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The life and death of zombies – evidence from government subsidies to firms*

Satu Nurmi† Juuso Vanhala‡ Matti Virén§

May 12, 2020

Abstract

We analyze the demographics of zombie firms and durations of zombie spells as well as their determinants, including an application on public subsidies using firm level population panel data from Finland. Firm-level analysis of firm demographics reveals that zombie-firms, as commonly defined in the literature, are often not truly distressed firms but rather companies with temporarily low revenues relative to interest payments. More importantly, we find that roughly a third of these firms are in fact growing companies and two thirds recover from the zombie status to become healthy firms. We also show that the increase of zombie firms over the past 15 years has mainly been driven by cyclical factors, as opposed to a secular trend. In our policy application on government subsidies to firms, estimation results strongly suggest that subsidy-receiving firms are less likely to die, regardless of the type of subsidy. However, with regard to recovery there is heterogeneity in the effects depending on the type of firm and the type of subsidy received. Thus, we do not find a robust positive association of subsidies with zombie recovery.

Keywords: Zombies, Misallocation, Firm exit, Firm growth, Subsidies, Productivity.

JEL classifications: D22, D24, G33, H25, L16, L25, O25

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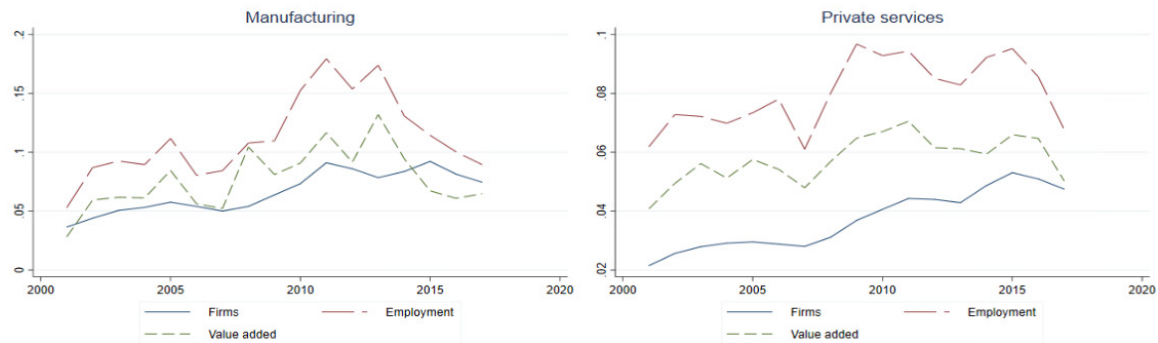
1 Introduction

The decline of productivity growth in OECD countries over the last decades has raised interest in the micro determinants of productivity and economic growth, including rising productivity dispersion, declining reallocation and declining business dynamism (e.g. Andrews et al. 2016, Decker et al. 2014, 2018, Gopinath et al. 2017, Criscuolo et al 2014). In this context there has been a renewed interest in the persistent survival of poorly performing ‘zombie’ firms and their effects on the economy. Whereas the earlier literature studied zombie firms in the stagnating Japanese economy of the 1990s (e.g. Hoshi 2000, Caballero et al. 2008), a number of recent studies has documented a rise in the proportion of zombie firms in the firm population across OECD economies since the financial crisis (e.g. Acharya et al. 2016, Adalet McGowan et al. 2018, Banerjee and Hoffman 2018). Zombies have mostly been analysed in the context of productivity and growth, as well as financial stability. Focus has been on resource misallocation and congestion effects of zombies on healthy firms and ultimately on the negative effects of zombie firms on growth and employment. There is less understanding, however, of the demographics of zombies. Little is known about what zombies really are: Are they truly distressed declining firms or temporarily unprofitable growing firms? What is driving the rise in the proportion of zombie firms, higher entry of new zombies or more persistent survival of old zombies? Do zombies eventually die or do they recover to become healthy firms? For policy these are important issues. If recovery is frequent, then the policy conclusion of rapid elimination of zombies may be inappropriate.

In this paper we perform an ‘autopsy’ of zombies by studying in depth aspects of their demographics that are novel to the literature. Using firm-level data from Finland (1999-2017), we study the entry and exit margins into and out of zombie status as well as zombie survival, to analyse the drivers of the rise in the proportion of zombie firms. Going a step further we decompose the zombie exit margin into exits out of the market (firm death) and exits to becoming healthy firms (recovery). In addition we consider demographics for another dimension, namely the demographics of declining vs. growing zombies.

To demonstrate the policy relevance of our framework, we apply it to analyse the role of government subsidies to firms in keeping zombies alive. Although the role of various economic policies in generating zombies has been discussed in the recent literature, our data is particularly suitable to study subsidies as it includes firm-level information on public subsidies paid to firms, both at the aggregate subsidy level and disaggregated to various subsidy categories (R&D, employment, energy subsidies etc.). Furthermore, two other policies discussed in the literature, namely low interest rates and bank forbearance, seem to be less relevant for zombies in Finland.

Figure 1. Proportion of zombie firms and zombie shares of employment and value added, manufacturing and private services, 2001-2017.



Note: Zombies are defined as firms with the ratio of earnings before interest and taxes (ebit) and the interest paid/financial charges being less than one ($\text{ebit}/\text{interest} < 1$) for three consecutive years. Manufacturing includes NACE rev. 2 sectors 10-33 and private services includes sectors 45-63 and 69-82.

Our analysis reveals features of zombie firms that importantly changes generally accepted views of these firms and their effects as presented in the recent literature and policy narratives. First, a secular rise in the proportion of zombie firms over the past 15 years is present in our data, but it is relatively modest. Rather, our data that allows us to go back beyond the financial crisis as well as examine a longer span of post crisis years than most other studies, shows large cyclical swings in the share of zombies, especially for large firms, and a decline in the zombie share in the most recent years. These observations cast doubt on the views of the crisis and its' policy responses leaving a permanent rise in the zombies.

More importantly, we find that roughly a third of the zombies, as defined in the recent literature, are growing firms in terms of value added or workers. This result does not concern only young start-up companies – it extends also to more mature firms. The conventional definitions of zombies thus seem to also catch growing firms whose performance measures may look temporarily weak due to e.g. investments into future performance. Furthermore, the literature has raised the concern that zombie firms have a detrimental effect on healthy firms, by misallocation of resources to poorly performing firms and thus congesting the markets. Interestingly, we find that both declining zombies (true zombies) and growing zombies (false zombies) have a negative effect on the performance of other firms in the market. This seems to imply that instead of a misallocation effect, it may be simply higher competition that constrains the opportunities in the market.

A striking finding is that in our data roughly two thirds of firms recover from the zombie status to become healthy firms again. According to an independent competing risks model, there appear to be

clear differences between the factors behind different exit destinations. Both zombie exit risks, i.e. the chance of recovering to becoming a healthy firm and the probability of a complete shutdown decrease with firm size and capital intensity. The risk of death also decreases with firm age on the condition that the firm has survived so far as a zombie. Higher labor productivity is positively related to the probability of recovery and negatively related to the probability of death. With recovery, the baseline hazard rate declines with the time spent as a zombie whereas for death the hazard rate is slightly increasing.

In our policy application on government subsidies to firms, estimation results suggest that subsidies are related to the presence of zombie firms and to their allocation across industries. We take a closer look at aggregate and specific subsidies in relation to zombie-exits. Our competing risks model suggests that receiving a subsidy is negatively related to death, but we do not find a robust positive association of subsidies with zombie recovery. Cumulative hazard estimates show that there is hardly any difference between firms that do and do not receive subsidies in the hazards for recovering firms whereas the differences are large in the hazards for dying firms. The death hazards are considerably lower for firms that receive subsidies. Looking at individual subsidies separately, recipients of R&D and employment subsidies have lower death hazards, but recovery hazards appear perhaps surprisingly lower for R&D subsidy recipients and higher for employment subsidy recipients. Overall, it seems that government subsidies are not a decisive feature driving the recovery of weakly performing firms. However, these results suggest that firms receiving subsidies have a lower death rate. This may manifest as longer zombie spells, if the subsidies do not pull the firms to recovery but only keep them alive as zombies.

Our study relates the literature on zombie firms, on which the seminal studies concerned Japan in the 1990s (e.g. Hoshi 2000, 2006, Caballero et al. 2008). Those studies showed that zombie-dominated industries exhibit more depressed restructuring, characterized by more depressed job creation and destruction and lower productivity. More recently there has been a renewed interest to the presence and consequences of zombie firms in the aftermath of the Great Recession (Adalet McGowan et al. 2018, Acharya et al. 2017, Borio 2018). Hoshi (2006) studies the entry and exit probabilities of zombie firms, however the paper does not consider the possibility of zombies recovering to non-zombie status. Jiang et al. (2017) is one of the few studies on public subsidies to zombie firms.

The paper proceeds as follows. Section 2 describes the data and identifying zombie-firms as well as provides a description of the evolution of unprofitable and zombie firms in the Finnish economy. Section 3 analyzes zombie demographics, i.e. entry and exit to zombie status and exit destinations. Section 4 applies our framework to study the role of government subsidies for zombie demographics. Section 5 concludes.

2 Preliminaries

2.1 The data

The basis for our main analysis are annual enterprise-level data based on the Financial Statement Statistics and the Business Register of Statistics Finland over the period 1999–2017.¹ In the analysis we concentrate on non-financial private business sector enterprises (NACE rev. 2 sectors 10–63 and 68–82) with at least 1 person. The database is harmonized with regard to the basic financial indicators over the period.

In the demographics analysis an advantage of our dataset is its’ completeness. The firm death rate can only be estimated if the coverage of the dataset is complete. In many countries only datasets relying on samples are available, and this leads to firms dropping out of the data due to sample attrition so that the death rate cannot be appropriately estimated. As a robustness check we control for artificial entry and exit due to mergers and acquisitions, which could potentially bias the estimates somewhat, but this did not have any considerable effect on our results.

In order to analyze firm subsidies in the context of zombies, we complete the database by linking firm-level information on public subsidies based on data provided to Statistics Finland by state-owned institutions, such as the Ministry of Employment and the Economy and Business Finland, which have paid subsidies directly to enterprises. In contrast, tax subsidies and agricultural subsidies are not included in the statistics. In addition to calculating the total of direct subsidies payed to each firm, we divide the subsidies into three broad categories based on their type: R&D subsidies, employment subsidies and other subsidies (e.g. investment subsidy or energy subsidy). The coverage of the subsidy data improves during the first years of the dataset but most of the content is available from 2003 onwards.

2.2 Identifying zombies

There are basically two broad approaches in defining zombie firms. In the seminal papers by Hoshi (2006) and Caballero et al. (2008) that focus on firm-bank relationships in Japan in the 1990’s, the zombie measures attempt to identify firms that make extremely low interest payments given their levels of debt and who are likely to receive financial aid from lenders. A number of recent papers have studied

¹ The dataset is collected according to the protocol of the Competitiveness Network (CompNet) and augmented by a number of variables.

zombie firms in European countries along these lines (e.g. Acharya et al. 2016, Schivardi et al 2018). In a second approach, recent studies have used various measures of weak performance of firms to identify zombies. These measures include firms with negative profits (Bank of England 2013) or negative value added, or firms with a persistently low interest coverage ratio (earnings before interest and taxes (EBIT) relative to the interest paid and financial charges) (e.g. Adalet McGowan et al. 2018, Bank of Korea 2013).

We follow the recent literature by defining zombies as firms with an interest coverage ratio (ICR), that is less than one for three consecutive years (e.g. Adalet McGowan et al. 2018)

$$ICR(3) = \frac{EBIT}{interest+financial\ charges} < 1 \quad (1)$$

This condition indicates that in order to meet its interest payments, a firm has to take new loans or receive other outside funding as its earnings are insufficient to cover interest expenses.² We do not set a minimum age requirement in our definition of zombies, as in e.g. Adalet McGowan et al. (2018), although the ICR(3) condition implicitly sets a three-year age threshold. We show below that firm age is not a key determinant of zombie firms in our data.

We use the interest coverage ratio as our starting point for a number of reasons. First, there does not appear to be evidence of subsidized loans to zombies in Finland. The implicit interest rate (gross interest expenses/total debt) in Finland has been almost 100 bp higher for firms with $ICR(3) < 1$ compared to the other firms during the whole sample period (see Figure A.2. in the appendix). This result also carries on to the industry level; interest rates are in all cases higher for zombie firms.^{3 4} Therefore firm performance measures that rely on the ICR(3) measure seem more appropriate to capture distressed firms from our data than the measures based on interest payments. Also, as Adalet McGowan et al. (2018) note, interest coverage ratios encompass channels other than subsidised credit through which zombie firms may be kept alive (e.g. government guarantees to firms). Second, our data on interest payments by firms is not sufficiently detailed to construct relatively sophisticated measures similar to those used by Hoshi (2006), Caballero et al. (2008) or Schivardi et al. (2018). Furthermore, Schivardi et al. (2018) note that in their study the definition based on the interest coverage ratio is almost a strict

² Alternative values for the ICR condition are used in the literature, e.g. in Acharya et al (2019) zombies have an interest coverage ratio that is below the median. To evaluate the importance of the ICR threshold in our definition for weak performance, we considered firms which are close to the above mentioned definition, for which $1 < ICR(3) < 2$. We found that firms in this range are in qualitative terms similar to (the rest of) non-zombies. The threshold value $ICR(3) < 1$ seems thus to be reasonably well set.

³ This is in line with e.g. Steinkamp et al. (2018) who find that "evergreening" of loans is less pronounced in Germany, Netherlands, Finland and Luxembourg than in Greece, Italy, Portugal and Spain.

⁴ There is one caveat, though. The firms with $ICR(3) < 1$ are so much more indebted than other firms (Figure A.3. in the appendix) that a justified question is whether the observed risk premium is large enough to cover the risks of the zombie firms. The answer to this question is, however, beyond the scope of the current paper.

subset of that based on the comparison between return to assets (ROA) to their measure of the cost of capital for the safest borrowers in their sample.⁵

Since public subsidies paid to firms are also a part of the firm financial sheet item “other operating income”, we have excluded them from the calculation of *ebit* before the definition of zombies. This increased the number of zombies by 7% but did not change the conclusions of our analysis.⁶

We also use a second condition, namely the requirement that the annual growth rate of the firm in terms of employed workers is not positive on average over a two year period within the zombie period.⁷ We study this “shrinking” condition to separate truly distressed firms from growing firms with temporarily low earnings, but potentially bright future prospects. For example, start-up firms may have various costs, including investment, labour costs and R&D expenses, but low sales in the first years of activity. In later stages, a firm going through a phase of restructuring may incur large investments and have a heavy debt and interest burden, with temporarily low sales. Finally, we require that the firms are active.⁸

One caveat should be mentioned regarding our measurement of zombies. There is the possibility that a firm may show poor performance by the $ICR(3) < 1$ condition due to financial arrangements between parent-daughter companies or foreign affiliates, due to intra-firm reasons (e.g. taxation and internal items). Our current data does not allow to study this issue, however.

3 The rise and congestion of zombies?

The recent literature has documented a rise in the proportion of zombie firms, raising concerns over their potentially detrimental effect on productivity. A concern of this literature is that the increasing survival of these firms congests markets and constrains the growth of healthy firms operating in the same market.

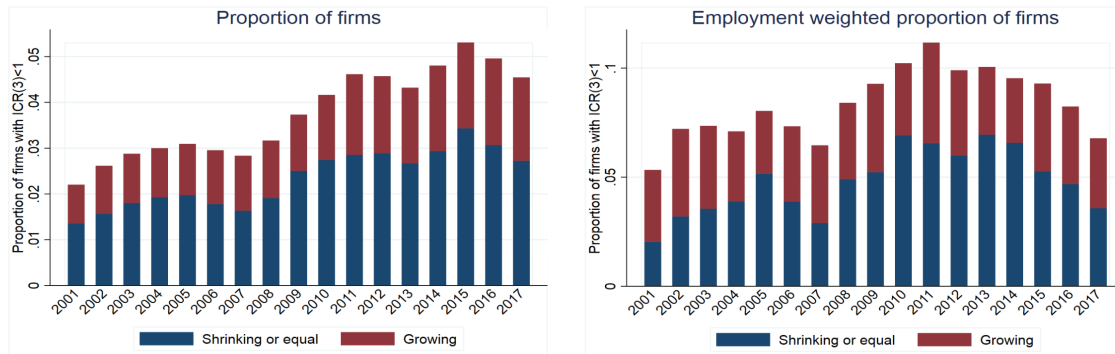
⁵ We also considered using EBITDA, earnings before interest, taxes, depreciation and amortization and results are qualitatively the same although there is a level shift in the zombie shares.

⁶ It should also be noted that there is a serious break in the overall subsidy time series in 2007 due to the joining of the Ministry of Trade and Commerce and the Ministry of Labour and due to the changes in the subsidy programs by the Ministry of Agriculture and Forestry. Due to this break some information is missing in 2007 which results in a temporary drop in the total amount of (other) subsidies paid. However, excluding this year from the analysis does not markedly change our results.

⁷ We use a two-year growth period to measure growth within 3-year zombie periods. Using a 3-year growth period would reduce the number of observations in the data considerably.

⁸ Some recent studies use indebtedness or leverage as an additional criteria to an interest coverage ratio criteria (e.g. Acharya et al. 2019, Schivardi et al 2018). Indeed, high indebtedness is a distinctive characteristic of zombie firms. When we consider indebtedness (total debt/value added), it turns out to be positively correlated with the ICR-condition (the coefficient estimate being 0.099 and t-value 3.75 in a panel regression with fixed effects and time and industry controls). We consider indebtedness of firms as an additional criteria for zombies in the robustness analysis.

Figure 2. Share of shrinking and growing firms with $ICR(3) < 1$, 2001-2017.



Similarly to many other OECD countries, the proportion of firms commonly defined as zombies in Finland has increased since the turn of the millennium (Figure 1 in Section 1). Despite the clear rise, the proportion of zombie firms in Finland has still remained lower than in many other European countries.⁹ The shares of employment and capital (mis)allocated to these firms or the share of value added produced in these firms are of a considerable magnitude, however, and reflects the fact that large firms are overrepresented in zombies. Also, the larger fluctuations of these variables relative to the fluctuations in the growth of the proportion of zombies reflect changes in zombie status of relatively large firms. Furthermore, our data shows that especially in manufacturing the rise in the employment-weighted zombie share has been driven to a large part by the financial crisis and its aftermath. As our data extends to 2017, it can be observed that the zombie share and the shares of employment and capital allocated in zombie firms have been falling in recent years. In services the pattern is less obvious.

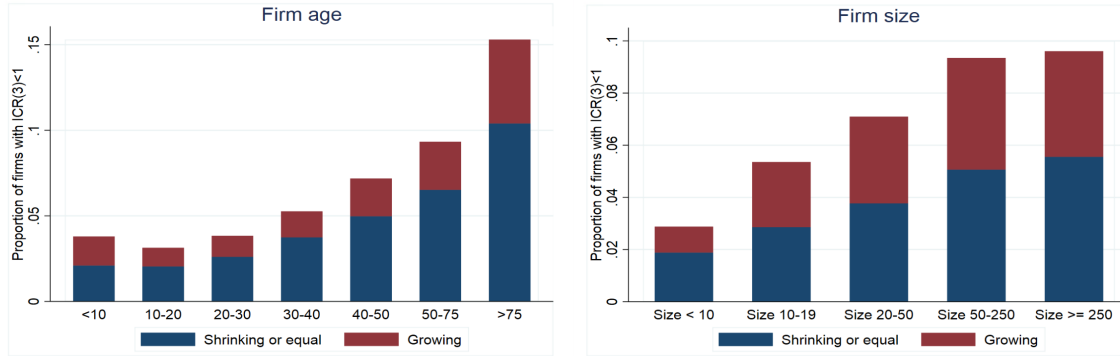
More importantly, when we also use the “shrinking” condition to separate truly distressed firms from growing firms with temporarily low earnings, the rise of zombies seems to be less alarming than the aggregate figures suggest. When we distinguish between shrinking or equal remaining and growing $ICR(3) < 1$ firms, for which the annual growth rate in terms of employed workers is not or is positive on average over a two year period within the zombie period, we find that the proportion of growing firms is on average 37 % and in employment weighted terms even higher, 43 % (Figure 2).¹⁰

⁹ See Adalet McGowan et al. (2017) for a cross country documentation of the evolution of zombie firms since the financial crisis.

¹⁰ Variation across the years in the proportion of growing firms of firms with $ICR(3) < 1$ between 32 and 42 percent. In employment weighted terms there is more fluctuation, between 30 and 62 percent.

Figure 3. Shrinking and growing zombie firms by firm age and size.

b.



Note: Zombies are defined as firms with the ratio of earnings before interest/ taxes (ebit) and the interest paid/financial charges being less than one ($\text{ebit}/\text{interest} < 1$) for three consecutive years.

These firms can hardly be described as true zombies. Associating this phenomenon to young firms, some studies (e.g. Adalet McGowan et al. 2018) have applied an age threshold of 10 years to separate young firms whose performance measures look weak in the beginning of their life-cycle.¹¹ Such a threshold, however, does not fully address the problem at hand, as even among older and larger firms fulfilling the $\text{ICR}(3) < 1$ condition there is a considerable share of growing firms.¹² Figure 3 plots the proportion of firms with $\text{ICR}(3) < 1$ by firm age and size. Figure 3a shows that although the share of growing $\text{ICR}(3) < 1$ firms is highest for under 10-year-old firms (44 %), roughly 30 percent of the $\text{ICR}(3) < 1$ firms are in fact growing firms in all remaining age classes. Also, as shown in figure 3b, the proportion of growing firms fulfilling the $\text{ICR}(3) < 1$ condition increases with firm size, from 34 to 42 percent. The proportion of growing firms of all firms fulfilling the $\text{ICR}(3) < 1$ condition is similar when measured by growth of real value added. So in our data it is clear that growing zombie-firms are not only a start-up company phenomenon. In the firm demographics analysis below we make the distinction between shrinking and growing firms fulfilling the $\text{ICR}(3) < 1$ condition and highlight the importance of this condition. Descriptive statistics (median values) for all firms and zombies are presented in Table 1.

In the zombie literature an area of focus has been on resource misallocation and congestion effects of zombies on healthy firms (Caballero et al. 2008, Adalet McGowan et al. 2018). The argument is that the weakly performing but resilient zombies serve as a drag on the whole sector in which they operate. As they compete for the same resources (thus increasing input prices) and operate in the same market (increasing competition and reducing output prices) as healthy firms, they squeeze the profits, job creation and investment of the latter.

¹¹ The requirement that the $\text{ICR} < 1$ for three consecutive years implicitly generates a three-year age threshold.

¹² For firms aged 10 years or more 32 % have positive employment growth and $\text{ICR}(3) < 1$.

Table 1 Descriptive statistics, median values, 2001-2017.

	Non-Zombies	Zombies	Declining or equal zombies	Growing zombies
Labour productivity, 1000 euro	40.4	29.9	30.4	29.2
Firm size, workers	2.2	4.1	3.4	5.6
Firm age, years	12	15	17	13
EBIT	27.3	-25.2	-24.3	-26.8
Interest coverage ratio	13.1	-4.3	-4.4	-4.2
Implicit interest rate*	6.8	7.3	7.3	7.4
Indebtness (total debt/value added)	0.01	0.31	0.34	0.27
Leverage (total debt/total assets)	0.01	0.20	0.2	0.2
Obs.	1 951 390	68 390	42 662	25 728

* We define implicit interest rate_{it} = interest_{it}/((total debt_{it-1} + total debt_{it})/2).

To study these congestion effects in our data, we use a congestion-equation similar to those in Caballero et al (2008) and Adalet McGowan et al. (2018), albeit making the distinction between declining and growing firms with $ICR(3) < 1$:

$$\Delta x_{it} = a_0 + a_1(1 - zombie_{it}) + a_2(1 - zombie_{it}) * zombie_share_{jt} + controls_{it} + u_{it} \quad (2)$$

For the dependent variable x_{it} we used either output (real value-added, *rva*) growth, employment (*l*) growth, labor productivity (*rlp*) growth, in firm *i* in sector *j* in year *t*. $zombie_{it}$ is a dummy equal to 1 if the firm fills the $ICR(3) < 1$ criterion and the $zombie_share_{jt}$ is either the employment or capital share of zombie firms in sector *j* (the choice between labor and capital did not make any noticeable difference).

The estimates clearly suggest that not being a zombie is positively related to firm performance (e.g. faster output growth). The more interesting result is related to the cross-term $(1 - zombie_{it}) * zombie_share_{jt}$. The negative sign of this coefficient tells us that a large concentration of zombie firms in an industry is associated to lower output, employment and productivity growth, pointing to a congestion effect arising from these firms.

More interestingly, if we make a distinction between shrinking or equal and growing $ICR(3) < 1$ firms, the latter have a stronger negative congestion effect on non-zombies. Taken at face value, this seems to imply that the congestion effect that weakens the performance of non-zombies in the market may not necessarily be a question of misallocation of resources to poorly performing firms. Instead it may be simply the higher number of firms in the market – harder competition – that constrains the investment and growth opportunities of in the market.

Table 2. Congestion effects of zombies.

RHS variable	Number of firms	Decl. or equal firm	Growing firm	Capital stock	Employment	Real value added
Dependent variable	$\Delta \log(rva)$					
Non-zombie dummy	.281 (93.77)	.366 (108.16)	.099 (23.10)	.177 (59.43)	.240 (88.70)	.240 (88.48)
Non-zombie dummy	-4.887	-7.378	-13.710	-.545	-1.627	-2.149
*zombie industry share	(105.10)	(105.10)	(105.30)	(36.15)	(78.05)	(79.21)
Log likelihood	-880093	-878523	-881209	-885724	-882951	-882845
Dependent variable	$\Delta \log(l)$					
Non-zombie dummy	.231 (135.83)	.340 (178.02)	.008 (3.45)	.153 (90.32)	.191 (111.30)	.181 (106.79)
Non-zombie dummy	-3.302	-5.049	-9.806	-.314	-.934	-1.089
*zombie industry share	(128.28)	(126.87)	(132.49)	(36.81)	(78.87)	(90.66)
Log likelihood	-212463	-205836	-214337	-221184	-218364	-219074
Dependent variable	$\Delta \log(rlp)$					
Non-zombie dummy	.061 (21.93)	.046 (14.72)	.080 (20.02)	.037 (13.61)	.066 (23.62)	.079 (26.66)
Non-zombie dummy	-1.346	-2.124	-3.544	-.207	-.660	-1.041
*zombie industry share	(31.07)	(32.43)	(29.24)	(14.48)	(34.05)	(41.24)
Log likelihood	-779569	-779550	-779611	-780007	-779455	-779141

Equations are estimated with fixed firm effects. Including controls for years, sectors and age does not affect the qualitative results but the statistical properties deteriorate so that most of the coefficients of the multiplicative terms are no more significant. The number of data points for the $\Delta \log(rva)$ and $\Delta \log(rlp)$ equations is 1 429 684 and for the $\Delta \log(l)$ equations 1 661 420.

This result might also be due to some temporary changes in income and expenses. To find out whether this is the case we estimated equation (2) so that the R.H.S variables enter the equation with a lag. The lag length was extended in a stepwise manner up to three years. In almost all cases, the coefficients remained the same both in terms of magnitude and sign suggesting that the dynamic specification does not make any qualitative difference. In terms of fit, there is certainly a difference. Thus if we estimate a dynamic specification with the lagged dependent variables (i.e. with the Koyck lag structure) the t -value of the coefficient of the lagged dependent variable is between 85.39 and 120.43 (depending on the panel-setting specification) suggesting that the congestion effects are not of short-run nature only.

4 Zombie demographics

The aggregate level rise in the proportion of zombie firms has been documented in the recent literature for many OECD countries. There is little knowledge, however, of the micro-level dynamics behind the rise. Studying the behavior of the entry and exit margins into zombie status, and decomposing the exit destinations into exits out of the market (firm death) and exits to becoming a healthy firm (recovery) provides us with information on the pool of zombie firms and on the fate of firms once they have become zombies. These features have important policy implications.

4.1 Zombie entries and exits

A concern in the literature and policy debate has been the perceived increasing survival of zombie firms and policies that potentially favor this development. The stock of zombie firms is, however, determined by two flows, firm entry into and exit out of zombie status. The former has received less attention. Although some policies such as low interest rates or firm subsidies may potentially support zombie survival, at the same time the same policies may prevent firms becoming zombies in the first place.

Examining the zombie entry and exit rates, we observe a mildly increasing trend in both flows. The increase is steeper in manufacturing than in services (Figure 4). More importantly, the flows appear to follow closely (with a lag) the cyclical developments of the Finnish economy. Following the outburst of the crisis, Finnish exports and GDP collapsed in 2008-2009, followed by a short-lived recovery in 2010 and several years of stagnation in 2011-2014.¹³ In manufacturing, there was a sharp but temporary rise in the zombie entry rate following the collapse of exports and GDP. This was followed by an increase in the zombie exit rate, although the rise in the exit rate remained more moderate. These developments imply that in the aftermath of the financial crisis a part of the new zombies exited the zombie status relatively fast, but as the rise in the exit rate remained more modest than entry, a part became longer term zombies. In the stagnation phase zombie entry and exits developed more in parallel.

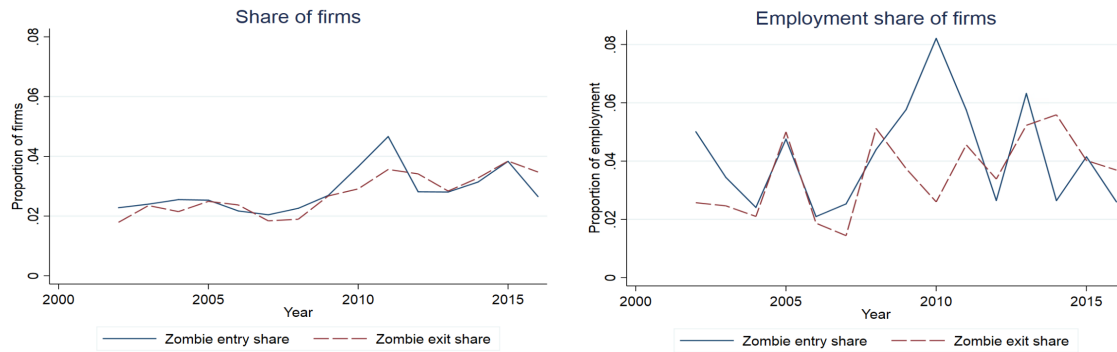
A similar, but milder, response to the financial crisis took place in services. This reflected the more indirect exposure of the services sector to foreign trade and competitiveness. However, in services zombie entries started rising again in 2014-2015, reflecting the stagnant domestic economy. The exit rate followed almost in parallel, though, so zombie spells on average remained short. In the last year of the data, zombie exits have been higher than entries, consistent with the recovery of the economy.

The proportion of zombie firms does not directly reveal the economic significance of these changes, as small firms dominate the population of firms in our data. This is a common feature observed across countries, see e.g. Bartelsman et al. (2009). To gain further insight we assess the changes in zombie shares by weighting the firms by employment. From the right-hand-side panels of figure 4 we see that the fluctuations in employment weighted zombie proportions is significantly larger than the simple firm proportions. This means that large firms were proportionally more prone to both enter and exit the zombie status. Moreover, in employment weighted terms there is hardly any rising trend even if the pure proportion of zombie firms exhibits a mild rise. This suggests that any trend rise in zombies is related to smaller firms, but the macroeconomic significance of the phenomenon has not changed.

¹³ The drop in year-on-year GDP was over 9% in 2009Q1 and that of the volume of exports of goods and services over 20% in 2009.

Figure 4. Share of zombie firms and employment share by demography status, 2002-2016.¹⁴

a. Manufacturing



b. Private services



4.2 Zombie exit destinations: deaths and recoveries

We next study the fate of zombies by examining the exit destinations. A firm may exit the zombie status because of a shutdown and it exits the market (firm death). A firm may also leave the zombie status due to recovery, so that it becomes a healthy firm ($ICR \geq 1$). The fate of the zombies is a key issue for policy recommendations, as providing life support (by e.g. subsidies or low interest rates) to death-ripe firms is harder to justify than supporting temporarily unprofitable but rising firms.¹⁵

¹⁴ We have defined zombies as firms with $ICR < 1$ for three consecutive years. However, for many firms the duration of zombie spells is significantly longer. Of all zombie spells, roughly a half have a duration of 3 years and a fifth of the spells have a duration of 4 years, 10 percent have a duration of 5 years and the remaining 15 percent have a longer duration. Although the number of firms with very long zombie spells is relatively low, it is still noteworthy that firms are able to survive as zombies for extended time periods. In the data almost 2 percent of the zombie spells have a duration of 10 years or longer. As for the recurrence of zombie spells, the data shows that most companies that become zombies have only one zombie spell. Some firms do have repeated zombie spells however. Almost 10 percent of firms have 2 spells, but there are very few firms that have more. The maximum number of years in the sample is 17, which obviously restricts the number (and length) of possible zombie spells.

¹⁵ In the literature the fate of zombie firms has received relatively little attention, although a couple of recent studies have addressed the eventual recovery of zombie firms in Japan (e.g. Fukuda and Nakamura 2011, Nakamura 2017, Goto and Wilbur 2018).

Figure 5. Proportions of zombie exits: recovery and death, 2002-2016.



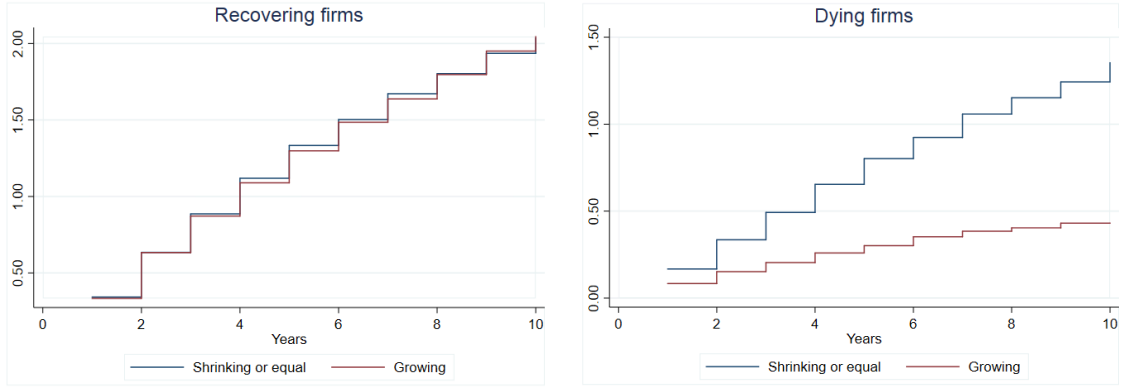
Strikingly, in our data zombie spells frequently end in recovery: the share of dying firms was 34 % and the share of recovering zombie firms was 66% in 2017, so two thirds of the zombie spells end in a recovery to becoming a healthy firm. The recovery share is also remarkably stable over time. The high recovery rate could potentially reflect the previously highlighted feature of the data, that a large share of firms classified as zombies may in fact be growing firms that are temporarily unprofitable due to e.g. restructuring or investments into future profitability.

To study the exit destinations of zombie firms in more detail we examine the cumulative exit hazards of zombie firms to each exit destination (recovery or death) for declining and growing zombies (Figure 6). These cumulative hazard estimates show that the recovery hazards for shrinking zombie firms are very similar to those of growing zombies (Figure 6, left panel). A possible explanation for the relatively small differences between the growing and declining zombies could be that the truly distressed firms, as a response to their weak performance, take downsizing measures to restore profitability and promote recovery.

However, the differences are larger in the death hazards. The death hazards are considerably higher for shrinking zombie firms than for the growing zombies (Figure 6, right panel). This corresponds to the hazard rates of growing vs. declining firms overall (including non-zombies), pointing to a “shadow of death” effect: a decline in operations, if driven by demand and not cost-cutting measures to enhance profitability, is naturally more likely to result in the firm exiting from the markets. In our data, of dying firms over 70 % are declining and 20 % are growing.¹⁶ Moreover, growing zombie firms may survive

¹⁶ The literature has pointed out the stylized fact that the performance of firms in terms of productivity and employment growth deteriorates in the years before exit (Griliches and Regev 1995, Almus 2004).

Figure 6. Nelson-Aalen cumulative exit hazard estimates for declining and growing zombie firms, 2003-2016.



longer as zombies because they have positive prospects and are possibly more likely to receive funding during a non-profitable spell. This does not, however, seem to translate into a higher recovery hazard in a similarly clear manner. In the data, of recovering firms 56% are declining and 37 % are growing.

4.3 Determinants of exit destinations and zombie duration: competing risks model

We next analyze the determinants of the duration of zombie spells i.e. we model the probability of exiting the zombie status on the condition that the firm still was a zombie in the previous year. To explain the duration of zombie spells we follow Ilmakunnas and Nurmi (2010) by applying discrete-time duration models. A discrete-time model is preferred because the annual nature of the data causes interval-censoring. We use flow data of new cohorts of zombies to avoid problems of modelling the initial participation decision.

We use a discrete-time proportional hazard duration model, where the discrete interval hazard rate follows a complementary log-log distribution (e.g. Prentice and Gloeckler, 1978)

$$h_{it} = \text{prob}(T_i < t + 1 | T_i \geq t) = 1 - \exp[-\exp(\beta'x_{it} + \gamma_t)] \quad (3)$$

where γ_t is the baseline hazard, which is modelled by including duration dummies for each interval t in the estimation. T_i refers to the analysis time or the duration from entry into zombie status until exit from zombie status. $\beta'x_{it}$ is a linear function of the explanatory variables related to zombie exit. We extend the overall zombie exit model to an independent competing risks setting where we estimate separate models for two alternative exit destinations, i.e. 1) exit from the zombie status to a recovery and continuing as a non-zombie, 2) exit from the zombie status accompanied by a complete shutdown of

Table 3. Exit destinations and firm characteristics, competing risks model.

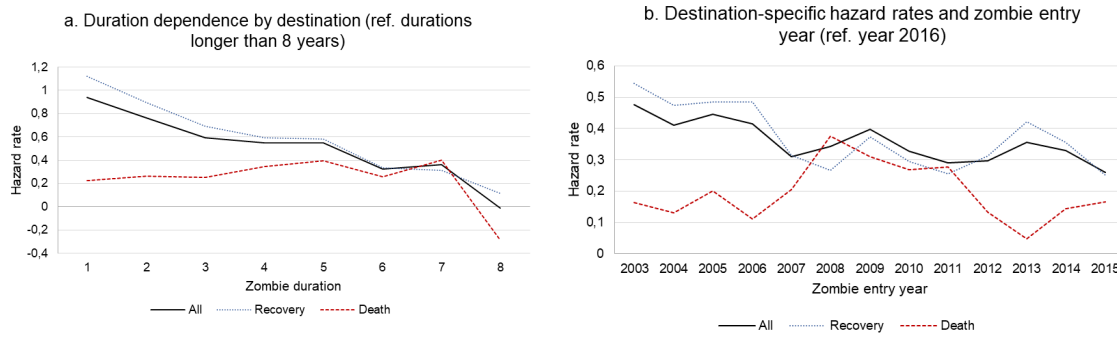
Variables	All zombie exits	Recovery	Death	Recovery		Death	
				Declining /stable	Growing	Declining /stable	Growing
Log of labor productivity	0.0188 (1.782)	0.195 (14.88)	-0.270 (-16.98)	0.186 (11.65)	0.229 (10.11)	-0.238 (-13.24)	-0.436 (-14.48)
Log of employment	-0.248 (-32.59)	-0.105 (-13.45)	-0.577 (-28.75)	-0.0931 (-9.371)	-0.142 (-10.40)	-0.540 (-24.20)	-0.351 (-8.768)
Log of capital intensity	-0.0407 (-10.10)	-0.0440 (-9.823)	-0.0327 (-4.247)	-0.0383 (-6.878)	-0.0539 (-7.505)	-0.0226 (-2.603)	-0.0922 (-5.867)
Exporter	0.00126 (0.0436)	-0.00971 (-0.303)	-0.0603 (-0.961)	-0.0168 (-0.413)	0.00848 (0.157)	-0.0983 (-1.379)	-0.121 (-0.881)
Firm age 5-10 years	0.0460 (1.827)	0.210 (6.782)	-0.294 (-6.827)	0.277 (6.306)	0.145 (3.216)	-0.370 (-7.141)	-0.281 (-3.426)
Firm age 10-15 years	0.0523 (1.962)	0.317 (9.877)	-0.508 (-10.57)	0.347 (7.777)	0.320 (6.611)	-0.592 (-10.56)	-0.561 (-5.549)
Firm age over 15 years	0.00423 (0.182)	0.299 (10.59)	-0.617 (-15.04)	0.333 (8.217)	0.289 (7.056)	-0.714 (-14.64)	-0.714 (-8.836)
Observations	45,335	45,335	45,335	28,588	16,747	28,571	16,514
Log likelihood	-29356	-27543	-14824	-17358	-10118	-10677	-3831

Discrete-time proportional hazard duration model where the discrete interval follows a complementary log-log distribution. Controls not reported include dummies for durations, zombie cohorts, company type, 2-digit industry and nuts3-region. Clustered standard errors by firm. Only zombie entries from 2003 onwards are included.

firm operations or death. In addition, we consider these two exit destinations separately for declining and growing firms. The underlying assumption is that there are no correlations between unobservable factors affecting each destination-specific hazard. Spell endings to the other destination are treated as right censored at the point of exit. We allow for multiple spells per firm in the estimations.

In the exit models, we include various time-varying firm-level explanatory factors explaining zombie duration, including firm size, age, productivity, capital intensity and controls for zombie entry year, industry and region. According to the results in Table 3 and Figure 7, a single-destination model on all zombie-exits does not provide a rich enough picture of the exit process. There appear to be clear differences between the factors behind the different exit destinations. First, we find that with recovery the baseline hazard rate (modelled by including duration dummies for each interval) clearly declines with the time spent as a zombie whereas for death there is no clear pattern of duration dependence (see Figure 7a). This suggests that the chances of recovery deteriorate over time whereas longer zombie duration does not predict death after observable firm characteristics are controlled for. The best firms recover rapidly so the remaining, selected group of firms have much lower chances of exiting the zombie status due to their characteristics.

Figure 7. Destination-specific hazard rates by zombie entry year and duration.



As expected, there are opposite effects of labor productivity on recovery and death. Higher labor productivity is positively related to the probability of recovery and negatively related to the probability of death. This reflects productivity enhancing reallocation between continuing firms (as opposed to entry and exit only). Furthermore, the coefficients for labour productivity are somewhat larger for growing firms than for declining firms, indicating that the relationship between productivity and exiting either by recovery or death may be stronger for growing firms. There may be a number of reasons for this.

For example, productivity for growing firms may have more importance for their future decisions and profitability, whereas for declining firms productivity is usually lower on average and it does not seem to predict their future as much. One reason may be poor management or other factors in declining firms that the model does not capture. These firm dynamics reflect productivity augmenting changes in firm structures pointing to resource reallocation between continuing firms, not only entry and exit.

Both zombie exit risks, i.e. the chance of recovering to a healthy firm and the probability of a complete shutdown decrease with firm size (employment) and capital intensity. Put differently, larger firms with heavier sunk costs are more likely to continue as zombies. A 10% increase in firm size decreases the risk of death by about 6%. One explanation for the negative relationship between firm size and zombie death can be that local authorities may be reluctant to let a large company fail if the immediate regional employment consequences are large. However, also the chances of recovery fall with size which may refer to more complex financial arrangements or rigid structures of large firms. The role of public subsidies to firms will be discussed in the following section.

There are opposite effects of firm age on recovery and death. Higher firm age is positively related to the probability of recovery and negatively related to the probability of death on the condition that the firm has survived so far as a zombie. According to the results, the hazard of death for a zombie-firm older than 15 years is $\exp(-0.617) = 0.5$ times the hazard for a zombie-firm less than 5 years old. Old well-

established firms may have “deeper pockets” or better access to external finance which help them through rough patches, whereas younger firms’ financial constraints may be tighter.

We also observe that the more recent the zombie entry year, the lower is the exit hazard from zombie status (Figure 7b). In particular this seems to be the case for the recovery hazard which has declined with the zombie entry year. This indicates an increased incidence of “long term zombies”. The death hazard has not declined in a similar manner, rather there was a period of a higher death hazard for firms that became zombies over the crisis years 2008-2011, after which the death hazard returned to the pre-crisis level.

5 Policy application: do government subsidies keep zombies alive?

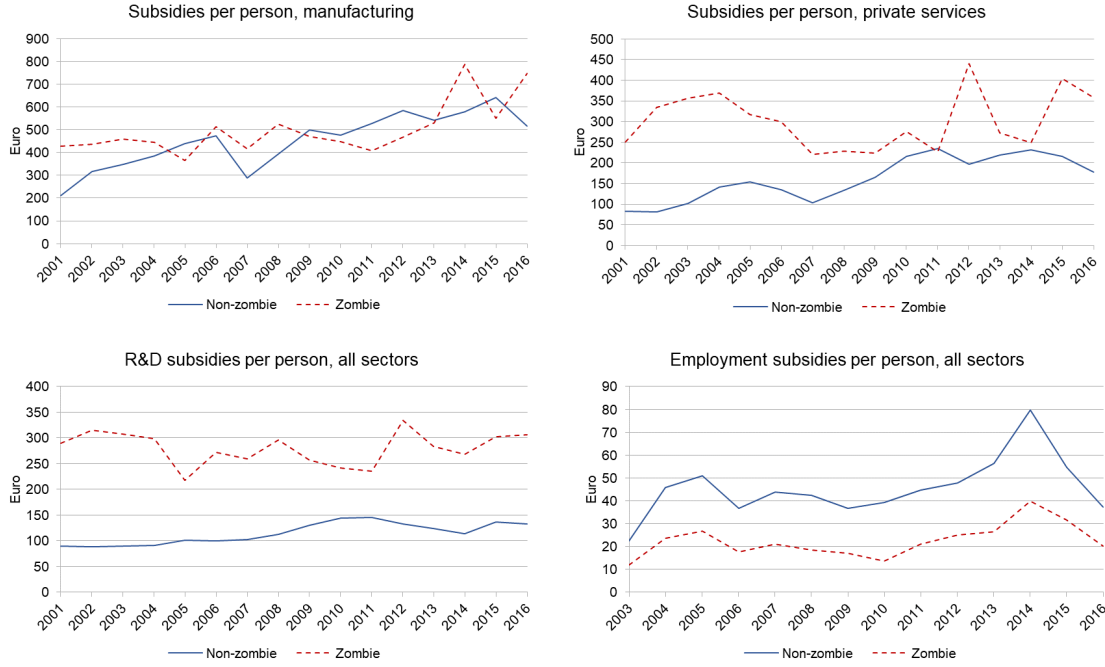
We next apply our framework to study the effect of government subsidies on zombie demographics. The policy relevance is clear as public subsidies to firms are of a considerable magnitude (Figure 8) and to the degree that zombies are low productivity firms and congest the markets in which they operate, public subsidies may distort markets in a harmful way. Our data is particularly suitable to study the effect of government subsidies on zombie demographics as it includes firm level information on public subsidies paid to firms, both at the aggregate subsidy level and disaggregated to various subsidy categories (R&D, employment, energy subsidies etc.). Also, as we discuss below, low interest rates and bank forbearance are less relevant for Finland.¹⁷

In Finland the evolution of public subsidies to firms at the aggregate level is similar in manufacturing and services, albeit in services there is a larger difference between zombies and non-zombies receiving subsidies. The level of subsidies in manufacturing is overall higher than in services. In individual subsidy categories there are some differences (Figure 8).¹⁸

¹⁷ The recent literature has discussed the possible role of economic policies in generating the rise in the proportion of zombie firms (e.g. Acharya et al. 2017, Borio 2018, Jiang et al. 2017). These policies include government subsidies to companies (e.g. Jiang 2017), subsidized loans to insolvent companies and the holding of non-performing corporate loans in banks' balance sheets (e.g. in Japan in the 1990s, see e.g. Hoshi 2000, Caballero et al. 2008). The impact of exceptionally low interest rates on the survival of zombies (e.g. Adalet McGowan et al 2017, Acharya et al 2017, Borio 2018) has also recently been highlighted. See appendix A1 for a brief discussion on Finland.

¹⁸ The subsidies are expressed as subsidies per person in all firms of a sector (Laukkanen and Maliranta 2019). The figures thus include also firms that do not receive subsidies. We use subsidies per person because it characterizes subsidies in a comparable way in different firm subpopulations.

Figure 8. Government subsidies to firms.



Although government subsidies to firms are substantial in many countries, their role to the survival of weakly performing firms has been studied relatively little (one exception is Jiang et al. 2017). One of the reasons for this is likely to be the wide variety of forms of enterprise support, and that the impact of the various forms of support can be expected to differ, at least in quantitative terms. This diversity also applies to the data available to us (Figure 8).

5.1 Government subsidies and zombie survival

One possible explanation for the persistent survival of zombie companies is that they receive disproportionate amounts of subsidies (for example employment subsidies and start-up funding). We tested this hypothesis with our panel data by examining a simple regression model of dependency between firm subsidies and weak firm performance. We use the specification

$$\Delta(\text{Zombie}_{it}) = \alpha_{i0} + \beta_1 \text{Zombie}_{it-1} + \beta_2 \text{share}_{it} + \beta_3 d_subs_{it} + \text{controls} + \mu_i, \quad (4)$$

where the dependent variable is the indicator of a zombie firm, *share* indicates the zombie firms' share of subsidies in each industry, *d_subs* is a dummy variable that shows whether the firm has received subsidies. Table 3 presents results of logit estimates (*Logit*) and, to get a picture of marginal effects, a set of results from a linear probability model (*OLS*).

Table 4. Zombies and firm subsidies.

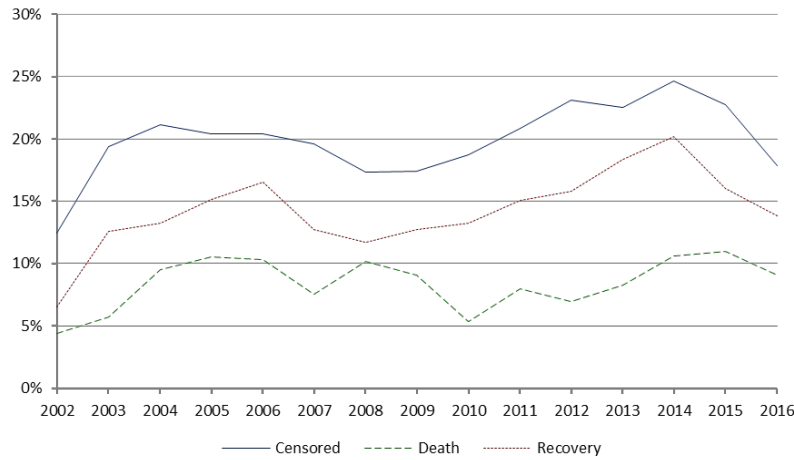
	1	2	3	4	5	6	7
Zombie _{t-1}	3.917 (267.03)	3.651 (163.61)	2.918 (140.79)	2,295 (94.88)	1.136 (223.75)	.272 (453.84)	.606 (1057.78)
share	1.064 (32.46)	.909 (20.59)	1.257 (30.54)	1.605 (24.49)	.665 (41.87)	.023 (12.35)	.021 (32.02)
d_subs	.436 (38.87)	.155 (7.36)	.665 (36.42)	.821 (28.71)	335 (39.73)	.041 (42.12)	.014 (35.21)
controls	years	years	years	years	years	years, sectors, age	years
R ² /sigma_u	0.987	0.961	1.287	1.110	1.268	0.1362	0.2949
Panel	Logit; RE	Logit, RE	Logit, RE	Logit; RE	Logit, RE	OLS, RE	OLS, RE
zombie def	Z3	Z3D	Z3G	Z3F	Z1	Z1	Z3

The dependent variable is the indicator of a Zombie-firm. Z3(Z1) denotes a zombie firm for a three-year (one-year) period, Z3D (Z3G) denotes a zombie with declining (growing) employment for a three year -period. Z3F denotes a zombie that continues operations at period t+1. Share indicates the zombie firms's share of subsidies in each industry, d_subs is an indicator variables that shows whether the firm has received subsidies. OLS denotes linear probability model and Logit RE denotes Logit estimates.

We use a number of different definitions for zombies. As a benchmark, in column 1 of Table 3 we define zombie firms as those having $ebit/interest < 1$ for three consecutive years (Z3) without any other restrictions. This follows the definition of e.g. Adalet McGowan et al. (2018), except that here there is no age restriction for the firms. In column 2 we use a similar definition but make a restriction to only those zombies that are declining or remain equal (Z3D) in terms of employment for a three year-period. In column 3 we take account of only those zombies that are growing (Z3G) in terms of employment for a three year-period. In columns 4-6 we consider a broader zombie definition s.t. one year with $ebit/interest < 1$ is a sufficient condition to be classified as a zombie, as well as some results with OLS.

The outcome of the estimation results suggest that government subsidies are related to the presence of zombie firms and to their allocation across industries (Table 4). The bigger the share of subsidies allocated to zombie firms in a sector, the higher is the proportion of zombie firms. Similarly, the fact that a firm receives subsidies increases the probability that a firm is a zombie firm. The result does not depend on the way of defining a zombie firm nor the estimator or the controls. A problem is that the data do not allow us to make affirmative conclusions on causality. We do not know whether subsidies are requested before the zombie phase, in anticipation of financial difficulties, or after the difficulties have been realized.

Figure 9. The share of zombie firms receiving subsidies by year and exit category, 2002-2016.

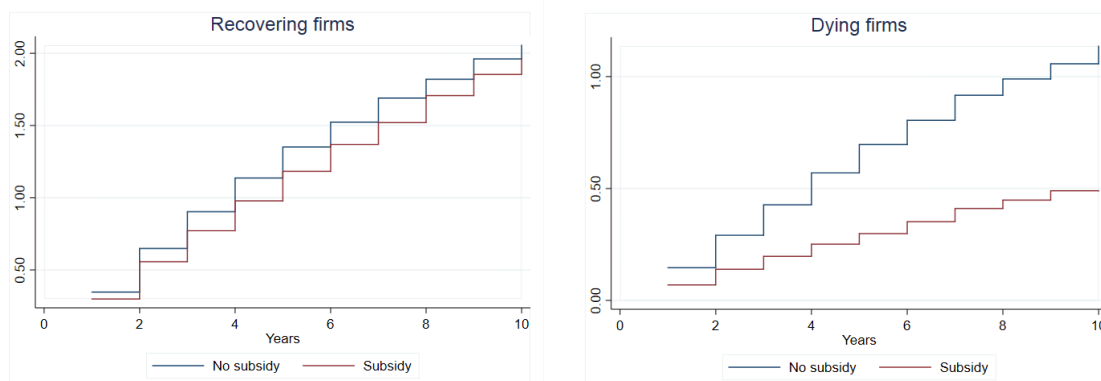


The analysis in Section 3 points to the importance of a shortfall of zombie-exits relative to entries in most years and to the increasing number of “long-term zombies” in generating the rise in weakly performing firms. We therefore take a closer look at subsidies in relation to the zombie-exit margin. Figure 9 plots the shares of zombie firms receiving subsidies by exit category. For recovering firms the share receiving subsidies is on average 13,4% and those not receiving subsidies 86,6%. For dying firms the corresponding shares are on average 7,9% and 92,1%. Thus recovering firms are more frequently subsidy receivers. However, for those firms that do not exit the zombie status i.e. remain as zombies the share receiving subsidies is the highest, 18,3%. This may be an indication of the existence of firms that are permanently or for prolonged periods dependent on life-support through subsidies.

The cumulative hazard estimates for firms that do and do not receive subsidies are plotted in Figure 10. The figures show that there is hardly any difference between firms that do and do not receive subsidies in the hazards for recovering zombie firms (left panel). However, the differences are large in the hazards for dying firms (right panel). The death hazards are considerably lower for firms that receive subsidies.

According to these descriptive results, it would seem that the subsidies are not a decisive feature driving the recovery of weakly performing firms. However, these results suggest that firms receiving subsidies have a lower death rate. This may manifest as longer zombie spells, if the subsidies do not pull the firms to recovery but only keep them alive as zombies. This result is consistent with Ottaviano et al. (2009) and Koski and Pajarinen (2014), who argue that subsidy allocation to relatively inefficient firms may increase their survival probability at the cost of industry-level performance and consequently hinders re-allocation of resources to the more efficient firms.

Figure 10. Nelson-Aalen cumulative exit hazard estimates for subsidized and non-subsidized zombie firms, 2003-2016.



5.2 Government subsidies and exit destinations: competing risks model

We next apply a similar simple independent competing risks model as in Section 3.4 to study the role of public subsidies to firms as a factor behind the different exit destinations. We consider an aggregate measure of subsidies as well as a sub-division by subsidy type. As in Section 3.4, we analyze different exit destinations, recovery and death, as well as different types of zombie firms, declining and growing.

When controlling for numerous firm-specific factors, the results in Table 5 suggest that firms receiving subsidies are less likely to die. We find that the coefficient for receiving a subsidy is highly statistically significant and negatively related to death. According to the results, the hazard of death for a subsidized firm is $\exp(-0.441) = 0.6$ times the hazard for a non-subsidized firm.

The aggregate subsidy variable used incorporates various subsidies of different types, with possibly differing effects on firms. Also firms that apply for R&D-subsidies or employment subsidies may differ. It is also possible that the firm receives more than one type of subsidy. We therefore consider the subsidy sub-categories separately, namely we analyse the effects of R&D subsidies, employment subsidies and other subsidies (Table 5). Here we find that the death hazards are lower for recipients of all types of subsidies, so that subsidizing a zombie is related to higher chances of survival. However, the recovery hazards decrease with R&D subsidy and increase with employment subsidy. This result may seem puzzling at first glance, it may be related to firms being in a growth phase where their financial status as a zombie continues even after receiving a subsidy.

Table 5. Exit destinations and firm subsidies, competing risks model.

	All zombie exits	Recovery	Death	All zombie exits	Recovery	Death
Subsidy received	-0.157 (-6.580)	-0.0415 (-1.559)	-0.441 (-8.183)			
R&D subsidy				-0.278 (-5.410)	-0.271 (-4.844)	-0.269 (-2.190)
Employment subsidy				-0.0957 (-3.462)	0.0139 (0.455)	-0.387 (-6.150)
Other subsidy				-0.165 (-3.519)	-0.0164 (-0.322)	-0.556 (-4.814)
Observations	45,335	45,335	45,335	45,335	45,335	45,335
Log likelihood	-29334	-27542	-14786	-29326	-27531	-14783

Discrete-time proportional hazard duration model where the discrete interval follows a complementary log-log distribution. Controls not reported include firm type, firm labour productivity, firm size, firm age, capital intensity, exporter status, dummies for durations, zombie cohorts, 2-digit industry and nuts3-region. Clustered standard errors by firm. Only zombie entries from 2003 onwards are included.

In order to shed light on the differences between zombies according to their growth phase, we examine the relationship between subsidies and exit destinations by firm growth category (Table 6). We observe some differences across declining and growing firms. The results for the aggregate subsidy variable show a negative relation between receiving subsidies and firm death for both growing and declining firms. For recovery, only the relatively small but negative relationship for growing firms is statistically significant.

If we examine the R&D subsidy in isolation the relationship between subsidies and death as well as recovery is negative for both growing and declining firms, so the growth phase of the firm does not explain this result on recovery. As expected, the negative relationship is the strongest between R&D subsidies and death for growing zombies, though. We further examine the interaction of firm size and R&D subsidies to zombie recovery (results are not reported here). We find some evidence that for larger zombies with at least 20 persons the negative relationship is very small, close to zero. Hence R&D subsidies to small firms may be more ineffective or time-demanding in relation to recovery.

There are also differences for the employment subsidy. The death hazards are more or less equal for declining and growing firms, but the negative relationship for recovering firms is not statistically significant.

These results would suggest that it is important to make a distinction between different kinds of zombie firms. But an important observation is that defining only declining zombie firms as zombies does not change the main conclusions. Controlling for size and age is important as well.

Table 6. Exit destinations by growth category and firm subsidies, competing risks model.

	Recovery		Death		Recovery		Death	
	Declining /stable	Growing	Declining /stable	Growing	Declining /stable	Growing	Declining /stable	Growing
Subsidy received	-0.0147 (-0.397)	-0.0814 (-2.092)	-0.373 (-5.469)	-0.373 (-4.093)				
R&D subsidy					-0.200 (-2.780)	-0.350 (-3.781)	-0.157 (-1.069)	-0.440 (-1.945)
Employment subsidy					0.0408 (0.929)	-0.0252 (-0.591)	-0.317 (-3.891)	-0.319 (-3.130)
Other subsidy					-0.0229 (-0.328)	-0.0184 (-0.242)	-0.572 (-3.890)	-0.336 (-1.748)
Observations	28,588	16,747	28,571	16,514	28,588	16,747	28,571	16,514
Log likelihood	-17358	-10116	-10661	-3822	-17354	-10110	-10658	-3821

Discrete-time proportional hazard duration model where the discrete interval follows a complementary log-log distribution. Controls not reported include firmcompany type, firm labour productivity, firm size, firm age, capital intensity, exporter status, dummies for durations, zombie cohorts, 2-digit industry and nuts3-region. Clustered standard errors by firm. Only zombie entries from 2003 onwards are included

We have done various robustness checks related to the definition of zombie exit and the selection of explanatory variables. The results are available upon request. First, regarding the definition of subsidies, using granted subsidies instead of paid subsidies affects the timing of the subsidy variable because the decision to grant a subsidy may precede the (possibly multiple) payments in several years. Even though the subsidy decision is meaningful to the firm, the payments are more closely related to the actual performance of the firm. However, we found that granted subsidies have very similar relationships with zombie exit destinations as paid subsidies.

Second, it is a common problem with business data analysis that the definition of firm birth and death is vulnerable to organizational changes that affect the firm identification code. As a robustness test, we have repeated the analysis using firm age defined according to the oldest establishment in the firm. The identification code of the establishment does not usually change as a result of mergers or acquisitions, which allows us to follow the continuation of operations in these firms in a more reliable way. Using firm age defined in this manner did not alter our results. Correspondingly, we found that 83% of all firm deaths can be considered as ‘real’ when cleansing for the artificial exit but this did not have any considerable effect on the coefficients of our interest.

Finally, noting that we may exclude some important explanatory variables related to differences in firm strategy and human capital, we tested controlling for firm-level unobserved heterogeneity by including normally distributed random effects in the model. However, the main results from the random effects model did not differ considerably from the pooled estimates. Using a multinomial logit model as an alternative model specification also resulted in similar findings.

To summarize, our results strongly suggest that firms receiving subsidies are less likely to die, regardless of the type of subsidy. However, with regard to recovery there is heterogeneity in the effects depending on the type of firm and the type of subsidy received. To conclude, we are not able to find any robust positive association of subsidies with zombie recovery. The results would seem to suggest that receiving a subsidy is not related to a considerable positive change in firm performance in relation to its debt level. Instead it may enable the firm to continue as a zombie or even be a prerequisite for operations. Thus, the existence of subsidies may provide one explanation to why zombie firms can survive over time.

Although we may argue that selection bias related to the allocation of subsidies is less severe when restricting the analysis on a distinctive group of zombie firms, we cannot however draw conclusions on the causality of subsidies on death or recovery of zombies or in relation to all firms. Instead we are able to paint a clearer picture on zombies as a persistent and highly policy-relevant phenomenon.

6 Conclusions

A rise in the proportion of zombie firms in the firm population across OECD economies in recent years has raised concern, as this phenomenon has been considered as an indication of resource misallocation. In the literature zombie firms are typically found to be less productive than other firms and they tend to have negative externalities on healthy firms by congesting markets.

Our analysis reveals features of zombie firms that importantly change generally accepted views of these firms and their effects as presented in the recent literature and policy narratives. An examination of zombie demographics on Finnish firm-level data reveals that zombie-firms, as commonly defined in the literature, are often not truly distressed firms but rather companies with temporarily low revenues relative to interest payments. Partly this is due to cyclical movements in output. More importantly, we find that roughly a third of these firms are in fact growing companies and two thirds recover from the zombie status to become healthy firms. We also show that the increase of zombie firms over the past 15 years has mainly been driven by cyclical factors, as opposed to a secular trend.

In our policy application on government subsidies to firms, we examine whether one possible explanation for the persistent survival of zombie companies is that they receive disproportionate amounts of public subsidies. Our results indeed suggest that government subsidies are related to the presence of zombie firms and to their allocation across industries. Our results strongly suggest that firms receiving subsidies are less likely to die, regardless of the type of subsidy. However, we are not able to find any robust positive association of subsidies with zombie recovery. Overall, it seems that

government subsidies are not a decisive feature driving the recovery of weakly performing firms. However, these results suggest that firms receiving subsidies have a lower death rate. This may manifest as longer zombie spells, if the subsidies do not pull the firms to recovery but only keep them alive as zombies. Thus, the existence of subsidies may provide one explanation to why zombie firms can survive over time.

In the zombie literature a key area of focus has been on resource misallocation and congestion effects of zombies on healthy firms. The weakly performing but resilient zombies serve as a drag on economic growth, as their productivity is generally lower than that of other firms and the resources allocated to them could be used more efficiently elsewhere in the economy. Our finding that also the growing “false zombies” have congestion effects on other firms in the market, raises the question of whether it is simply higher competition that reduces the performance of other firms, not misallocated resources. More importantly, our finding that two thirds of firms that exit the zombie status recover back to become healthy firms, casts more doubt on the concern over the congestion effect of zombies on healthy firms. If the zombie status reflects e.g. restructuring of firms into future performance, the policy conclusion of minimizing the number of these firms is misguided.

References

Acharya, Viral, Crosignani, Matteo, Tim; Eufinger, Christian and Hirsch, Christian, 2019. “Zombie Credit and (Dis-)Inflation: Evidence from Europe”. mimeo.

Acharya, Viral; Eisert, Tim; Eufinger, Christian and Hirsch, Christian, 2019. “Whatever it takes: The real effects of unconventional monetary policy”, *The Review of Financial Studies*, Vol. 32, Issue 9, September 2019, 3366–3411.

Adalet McGowan, Muge, Andrews, Dan and Millot, Valentine 2017. "Insolvency regimes, zombie firms and capital reallocation," OECD Economics Department Working Papers 1399.

Adalet McGowan, Muge, Andrews, Dan and Millot, Valentine, 2018. "The Walking Dead?: Zombie Firms and Productivity Performance in OECD Countries," *Economic Policy*, Volume 33, Issue 96, October 2018, Pages 685–736.

Aherne, A. and N. Shinada, 2005. “Zombie firms and economic stagnation in Japan”. *International Economics and Economic Policy* 2, 363-381.

Almus, M., 2004 “The Shadow of Death – An Empirical Analysis of the Pre-Exit Performance of New German Firms”. *Small Business Economics* 23, 189–201.

Andrews, Dan, Chiara Criscuolo, Peter N. Gal, 2016. "The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy," OECD Productivity Working Papers 5.

Bank of Korea, 2013. “Financial Stability Report”, Bank of Korea, Seoul.

Bartelsman, Eric, John Haltiwanger and Stefano Scarpetta, 2009. "Measuring and Analyzing Cross-country Differences in Firm Dynamics," NBER Chapters, in: Producer Dynamics: New Evidence from Micro Data, pages 15-76 National Bureau of Economic Research, Inc.

Bernard, Andrew B. and Bradford Jensen, J., 1999. "Exceptional exporter performance: cause, effect, or both?," *Journal of International Economics*, Elsevier, vol. 47(1), pages 1-25, February.

Borio, C. , 2018. "A blind spot in today's macroeconomics? Panel remarks in BIS-IMF-OECD Joint Conference on "Weak productivity: the role of financial factors and policies" Paris, 10–11 January 2018. <https://www.bis.org/speeches/sp180110.pdf>

Caballero, J., T. Hoshi and A. Kashyap, 2008. "Zombie Lending and Depressed Restructuring in Japan." *American Economic Review*, 98:5, 1943–1977

Criscuolo, Chiara, Peter N. Gal and Carlo Menon, 2014. "The Dynamics of Employment Growth: New Evidence from 18 Countries," CEP Discussion Papers dp1274.

Decker, Ryan A., John C. Haltiwanger, Ron S. Jarmin and Javier Miranda, 2018. "Changing Business Dynamism and Productivity: Shocks vs. Responsiveness," NBER Working Papers 24236.

Fukuda, Shin-ichi. and Nakamura, Jun-ichi., 2011. "Why Did 'Zombie' Firms Recover in Japan?". *The World Economy*, 34: 1124-1137.

Gopinath, Gita, Sebnem Kalemli-Ozcan, Loukas Karabarbounis, and Carolina Villegas-Sanchez. 2017. "Capital Allocation and Productivity in South Europe." *Quarterly Journal of Economics* 132 (4): 1915-1967.

Goto, Yasuo and Scott Wilbur, 2018. "Unfinished business: Zombie firms among SME in Japan's lost decades", *Japan and the World Economy*, Vol. 49, March 2019, 105-112

Griliches, Z. ja Regev, H., 1995. "Firm Productivity in Israeli Industry: 1979-1988". *Journal of Econometrics*, 65(1), 175-203.

Hoshi, Takeo. 2000. "Naze Nihon wa Ryudosei no Wana kara Nogarerareainoka?" (Why is the Japanese Economy Unable to Get Out of a Liquidity Trap?). In *Zero Kinri to Nihon Keizai* (Zero Interest Rate and the Japanese Economy), ed. Mitsuhiro Fukao and Hiroshi Yoshikawa, 233–66. Tokyo: Nihon Keizai Shimbunsha.

Hoshi, Takeo. 2006. "Economics of the Living Dead." *Japanese Economic Review*, 57(1): 30–49.

Ilmakunnas, Pekka & Satu Nurmi, 2010. "Dynamics of Export Market Entry and Exit," *Scandinavian Journal of Economics*, vol. 112(1), 101-126.

Jiang, Xinfeng, Sihai Li and Xianzhong Song, 2017. “The mystery of zombie enterprises – “stiff but deathless”, *China Journal of Accounting Research*, 10, 4, (341).

Koski, H. ja Pajarinen, M., 2014. ”Subsidies, the Shadow of Death and Labor Productivity.” *Journal of Industry, Competition and Trade*, 1-16.

Laukkanen, Marita and Maliranta, Mika, 2019. ”Yritystuet ja kilpailukyky”, Valtioneuvoston selvitys- ja tutkimustoiminnan julkaisusarja 2019:33.

Lopez-Garcia, P. , di Mauro, F., the CompNet Task Force, 2015. “Assessing European competitiveness: the new CompNet microbased database”. ECB Working Paper 1764. March.

Nakamura, Jun-ichi, 2017. “Japanese Firms During the Lost Two Decades: The Recovery of Zombie Firms and the Entrenchment of Reputable Firms”. Springer, Tokyo.

Ottaviano, G., Kangasharju, A. and Maliranta, M., 2009. ”Local innovative activity and regional productivity: implications for the Finnish national innovation policy. In Evaluation of the Finnish National Innovation System – Full Report”, The Ministry of Education and the Ministry of Employment and the Economy, 203–238. Helsinki: Taloustieto.

Prentice, R., and Gloeckler, L., 1978, ‘Regression analysis of grouped survival data with application to breast cancer data’, *Biometrics* 34, 57-67.

Schivardi, Fabiano, Enrico Sette and Guido Tabellini. 2018. “Credit Misallocation During the European Financial Crisis”, Working Papers LuissLab 18139, Dipartimento di Economia e Finanza, LUISS Guido Carli.

Steinkamp, S., Tornell, A. and Westermann. 2018. “Evergreening in the Euro Area: Facts and Explanation”. Working Papers 113, Institute of Empirical Economic Research, Osnabrueck University.

Stroz, N., M. Koetter, R. Setzer and A. Westphal, 2017. “Do we want these two to tango? On zombie firms and stressed banks in Europe”. ECB Working Paper 2104.

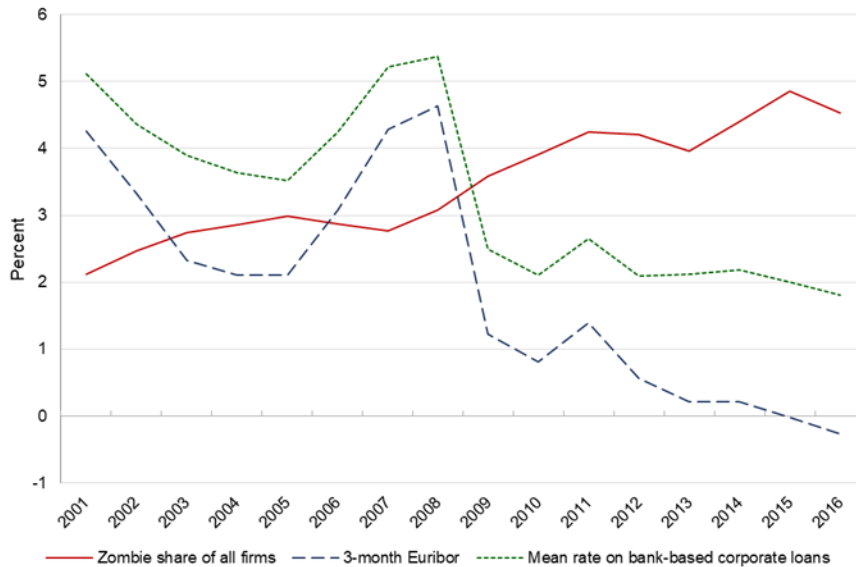
Appendix

A.1 Low interest rates

The recent literature has studied the role of ultra-light monetary policy as a factor behind the rise of zombies. The idea that low interest rates are related to the rise of zombies might seem obvious, as the rise of zombies coincides with the fall in interest rates (Figure A1). However, it is not so straightforward to explain a propagation mechanism that would explain the observed correlation. In fact, low interest rates should in the first place lower interest expenses and thus increase (not decrease) the values of *ebit/interest* expenses.

A more sensible explanation is related to cyclical developments of the economy after the financial crisis in 2008-2009. Lower output and income brought more firms to the limit of survival. In this kind of environment, low interest rates allowed poorly performing firms to obtain more loans and the low interest rate in the zombie measure ($ebit/interest < 1$) was compensated for by increased indebtedness thus producing a larger number of zombie firms. Thus, low interest rate could be a factor that prevented the death rate of firms from rising. At the same time, however, low interest rates may have reduced entry into zombie status. In any case, the increased indebtedness in general and in particular the indebtedness of zombies is something which is a genuine cause of concern looking into the future¹⁹.

Figure A1. Zombie share and interest rates, 2002-2016.



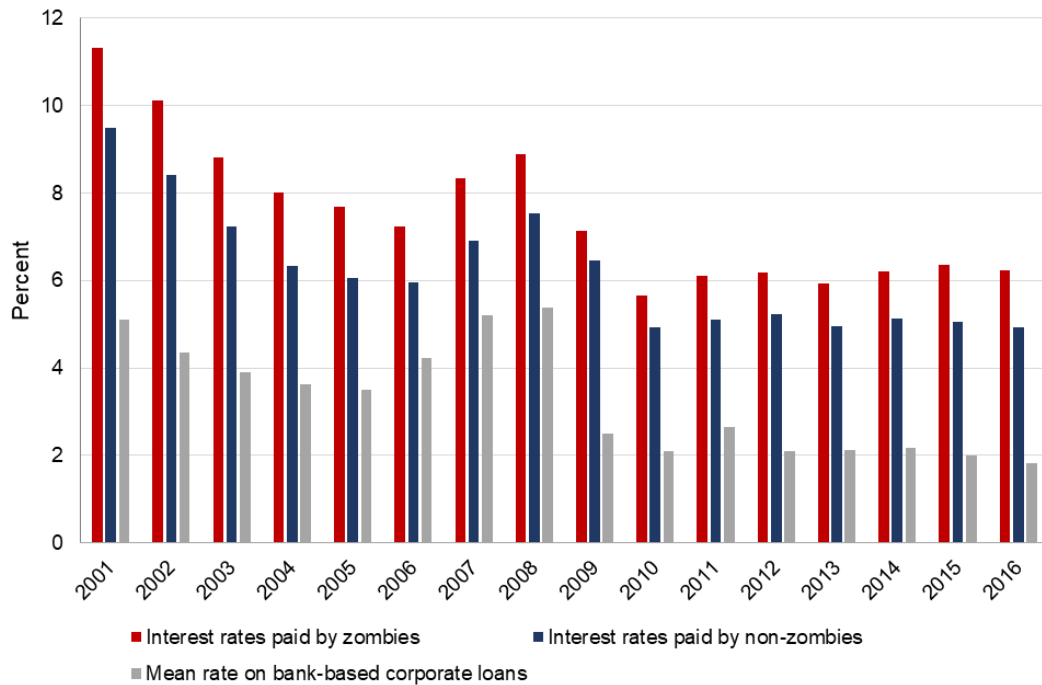
¹⁹ When we consider indebtedness (total debt/value added), it turns out to be positively correlated with the zombie variable (the coefficient estimate being 0.099 and t-value 3.75 in a panel regression with fixed effects and t_i controls).

A.2 Subsidised loans

We also consider subsidized credit, finding no evidence in the Finnish data (Figure A2). The implicit interest rate (gross interest expenses/total debt) in Finland has been almost 100 bp higher for the zombie firms compared with the non-zombie firms during the whole sample period. In other words, there does not appear to be evidence of subsidized loans to zombies. In fact, this result also carries on to the industry level; interest rates are in all cases higher for zombie firms.

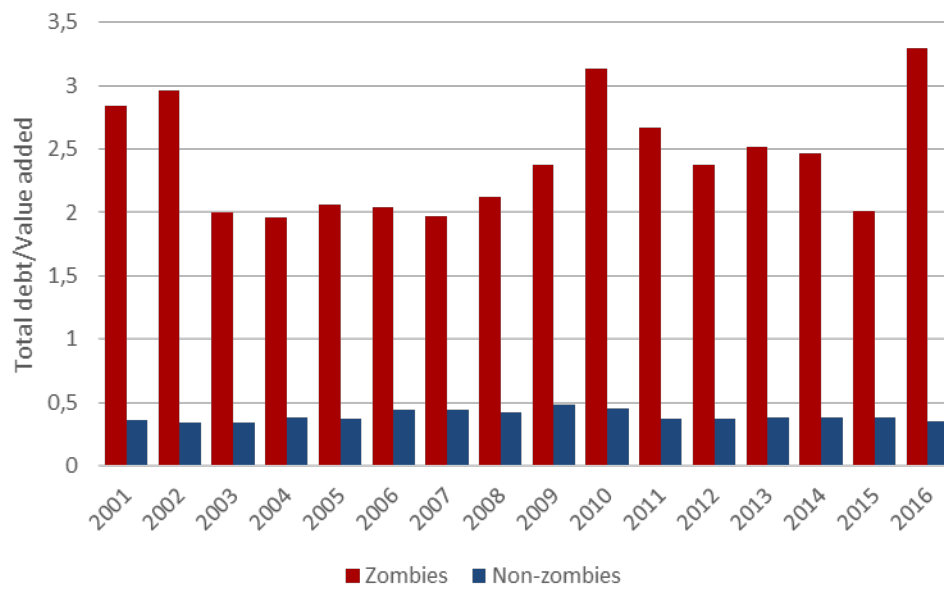
We may thus conclude that in Finland, there are no apparent signs of cross-subsidization of zombie firms (at the expense of non-zombie firms). There is one caveat, though. The zombie firms are so much more indebted than non-zombie firms (Figure A3) that that a justified question is whether the observed risk premium is large enough to cover the risks of the zombie firms. The answer to this question is, however, beyond the scope of the current paper.

Figure A.2. Implicit interest rates and zombie firms, 2001-2016.



Note that the implicit rates apply to all lending (not only to bank loans) and interest expenses and the stock of debt are different measures (interest expenses being the sum of expenses for the whole year which the loan stock the end of period value).

Figure A.3. Firm's indebttness and zombies, 2001-2016.



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