definitions (see McGowan et al. (2018) and Schivardi et al. (2017) for more details).



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