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Working Paper

Who funds zombie firms: Banks or non-banks?

Bank of Finland Research Discussion Papers, No. 2/2023

Provided in Cooperation with:

Bank of Finland, Helsinki

Suggested Citation: Tuuli, Saara (2023) : Who funds zombie firms: Banks or non-banks?, Bank of Finland Research Discussion Papers, No. 2/2023, ISBN 978-952-323-431-4, Bank of Finland, Helsinki, <https://urn.fi/URN:ISBN:978-952-323-431-4>

This Version is available at:

<https://hdl.handle.net/10419/268727>

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Bank of Finland Research Discussion Papers
2 • 2023

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Bank of Finland
Research

Bank of Finland Research Discussion Papers
Editor-in-Chief Esa Jokivuolle

Bank of Finland Research Discussion Papers 2/2023
9 February 2023

Saara Tuuli:
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ISBN 978-952-323-431-4, online
ISSN 1456-6184, online

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The opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the Bank of Finland.

Who funds zombie firms: banks or non-banks?

Saara Tuuli*

February 8, 2023

Abstract

Analyses of zombie firms have emphasised the role of bank financing as the reason for zombie survival. This conclusion was made despite no comparative analysis of the sources of external finance for zombie firms. This paper provides the first analysis of that sort using Finnish data. Surprisingly, the results show quite clearly that there is no connection between zombie survival and bank financing; this result is robust to various measurement and specification issues. Instead, a role is found for owners (i.e. equity funders) in keeping zombies alive in the (often correct) anticipation of the firm recovering.

Keywords: zombie firms, banks, credit constraints, firm-level data, panel data

JEL Codes: D25, E51, G2, G3

*I would like to thank the Bank of Finland, particularly Zuzana Fungáčová, Esa Jokivuolle, Matti Virén, Juuso Vanhala, Karlo Kauko and other Bank of Finland seminar participants, for their support and valuable comments. The dataset used in this paper builds on the panel dataset originally produced for the Bank of Finland Discussion Paper 4/2019 "Model-based regulation and firms' access to finance".

1 Introduction

Zombie firms – mature firms that are unprofitable but remain in the market rather exiting through bankruptcy or takeover – have attracted increasing attention over the past few years, particularly in the context of whether or not low interest rates and other policy measures have contributed their rising number. The covid-19 pandemic has given further impetus to this debate: the large-scale support measures put in place to support the corporate sector through the crisis could shield many firms from the process of creative destruction, leading to a misallocation of resources towards unproductive firms longer term.

This paper contributes to the literature focused on the role of banks - particularly weak ones - in keeping zombie firms afloat but is unique in three respects. First, this paper considers non-bank sources of external finance. The role of non-bank providers of finance has been extensively studied in the corporate finance literature but has so far been overlooked in the literature on zombie firms. Second, this paper uses survey data as opposed to just financial statement, credit registry and/or market data. In using survey data, merged with comprehensive business registry and bank and firm financial statement data, it is possible to identify non-bank sources of funding; identify firms' (self-reported) most important external financing relationships; and to go a step further in distinguishing between zombie firms and weak firms misclassified as zombies: firms' self-reported purposes for applying for external finance allows for the identification of firms with low earnings due to new investment and those with permanently weak balance sheets and cashflow. Third - with the notable exception of Nurmi et al (2022) - this paper considers flows into and out of zombie status as opposed to the stock of zombie firms using survival analysis techniques. The paper by Nurmi et al (2022) is also based on financial statement and business registry data of the Finnish statistics office, Statistics Finland, but the paper by Nurmi et al (2022) does not link zombie firms to the funders of those firms. Zombie lending is a central concept in the literature on zombie firms, given the hypothesis that zombie firms survive due to subsidised lending. Further, Nurmi et al (2022) differentiate between genuine zombies and weak firms based on whether the

firms' employment is growing or not whereas this paper uses firms' self-reported reasons for applying for external finance to do so.

The key findings of this paper are as follows. Banks are overwhelmingly the largest funder of zombie firms, perhaps justifying the focus of the literature on bank funding. This is, however, perhaps simply due to banks' balance sheet size: banks are broadly similar to other funding sources in terms of their share of zombies as a percentage of all firm relationships. Contradicting the results of the existing literature, no statistically significant relationship is found between zombie firms and banks or bank characteristics; only the link between equity funding and zombie status is robust across all specifications. The stickiness of the funder-firm relationship and the presence of subsidies is not found to make a difference to the results. The results are also little changed when the definition of a zombie is narrowed to only include zombie firms that applied for external finance for reasons other than for the purposes of new investment to distinguish between genuine zombies and weak firms misclassified as zombies. Changes in the stock of zombie firms is driven equally by entries into and exits out of zombie status, with exits overwhelmingly driven by recoveries as opposed to bankruptcy. Based on non-parametric and semi-parametric survival models, all funding sources, except for non-bank financial institutions, are associated with a longer zombie lifetime but no link is found between funding sources and entry into zombie status.

The overlap between the definitions proposed in the literature can, in cases, be small but the results using any definition challenge the perceived wisdom of a link between zombie firms and banks, at least in jurisdictions, such as Finland, that have a highly capitalised banking sector (e.g. IMF 2016) and a relatively efficient insolvency framework (e.g. Becker and Ivashina, 2021). Indeed, the early literature on zombies (Caballero et al 2008 and Peek and Rosengren 2005) was based on a highly unique institutional setting. Instead, the results presented here suggest that equity investors continue to fund firms classified as zombies based on definitions proposed in the literature in the (often correct) anticipation of firms recovering. As discussed in Nurmi et al (2022), a firm's exit decision is forward-looking and also based on the present value of future net income as opposed

to just current returns.

Where non-bank sources of funding are relevant (especially if the policy objective is taken to address the macro – as opposed to the financial stability – consequences of the presence of zombie firms), tackling the zombie problem via regulatory scrutiny of the quality of banks’ assets (as in e.g. Storz et al 2017 and Peek and Rosengren 2005¹) as way to avoid prolonged weakness in long-run growth or by addressing the procyclicality of capital requirements (e.g. Schivardi et al 2021) to reduce banks’ incentives to forbear on non-performing loans during downturns may not be particularly effective. In addition, calls for policy action under e.g. the EU Capital Markets Union to broaden SMEs’ access to funding sources could have unintended consequences for the prevalence of zombie firms or at least in reducing the estimates of them.

This paper is split into 6 sections. Section 2 provides an overview of the literature, with section 3 discussing the definitions of zombies used in different studies. Section 4 describes the dataset on Finnish firms used in this study and the estimates of zombie incidence it produces. In section 5, the link between zombie status and different funding sources are considered. The final section concludes.

2 Related literature

The literature generally finds that the prevalence of zombie firms has increased, with banks rolling over loans to non-viable firms instead of writing them off as being a key factor behind the rise in zombie firms. The impact of an increasing number of zombie firms is reduced aggregate productivity: zombie firms themselves are found to be less productive than their non-zombie peers but they also are found to create congestion effects, crowding out investment and employment growth at healthy firms.

An early contribution to the literature is by Caballero et al (2008) who find that the rise in zombie firms during Japan’s lost decade was linked to weakly capitalised banks evergreening loans to avoid charge-offs that would have pushed them against regulatory capital limits. Increased zombie congestion depressed the investment, employment and

¹This is implicit in Peek and Rosengren 2005 albeit in a unique institutional environment.

productivity growth of healthy firms. Similarly, in another paper focused on Japan’s lost decade, Peek and Rosengren (2005) find that the greater the financial stress faced by a firm and the weaker a bank’s health, the more likely banks were to increase lending. This behaviour was found to be more prevalent among banks reporting capital ratios close to the required minimum. More recent empirical papers, e.g. Schivardi et al (2021) and Bonfim et al (2022), provide support for the role of weak banks in the euro area. Schivardi et al (2021), in using Italian data for the period 2004-2013, find that undercapitalised banks were less likely to cut credit to non-viable firms. Bonfim et al (2022) use Portuguese data for 2011-2014 and find that banks subject to supervisory inspections were less likely to refinance zombie firms, leading to their default.

Another factor brought forward in the literature as a driver of zombie lending is inefficient resolution of insolvency (Becker and Ivashina 2022). As discussed in Acharya et al (2022), zombie lending might emerge in equilibrium if insolvency is a costly undertaking and lenders are disincentivised from restructuring. In this vein, Andrews and Petroulakis (2019) - in finding a connection between weak banks and zombie firms in Europe - call for an improvement in the design of insolvency regimes to reduce the barriers to restructuring weak firms.

Recent empirical papers on the euro area also highlight the role of monetary policy. While the potential effects of monetary policy on zombie incidence is not covered in this paper, monetary policy is also hypothesised to drive corporate zombification as low interest rates reduce debt service burdens for firms but also create incentives for risk-taking (such as extending loans to risky debtors) through the risk-taking channel of monetary policy. Acharya et al (2020) likens the euro area “missing inflation puzzle” to Japan’s lost decade, with Acharya et al (2019) finding that euro area banks used the capital gains from the ECB’s Outright Monetary Transactions to increase credit supply mainly to low-quality firms with which they had pre-existing relationships. Banerjee and Hofmann (2018) find evidence of a positive relationship between low interest rates and the number of zombies, with upward shifts in the share of zombies over economic downturns not fully reversed in subsequent recoveries.

Some empirical papers focus on the negative impact of zombie congestion. Storz et al (2017) finds zombie congestion to be associated with reduced lending to healthy firms. Acharya et al (2020) find that “zombie credit” is associated with a higher misallocation of capital and labour, reduced average net investment and labour productivity. Adalet McGowan et al (2017) and Banerjee and Hofmann (2018) study the OECD countries and 14 advance economies respectively. Both document a rise in the share of zombie firms and find that zombies weigh on economic performance; zombies are less productive, and they also constrain the growth of more productive firms.

Several studies depart from the papers mentioned above. Nurmi et al (2020) study Finnish firms between 1999 and 2017 and find that two-thirds of the firms classified as zombies in the literature actually recover to become healthy firms and that the increase in zombies is driven by cyclical factors as opposed to a secular trend; this is consistent with a similar finding in Banerjee and Hoffman (2022). Nurmi et al (2022) also find that firms in receipt of government subsidies are less likely to die and that their chances of recovery are higher.

3 Identifying zombies

The literature on zombie firms is largely empirical and there are two broad approaches in the literature for defining zombie firms. In the studies focused on banks e.g. in the papers by Hoshi (2004) and Caballero et al (2008), the focus is on firm-bank relationships and hence zombies are identified based on the extent to which the firm is in receipt of subsidised credit. In Caballero et al (2008) and Acharya et al (2019, 2020), for example, subsidised credit is identified observing firms’ interest rate payments against a hypothetical lower bound expected for only the most creditworthy borrowers. In the literature focused on zombie incidence and consequences for the real economy, various measures of weak performance are used to identify zombies. According to the leading definition in this literature, proposed by Adalet McGowan et al (2017), a zombie is defined as a firm aged ten or over that has an interest coverage ratio of less than one for at least three

consecutive years. The interest coverage ratio is calculated as the ratio of operating profits to interest expenses and the age-related criterion is used to avoid classifying start-ups and other productive young firms as zombies despite negative operating profits.

Some papers, such as Acharya et al (2019, 2020) and Schivardi et al (2021), identify zombies using elements of both approaches. In Acharya et al (2019), a firm is classified as a zombie if three criteria are met. First, the interest rate payments of a borrower must be lower than a hypothetical benchmark based on the median interest rate paid by the most creditworthy (AAA-rated) companies. Second, the firm must be rated BB or below, with credit ratings proxied by the firms' three-year interest coverage ratio relative to the median. Third, the syndicate composition of its lenders must have either remained constant or with banks leaving the syndicate not being replaced by new ones. By using Bureau van Dijk's Amadeus database, the study by Acharya et al (2020) uses a much wider range of firms and hence zombies are defined more generally as meeting two criteria: i) the firms' interest coverage ratio being below the median and the leverage ratio being above the median, where medians are calculated at the industry level and ii) debt financing is at a rate lower than that paid by the most creditworthy (AAA-rated) companies.

Schivardi et al (2021), in also taking a banks' decision as a starting point, define a zombie as a firm for which the expected marginal return of capital is below the risk-adjusted market cost of capital. A zombie firm is thus defined as a firm with a three-year moving average return-on-assets below the cost of capital of the safest firms in the sample. A second criterion is that leverage (used as a proxy for default risk) exceeds 40% with this time-invariant threshold being based on the distribution of leverage in the year 2005 for firms that existed the market in 2006 or 2007. Schivardi et al (2021) also consider an alternative measure of profitability, bringing their definition closer to that of Adalet McGowan et al (2017): a zombie is defined as a firm with the three-year moving average of the interest coverage ratio being below one and with leverage being above the threshold.

Other papers use the definition proposed in Adalet McGowan et al (2017) but drop the age restriction. For example, Banerjee and Hofmann (2018) find it unconvincing that

younger firms could not be unviable and mature loss-making firms could not have high growth potential. Indeed, the authors find that zombies as defined by Adalet McGowan et al (2017) have on average a higher Tobin’s q than non-zombies, that is, viewed by the markets as having higher profit potential. The authors try capture expected future profitability, replacing the age restriction with the criterion that zombies have a ratio of their assets’ market value to their replacement cost (Tobin’s q) that is below the median within their sector in any given year. Another example of the age restriction being dropped is Nurmi et al (2020, 2022), who find that firm age is not a key determinant of zombie status. Instead, the authors impose a “shrinking” condition: that the annual growth rate of the firm in terms of employed workers is not positive on average over a two-year period.

Other definitions include that by Storz et al (2017), who define a zombie as being a firm that, for at least two consecutive years, has a negative return on assets, negative net investment and a debt servicing capacity (earnings before interest, taxes, depreciation and amortisation or EBITDA over financial debt) of under 5%. Bonfim et al (2022) define a zombie as a firm with negative equity in the previous year, arguing that such a firm is technically insolvent and thus risky for a lender to refinance.

4 Data and estimates of Finnish zombie incidence

The data used in this paper is based on a merger of survey data, bank data and data on firms from Statistics Finland. The survey data is taken from an annual survey of credit conditions conducted since 1994 on behalf of a number of organisations including the Bank of Finland and what are now called the Confederation of Finnish Industries and the Ministry of Employment and the Economy. Over the sample used in this study, covering 1998-2015 (excluding 2005, 2011, 2013 and 2014), participating firms numbered around 1,000 per year and covered different (non-financial) industries and locations in Finland; the 2012 and 2015 surveys – covering nearly 3,500 and 3,000 firms respectively – are exceptions in terms of sample size. The number of survey observations total 18,433

and cover 8,646 individual firms. Where certain variables are not consistently reported for all years (e.g. the variables for the demand and supply of credit and changes in funder relationships), a shorter time series of 2000-2010 is used. Statistics Finland’s firms’ financial statement dataset is comprehensive: the dataset used here covers the period from 1986 to 2019² and includes all key financial statement variables e.g. turnover, assets, equity, debt, average financial costs, profit, personnel, wages, rent, interest expenses, etc. Data from the Finnish Business Register, acquired via Statistics Finland, has been used to complement the dataset for variables such as firm age and date of bankruptcy. Official statistics can be used for data for firms for years that they do not appear in the survey, allowing for the utilisation of a larger version of the dataset in regressions using lags and/or leads of financial statement data (Table 1). Key balance sheet metrics for the main commercial banks operating in Finland are from S&P’s SNL Financial database.

Calculating the incidence of zombie firms in Finland using this dataset is not without its problems. The data requirements for calculating the incidence of zombie firms based on subsidised interest rates are large and not met by the survey and financial statement data utilised here. Instead, an implicit interest rate is calculated based on interest expenses as a share of debt and compared with the lowest (implicit) interest rates paid by firms in the sample. The definition by Banerjee and Hoffman (2018, 2022) requires information on stock market valuations and therefore is not explored in this paper, which is based on a dataset reflective of the Finnish economy and hence, as in other European countries, consists mostly of SMEs. The measure based on the definition proposed by Bonfim et al (2022) produces estimates unrelated to all of the other measures and therefore is also not considered here.

Most of the estimates suggest that, since the early 1990s banking crisis and recession, the number of zombie firms in Finland has been quite small. These calculations nevertheless produce a wide range of estimates, with the Storz et al (2017) measure producing the smallest estimate (1.3%) and that by Acharya et al (2020) at 11% producing the largest

²Note that the financial statement data for 1986-1993 is based on a smaller sample of between 4,000 and 6,500 firms compared with around 200,000 to 400,000 in subsequent years. Pre-1994 data is therefore treated with caution and often excluded.

for 2019 (Figure 1). Many of the pair-wise correlations between different definitions are weak (Table 2).

The focus of the remainder of this study is on the credit conditions survey sample (Figure 2) – descriptive statistics of zombies based on the population of Finnish firms has been discussed elsewhere (e.g. Nurmi et al 2020 and Vanhala and Viren 2018). While being a much smaller set of firms, the survey provides useful information on firms’ self-reported funding sources and relationships, applications for credit and subsidies and their outcomes. Information on firms’ self-reported reasons for applying for new external finance can also help shed light on the extent to which firms may be misclassified as zombie firms as opposed to viable ones facing temporary credit constraints.

While the choice of zombie definition is not uncontentious, this paper predominantly utilises the definition proposed by Adalet McGowan et al (2017)³ in part by virtue of it being the leading definition of the literature to date. While definitions based on subsidised credit would be appropriate in considering zombie firms’ lenders, an implicit interest rate (relied on here due to lack of explicit interest rate data) is a rather crude measure on which to base calculations. The potential for Finnish firms being misclassified as zombies under the Adalet McGowan et al (2017) definition is discussed in section 5. Also in section 5, the alternative definitions are considered as robustness checks.

5 Who funds zombie firms: banks or non-bank lenders?

The focus of the literature to date on the funders of zombie firms has been limited to banks and the determinants of the type of bank most likely to lend to zombie firms. Consideration of other types of funders has been absent in the literature. As discussed in IMF (2016), Finnish non-financial corporations (NFCs) are not particularly reliant on bank funding. Domestic monetary financial institutions provide about 25% of NFC

³As discussed in e.g. Rodano and Sette (2019) and Storz et al (2017), using the earnings before interest and taxes (EBIT) numerator for the definition proposed by Adalet McGowan et al (2017) may overstate the scale of the zombie population because companies with high depreciation in a current period tend to have invested heavily in previous years; this would be counterintuitive with the concept of zombie firms, given that they would not be expected to invest. The numerator used here is therefore EBITDA instead of EBIT, as used in many recent papers.

borrowing, while inter-company loans account for 24% and a third is sourced from abroad, primarily in the form of loans (IMF, 2016). Public funding bodies, such as Finnvera, make up an important funding source for SMEs. Equity financing constitutes a larger share of NFCs' total liabilities (52%) than debt (38%) (IMF, 2016).

The funding types cited by firms as making up their *main* source of finance in the survey are grouped into five categories:

1. Internal funding
2. Banks
3. Public funding sources e.g. Finnvera
4. Non-bank private financial institutions e.g. other financial
5. Equity funding.

Figure 3 shows, using the Adalet McGowan et al (2017) definition, the share of zombies out of all firms reporting their *main* source of finance to be internal funds, a bank, a public funding source, a non-bank financial institution and equity funding. The data suggests that banks are overwhelmingly the largest funder of zombie firms, perhaps justifying the focus of the zombie literature on bank lending. The data is also consistent with anecdotal evidence of e.g. SMEs turning away from banks and seeking funding from public sources during the 2008-2009 financial crisis. Since then, the proportion of zombies predominantly financed by internal sources has increased and zombies predominantly financed by equity has decreased.

Although banks are the largest funder of zombies, public funding sources, at around 8.2%, have the highest share of zombies as a percentage of firms citing them as their main funding source (see Figure 4). This is followed by banks 6.6% and equity 5.5%. Zombies make up a much smaller share of firms predominantly financed by non-bank financial institutions 4.4% and by internal funds 3.5%. While there are important similarities and differences in the characteristics among zombie and non-zombie firms in general (Table 3), zombie firms also differ by type of funder (Tables 4-8). For example, based on Altman

Z-scores, the creditworthiness of zombies predominantly financed by equity or public sources is poorer than those financed by banks or non-bank financial institutions.

Due to a small number of zombie firms, linear probability (as opposed to logit) models are estimated to test the relationship between zombie status and different funding sources. Firms predominantly financed by internal funds are used as a reference group and, unless otherwise specified, 1998 is used as the reference year.

In estimating the relationship between zombie status and difference funding sources, the baseline specification is as follows:

$$Zombie_{ijt} = \alpha_i + \alpha_t + \beta_1 Funder_{ijt} + X'_{it}\gamma + u_{ijt} \quad (1)$$

where $Zombie_{ijt}$ is a dummy variable for zombie status. The dummy variable equals 1 if firm i , with its main source of funding granted by funder j at time t is a zombie firm based on the Adalet McGowan et al (2017) definition and zero otherwise. The term $Funder_{ijt}$ refers to the type of funder j that firm i identifies as its main source of external finance⁴ at time $t - h$: a bank, a public funding source, non-bank financial institutions or equity as discussed above. The α terms are firm and time fixed effects and X_{it} are firm-level controls. The coefficient β_1 is the key estimate of interest. Standard errors are clustered at the firm level.

The results suggest (Table 9) that the presence of a bank as a firm's main funding relationship is not significant and close to zero (models 1-2). Only the presence of equity funding as the main source of funding is statistically significant and this relationship is significant across all specifications. In the baseline specification (models 1-2), being funded predominantly by equity is associated with a 3% higher likelihood of zombie status than those predominantly financed by internal funds.

A central concept in the forbearance argument is that funder-firm relationships matter. The literature on Japan, in a unique institutional setting, centres around banks with existing relationships with zombie firms having the incentive to keep zombies afloat to

⁴The survey was conducted in Finnish and translates into "Who is your main financier (select only one)?" or "What is your most important source of external finance?". Multiple choices are presented as well as an open field for institutions not on the list.

avoid loss recognition; banks with no previous exposure to the zombie firm do not. This is implicitly accounted for in this study given that the identified funding type is based on firms' self-reported main source of external finance as opposed to any source of finance.

As discussed in Alvarez et al (2023), however, banks may also want to preserve valuable relationships and/or roll over loans due to an informational advantage over other funders (see also Hu and Varas, 2021). If so, controlling for funder relationships may make a difference to the results: only firms with a strong relationship with a bank are likely to their loans rolled over by their main bank. The logic is that, without the existing banking relationship, the zombie firm would not have been able to pay back existing credit and would have exited zombie status through bankruptcy.

The survey results suggests that funding relationships are indeed very sticky, but no more so among firms and banks than firms and other funding sources. The lowest percentage of firms replying “no” to having changed their main source of finance over the past three years is high at 81% and 82% among zombies predominantly funded by public sources and banks respectively. In a similar vein, firms, particularly non-zombies, across all funding types had few banking relationships: the vast majority (76% of non-zombies and 61% of zombies) reported only one or two banking relationships. The average number of banking relationships held by non-zombies is two and those held by zombies three.

The baseline specification is modified to include interaction terms between the funder type and the funder-firm relationship, proxied by a dummy variable, $FunderChange_{ijt}$, that equals 1 if a firm i reports at time $t - h$ to have not changed its main source of funding j over the past three years and zero otherwise:

$$Zombie_{ijt} = \alpha_i + \alpha_t + \beta_1 Funder_{ijt} + \beta_2 Relationship_{ijt} + \beta_3 Funder_{ijt} \times Relationship_{ijt} + X'_{it} \gamma + u_{ijt} \quad (2)$$

In terms of equation (2), the presence of a sticky relationship (defined as the firm citing no change to their main funding source over the past three years) is not statistically significant for any type of funding source (model 3). This is an intuitive result, given that there is not much variability between funding types in the extent to which funding

relationships are sticky.

Another possible explanation for the relationship between zombie status and equity funding (and lack thereof between zombie status and bank funding) is government subsidies. Nurmi et al (2022) find, for example, that government subsidies are related to the presence of zombie firms. In a study using Swedish data (albeit on start-ups), Söderblom et al (2015) find that subsidies signal legitimacy of new ventures, leading them to be able to attract more financial capital. The link found between funding sources and zombie status could possibly therefore be explained by the possibility of the supply of particular types of funding being more sensitive than others to the presence of subsidies.

In testing the potential role for subsidies, a dummy variable for subsidies is used: the variable equals 1 if firm i reported to have been in receipt of subsidised funding (either in the form of loans or equity) in the past twelve months and zero otherwise.

Equation (1) becomes:

$$Zombie_{ijt} = \alpha_i + \alpha_t + \beta_1 Funder_{ijt} + \beta_2 Subsidies_{ijt} + \beta_3 Funder_{ijt} X Subsidies_{ijt} + X'_{it} \gamma + u_{ijt} \quad (3)$$

The regression results (Table 9, model 4) suggest that self-reported support via subsidies contributes little to zombie status – the coefficients are not statistically significant and have low economic significance.

5.1 Zombie firms and bank characteristics

The results discussed above are based on zombie firms and banks in general. The academic literature, however, identifies weak banks (defined in various ways) as driving an increase in zombie incidence instead of banks in general. The logic is that weak banks – closer than other banks to their minimum regulatory capital requirements – forbear on loans to avoid taking a capital hit by writing them off. The external validity of the Finnish case to other jurisdictions may depend on the asset quality and capitalisation of the banking sector, both of which is very high in Finland. The sample used in this section includes only firms predominantly funded by banks and includes the years 2000-2010 given that the naming

of a particular bank as a main external funding source is available on a consistent basis only for those years.

The following model is estimated:

$$Zombie_{ijt} = \alpha_i + \alpha_t + Z'_{jt}\delta + X'_{it}\gamma + u_{ijt} \quad (4)$$

where Z_{jt} are bank-level characteristics that the literature (e.g. Storz et al 2017) and credit rating agencies like S&P⁵ use in describing the health of a bank: tier 1 capital ratio; total equity to assets as a measure of leverage or equity unweighted by risk; return on average assets; deposits to assets and loan-to-deposit ratios (as a measures of a bank's funding gap and exposure to the wholesale funding markets); liquidity ratio; and profitability metrics – net interest income to total income as a measure of stable revenue and cost-to-income as a measure of operational efficiency.

The results support a statistically significant increase in zombie incidence among bank-funded firms since 2000 but no statistically significant relationship between zombie status and bank characteristics (Tables 10-11, models 5-20).

A results using one- and two-year lags of the independent variables (as in Andrews and Petroulakis, 2019) does little to change the results due to the stickiness of relationships.

5.2 Survival analysis: does external finance increase entry to zombie status or decrease zombie exit or both?

The linear probability models above suggest that zombie status is associated with equity funding but not other funding sources but say little about the dynamics behind it. That is, does equity funding increase the entry rate from non-zombie into zombie status? Or does it decrease the rate of zombie exit? Or both? To help answer this question, this section considers non-parametric and semi-parametric survival models.

In terms of flows, Figure 5 shows that changes in the stock of zombies are driven by both entries into and exits out of zombie status. Exits out of zombie status are

⁵see e.g. S&P Global Ratings, 2022, “How We Rate Financial Institutions” https://www.spglobal.com/ratings/_division-assets/pdfs/070813_howweratebanks.pdf

overwhelmingly due to recovery from zombie status as opposed to exit via bankruptcy (Figure 6).

The Kaplan-Meier survival rate, a non-parametric estimate of survival probability, gives an indication of survival probabilities (or hazard rates) before the inclusion of any explanatory variables. The area below the survivor function shows the mean duration of zombie status. The Kaplan-Meier survival estimate (Figure 7) suggests that less than half of zombie firms remain zombies beyond three years; only a quarter persist as zombies beyond five years. This is broadly the profile for zombies funded by banks, while equity-funded zombie firms persist as zombies for a much longer period, with three-quarters of equity-funded zombies surviving past the five-year mark (Figure 8).

A similar exercise can be conducted for firms where the “failure” event is entry into zombie status. The probability of entry into zombie status is low, as expected based on the estimates of zombie incidence reported above. The risk of zombification increases over time, with the probability of remaining a non-zombie falling to 75% after a lifespan of 20 years (Figure 9). Equity-funded firms are more likely than bank-funded firms to fall into zombie status in their first eight years in the survey, but beyond that, the risk of zombification is higher for bank-funded firms than equity-funded firms (Figure 10). Given the overlap in the survival curves and the lack of evidence for a statistically significant difference between the distributions based on the logrank test, entry is not explored further in this paper.

The semi-parametric Cox (1972) proportional hazards model can be used to estimate the relationship between different types of funders and the probability of exiting or entering zombie status. The Cox proportional hazards model employs a maximum partial likelihood estimation method and has the following form (Cox 1972):

$$h_i(t) = h_0(t)exp(X_i'\beta) \quad (5)$$

where $h_i(t)$ is the time- t hazard of firm i ($t = 1998 - 2015$ in this paper) which is the probability that firm i will exit zombie status in year t , conditional on the firm i remaining in zombie status in time t . The term $h_0(t)$ is the baseline hazard function

that corresponds to the probability of an event when all explanatory variables are zero and controls for the evolution of risk common to all firms in a particular year such as changes in GDP. The term X_i is a vector of explanatory and control variables.

The estimates of the Cox proportional hazards model suggests that all external funding sources, apart from non-bank financial institutions, are associated with a statistically significant increase in the duration or lifetime of a zombie (Table 12). The economic significance of the result is the highest for equity and public funding sources, which are associated with a decrease in the exit rate out of zombie status of 72% and 70% respectively. Being predominantly funded by a bank is associated with a 42% decrease in the exit rate. Being funded by a non-bank financial institution is associated with a decrease of 5% in the exit rate but this result is not statistically significant. Controlling for funder relationships and subsidies makes little difference to the results. The Schonefeld residuals provide support that the proportionality assumption holds (Table 12).

These results are, of course, driven mostly by recovery out of zombie status as opposed to exit through bankruptcy and hence specifying the failure event to be recovery produces similar results (Table 12). Being funded by a bank, public funding source or by equity is associated with a longer zombie lifetime. Equity and public funding sources are associated with a decrease in the zombie recovery rate of just under 70%, whereas bank funding decreases the recovery rate of a zombie by 29%. Being funded by a non-bank financial institution is associated with a decrease of 3% in the recovery rate but this result is not statistically significant. Controlling for funder relationships and subsidies makes little difference to the results.

5.3 Sensitivity analysis and robustness checks

The results in the previous section suggest that changes in the stock of zombie firms is driven as much by exits as entries into zombie status. This observation brings into question the extent to which the Adalet McGowan et al (2017) definition captures genuine zombie firms as opposed to viable firms facing temporary liquidity squeezes and/or credit constraints; it would be desirable for a bank or non-bank lender to continue to fund firms

of the latter sort.

One way to try to distinguish zombie firms from viable, financially distressed firms is to add the criterion to the zombie definition that the firm has received new credit from a bank in that year, as proposed by Alvarez et al (2023). The authors consider zombie firms as a subset of distressed firms under this condition.

Narrowing the definition of zombies to include only firms that were awarded new credit in that year reduces the number of zombies by around half. Estimates of equation (1) using this narrower definition has little effect on the results apart from reducing the relationship between equity funding and zombie status from around 3% to around 2.5% (Table 13, models 29-30).

The self-reported main purpose for applying for new credit provides stronger support, however, for the argument that the Adalet McGowan et al (2017) definition – even when EBIT is replaced with EBITDA – may overstate the zombie problem: low earnings (and hence interest coverage ratio) may reflect higher capital investment. Indeed, the most popular reason for applying for new credit was investment among both zombies (26%) and non-zombies (18%). This holds true particularly for zombie firms predominantly funded by public sources, with 50% reporting that demand for new credit was for the purposes of investment. Firms relying predominantly on their internal funds are the other end of the scale at 9%, suggesting that the share of zombies in this subset of firms is less likely to constitute an overestimate.

Another popular reason for applying for new credit was for cash flow reasons as in e.g. Acharya et al (2019). This was reported much more frequently among zombies (22%) than non-zombies (10%), particularly among firms funded by public sources. This result is unsurprising given that non-zombies would intuitively be expected to have fewer cashflow problems. Similarly, the share of zombie firms citing the need for new credit for replacing existing credit and strengthening their balance sheet was four times higher than that for non-zombie firms.

Narrowing the definition of zombie firms to include only firms that were awarded new credit in that year for purposes other than new investment reduces the number of

zombies by another quarter. Estimates of equation (1) using this narrower definition does not change the statistical significance of any of the funder – firm relationships but the economic significance of the relationship between equity funding and zombie status reduces further to just under 2% (Table 13, models 31-32).

As robustness checks, the other zombie definitions discussed in section 3 are considered (see Table 14), given that the overlap between the definitions can be small. As can be anticipated a priori based on the correlations between different measures (Table 2), results using the definition used by Nurmi et al (2022) are very similar to those using the leading measure by Adalet McGowan et al (2017). Equity funding is found to be associated with zombie status, but no other external funding types.

Results using the zombie measured proposed Storz et al (2017) also suggest a relationship between equity funding and zombie status but bank funding is also found to have a statistically significant relationship with zombie status. Indeed, the economic significance is higher than that associated with equity. The relationship between bank financing and zombie status is, unlike that between equity financing and zombie status, not robust to the inclusion of control variables, however. No strong conclusions can be drawn from results using the zombie measures proposed by Schivardi et al (2021). These results (models 39-42) seem to have little in common with each other and with the measures proposed by Adalet McGowan et al (2017), Nurmi et al (2022) and Storz et al (2017). As discussed above, consideration of the Acharya et al (2020) definition is excluded here, given that the dataset used in this paper only allows for a calculation of zombie incidence based on that definition using a very crude measure of implied interest rates as opposed to actual interest rates and hence the definition proposed in Acharya et al (2020) is not considered.

6 Conclusions

This paper studies the funders of zombie firms based on survey data and financial statement data. Banks are found to be the largest funder of zombie firms, but only fund about

half of zombie firms in Finland. Banks are not unique in terms of their share of zombie relationships as a percent of all borrower relationships. Indeed, no statistically significant link can be found between zombie firms and banks, including weakly capitalised banks. Only the relationship between equity funding and zombie status is robust across all specifications. No link is found between zombie status and funder-firm relationships or between zombie status and being in receipt of subsidies.

Changes in the stock of zombie firms is driven equally by entries into and exits out of zombie status, with exits overwhelmingly driven by recoveries as opposed to bankruptcy. Equity, and to a much lesser extent, bank funding is associated with a longer zombie lifetime; no link is found between funding sources and entry into zombie status.

Equity investors are forward-looking and continue to fund firms based on the expected future value of the firm and hence in anticipation of the survival of a firm classified as zombies based on the definitions proposed in the literature. Efforts to reduce zombie incidence through bank regulation may therefore be ineffective, at least in countries with a strong banking sector and relatively efficient solvency framework, with policies to widen funding sources available to SMEs possibly having unintended consequences for estimating zombie incidence.

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Figures

Figure 1: Zombie incidence by definition – all firms

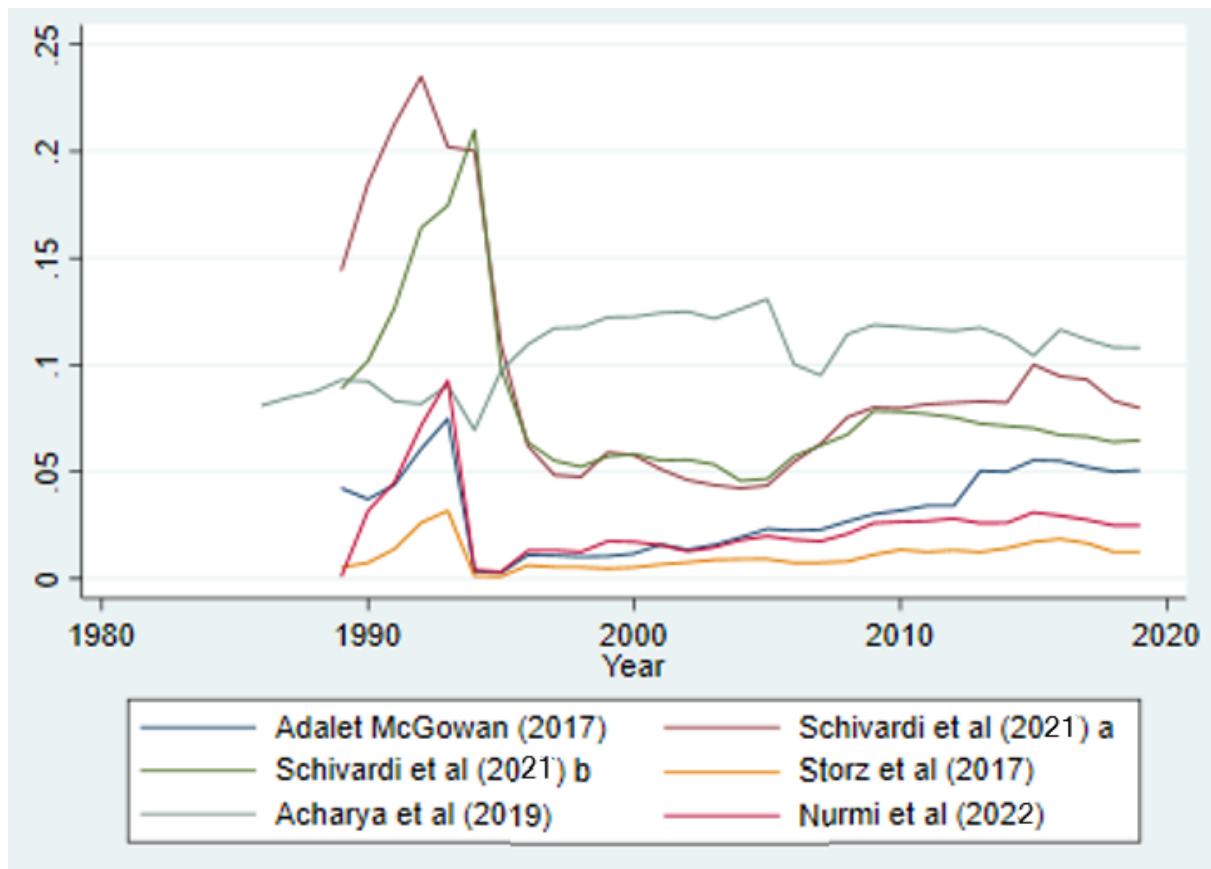


Figure 2: Zombie incidence by definition – survey data

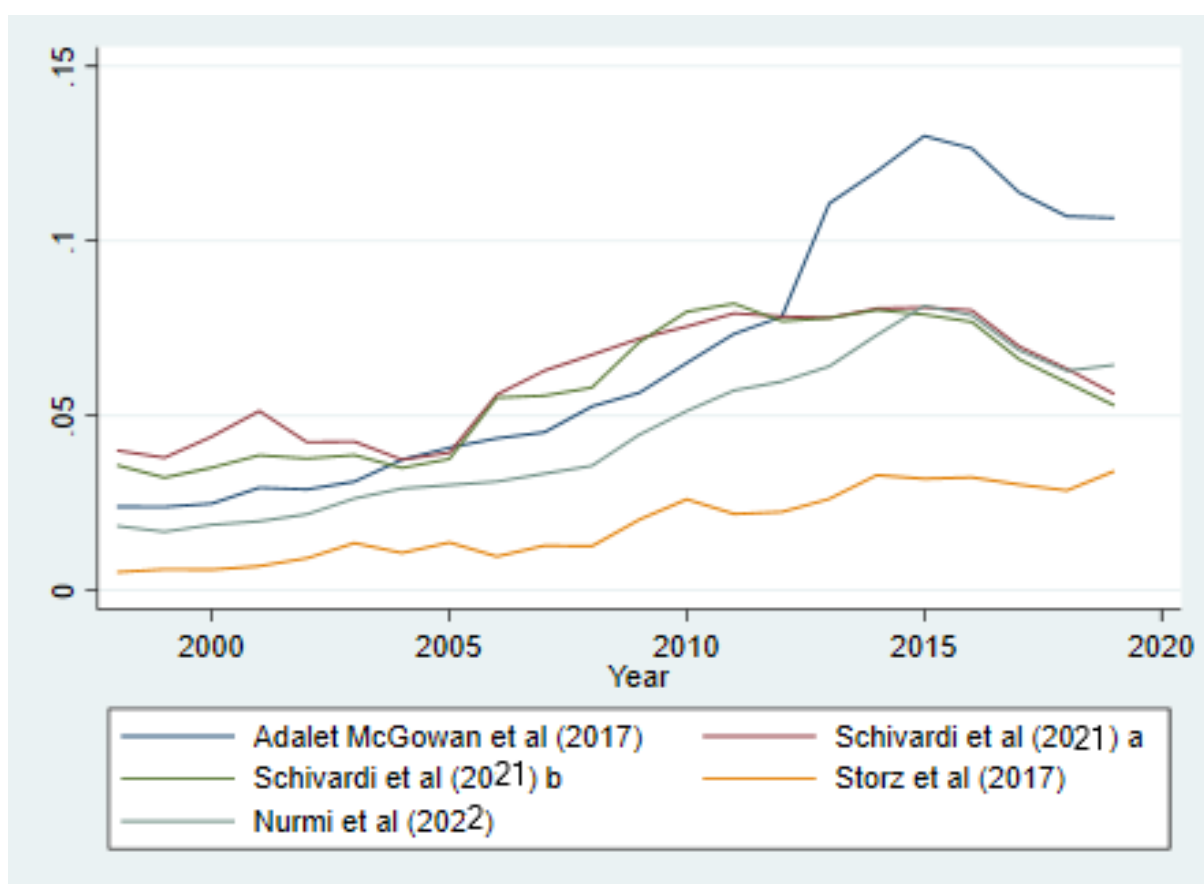


Figure 3: Zombie firms, breakdown by funder type

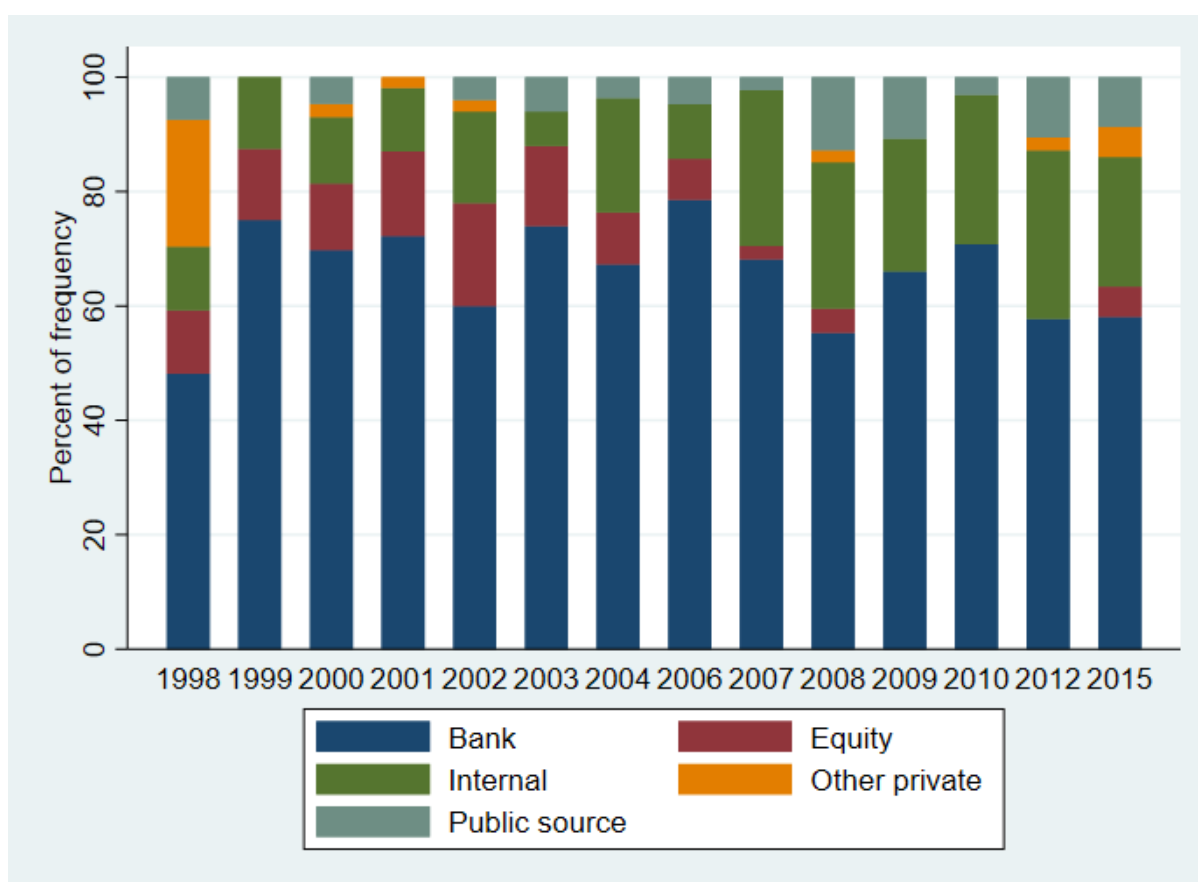


Figure 4: Zombie firms as share of total firm relationships by funder type

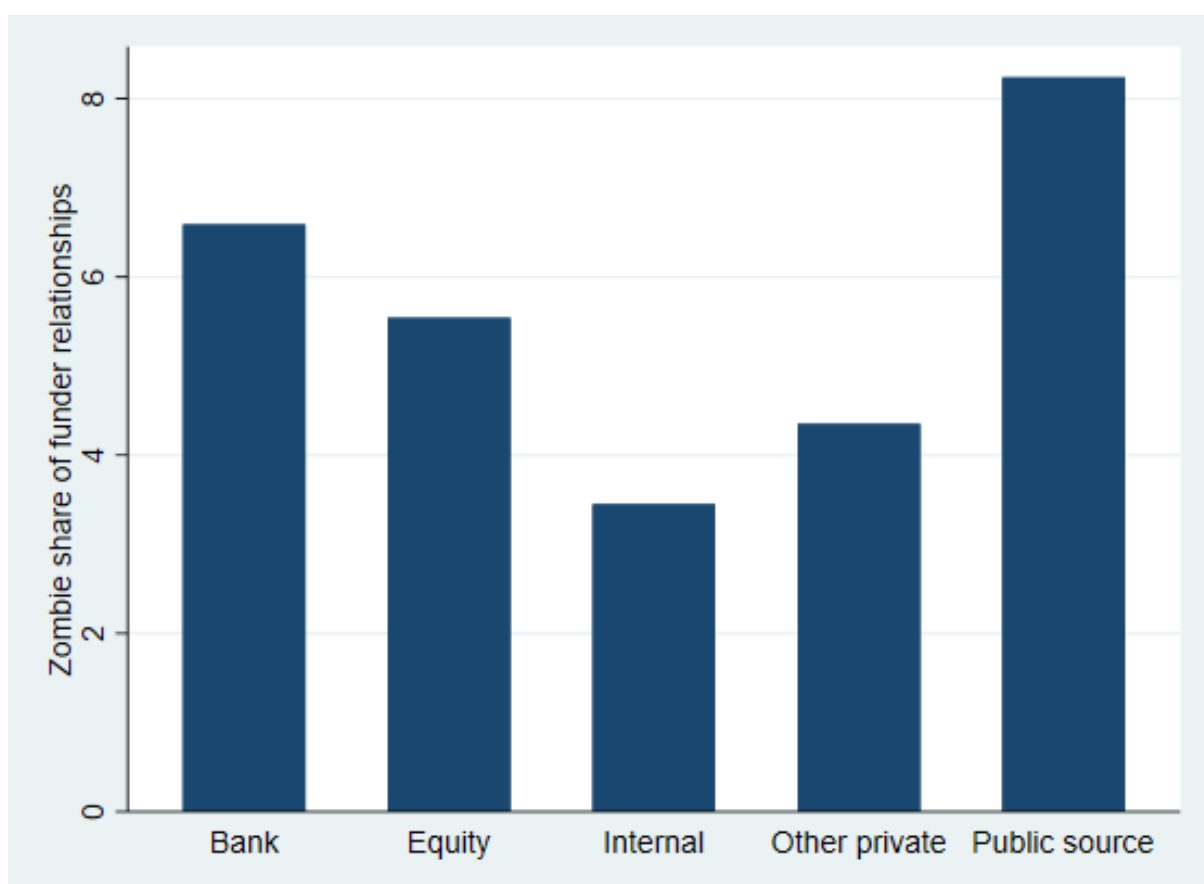


Figure 5: Entries and exits out of zombie status

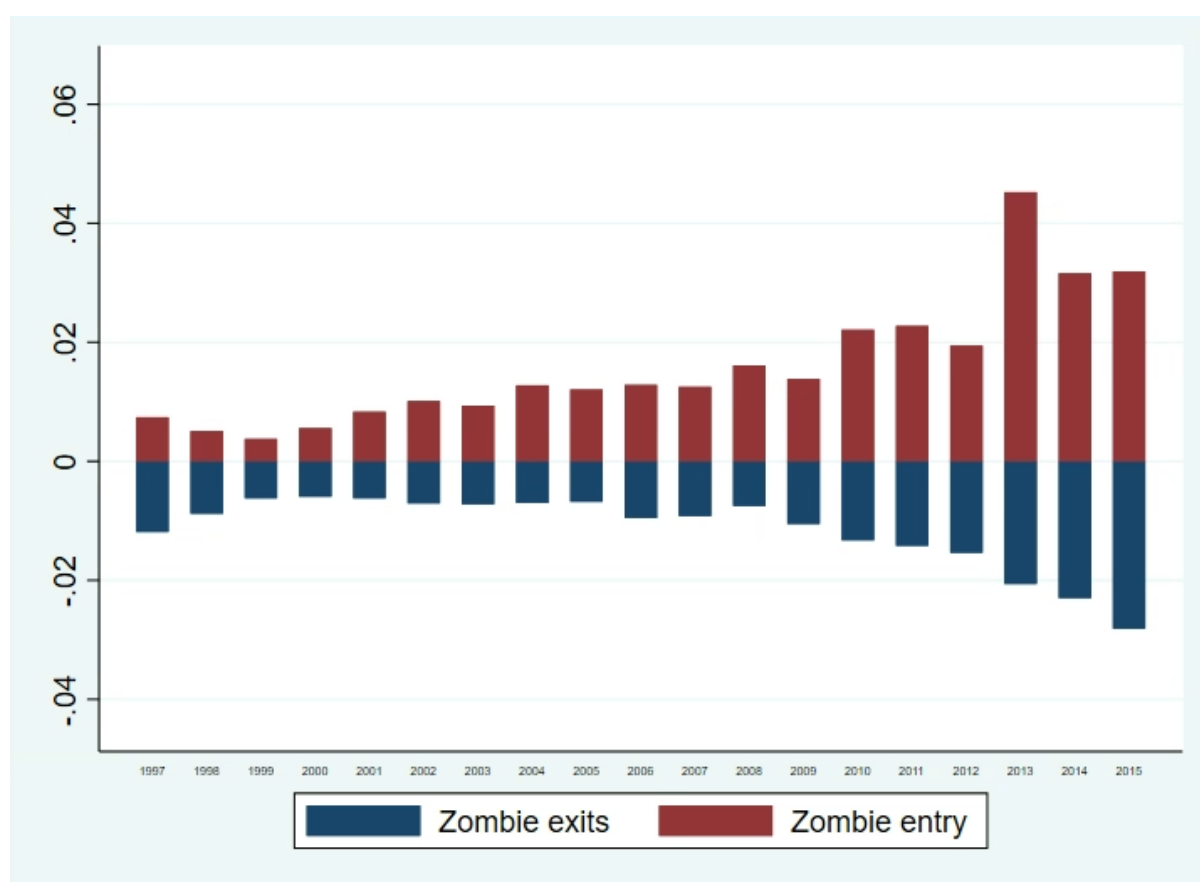


Figure 6: Exits out of zombie status: recoveries and bankruptcies

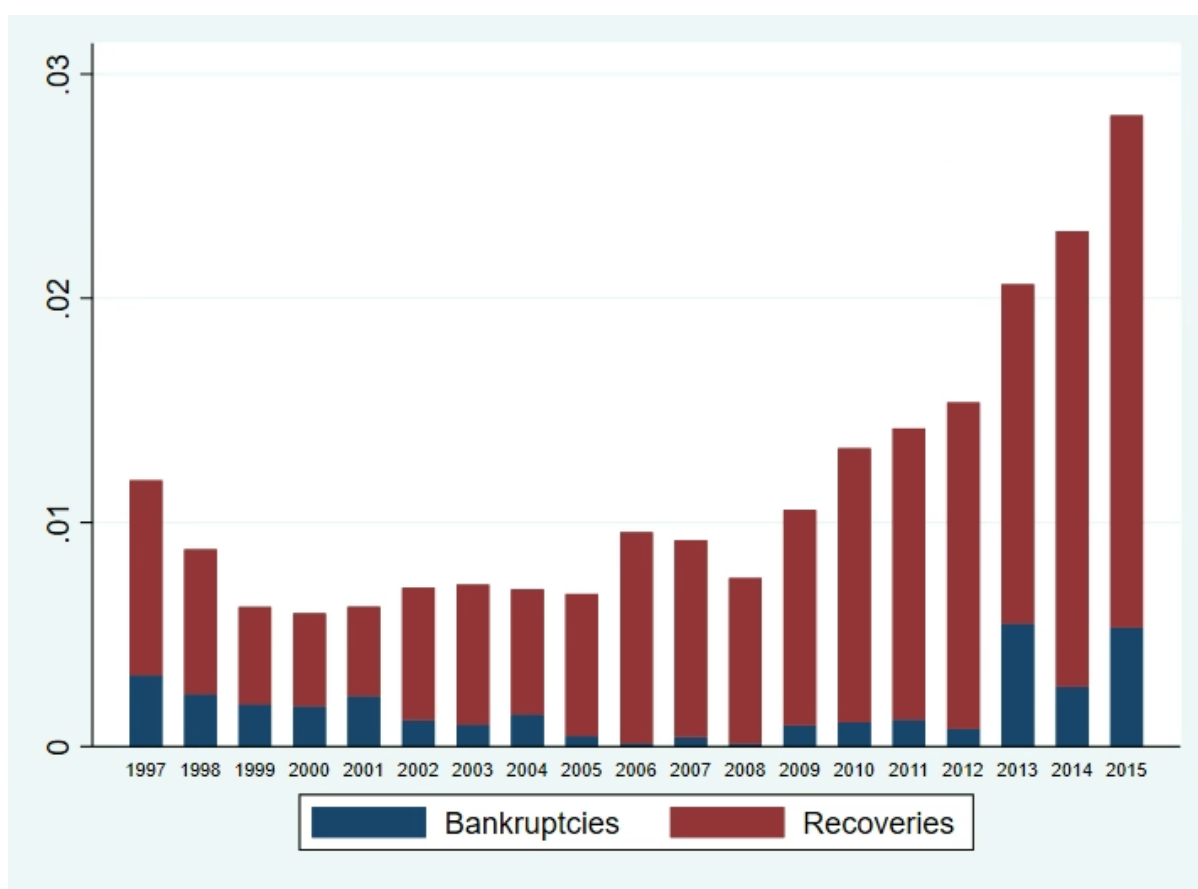


Figure 7: Kaplan Meier estimate of zombie survival

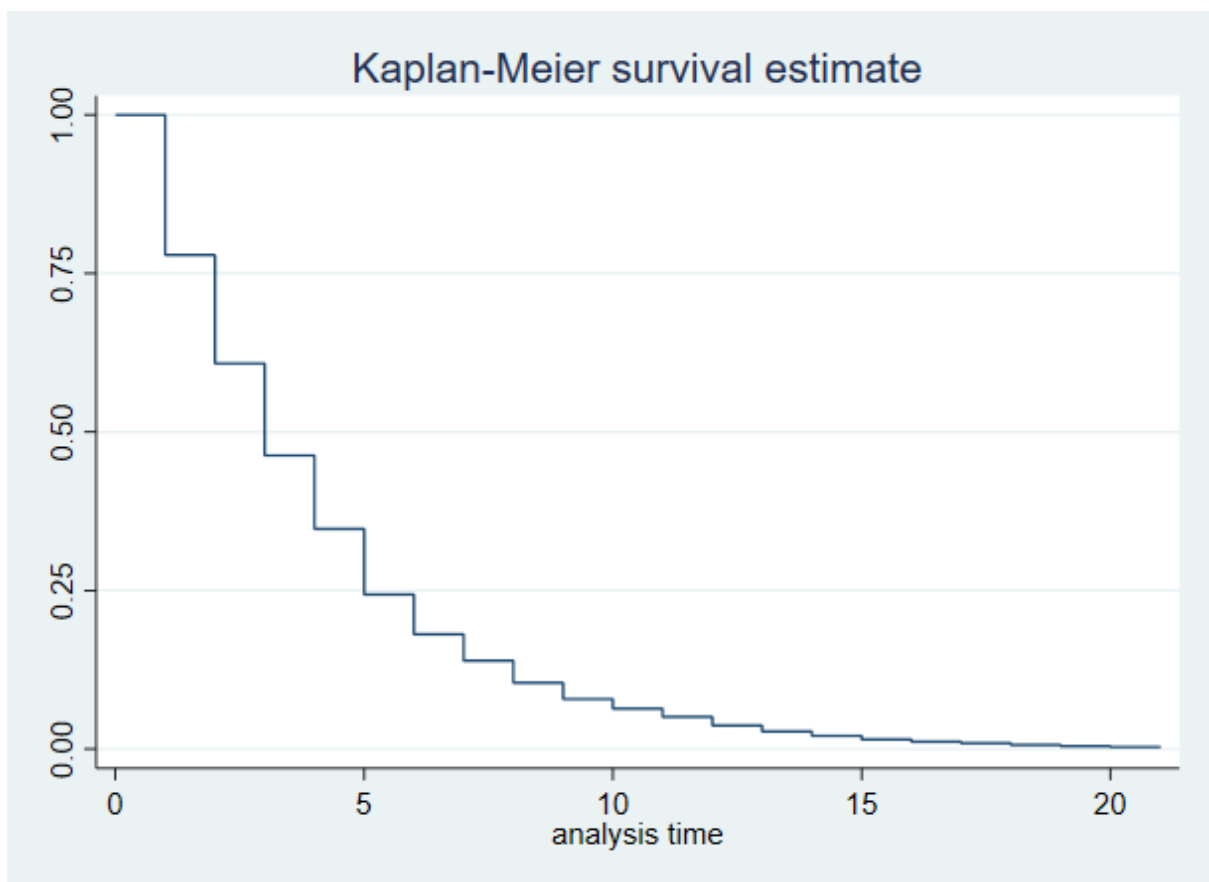


Figure 8: Kaplan Meier estimate of zombie survival: bank- and equity-funded zombies

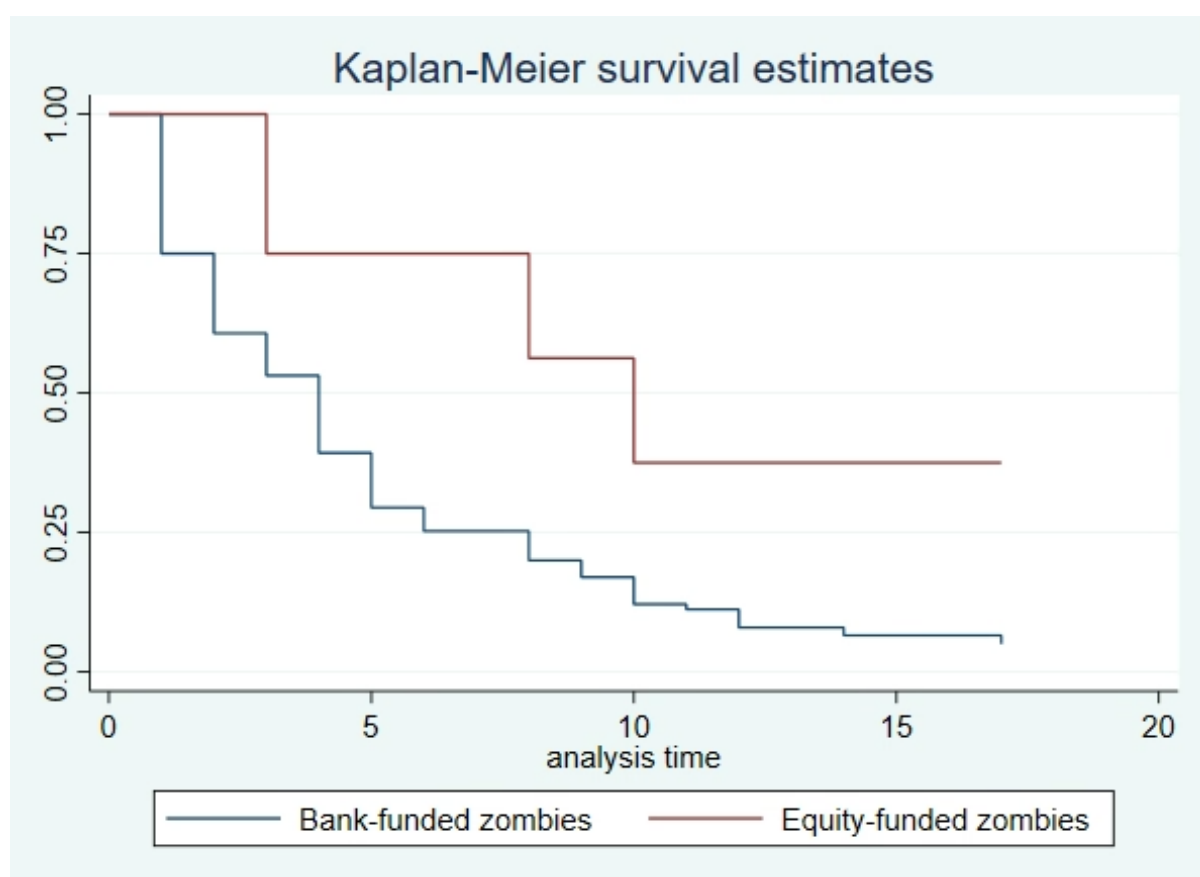


Figure 9: Kaplan Meier estimate of firm survival as a non-zombie

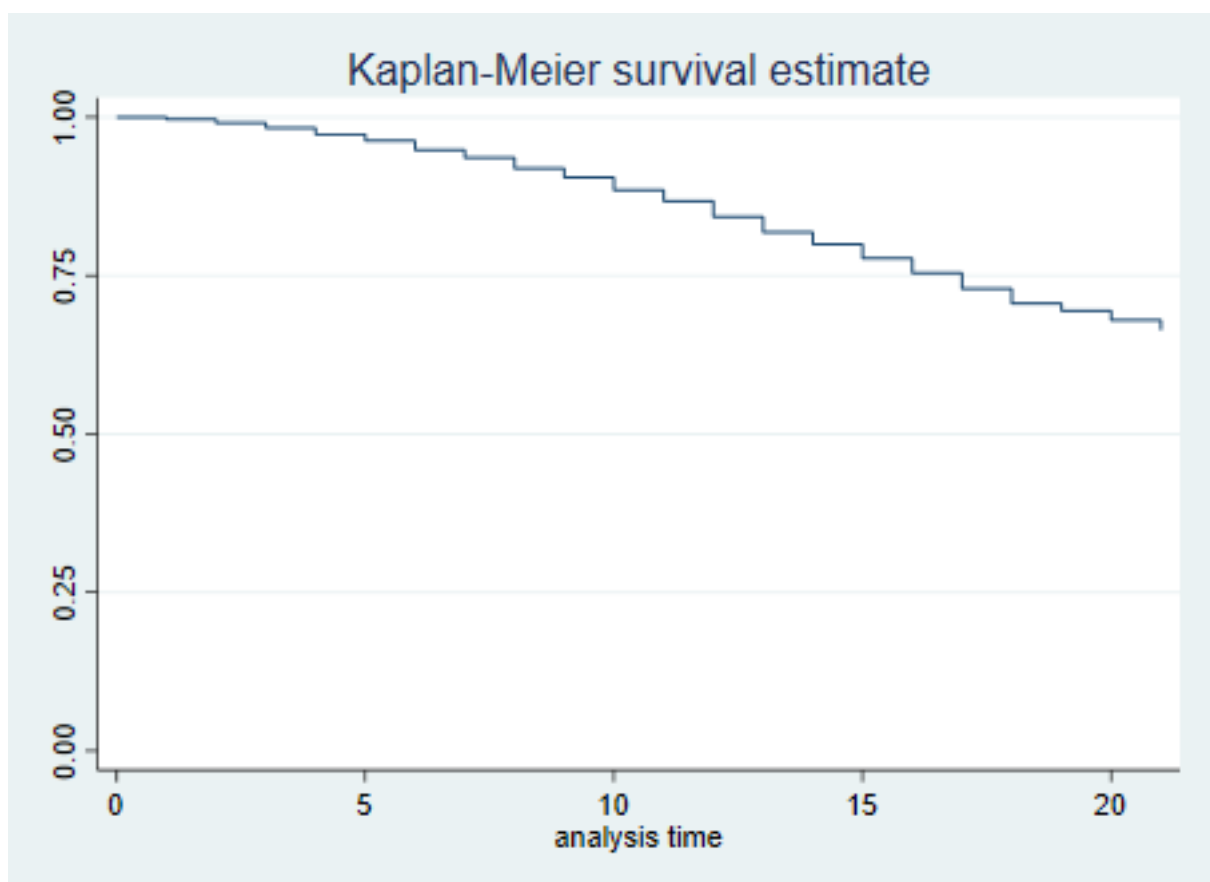
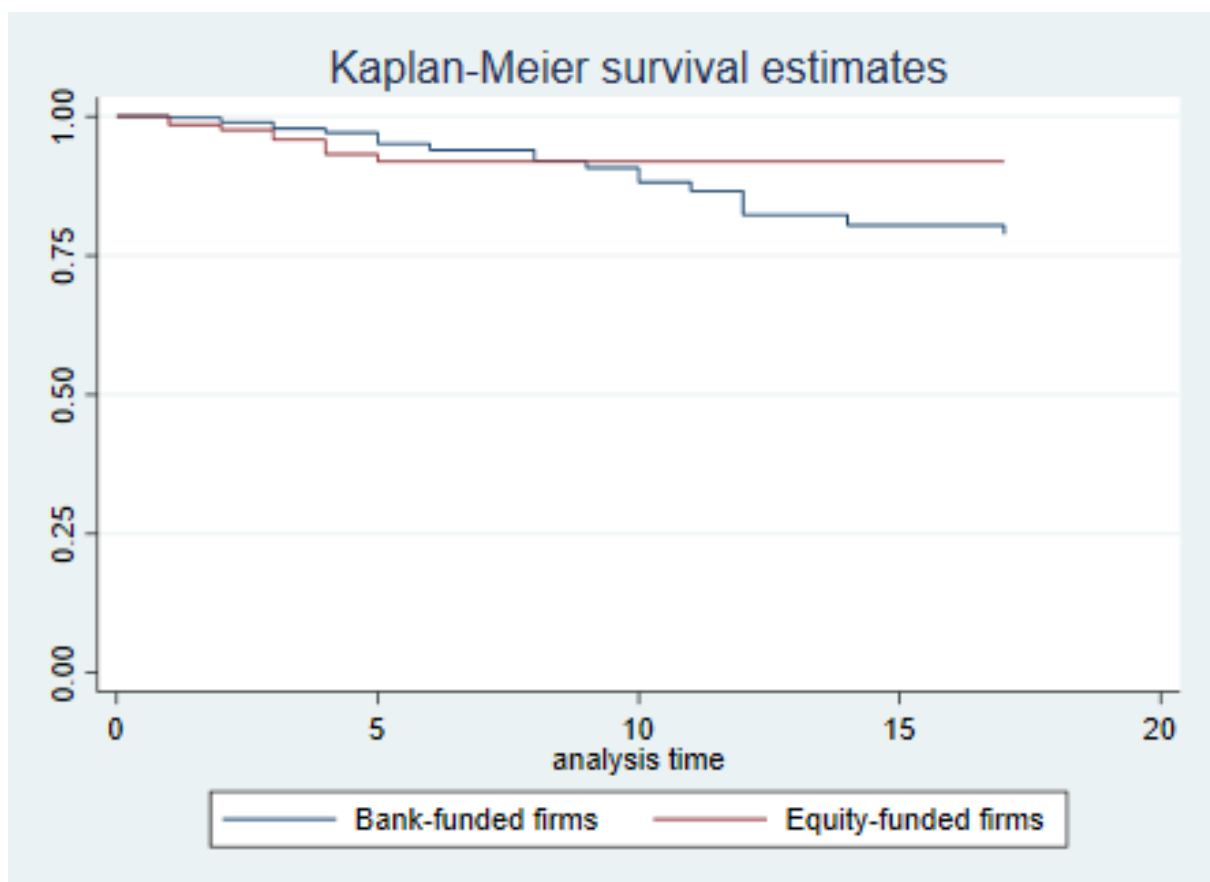


Figure 10: Kaplan Meier estimate of firm survival as a non-zombie: bank- and equity-funded zombies



Tables

Table 1: Panel structure

Number of observations per firm	Frequency	Percent
1	0	0
2	0.05	0.05
3	0.09	0.14
4	0.21	0.35
5	0.3	0.65
6	0.53	1.18
7	0.62	1.8
8	0.83	2.63
9	1.5	4.13
10	1.62	5.75
11	2.06	7.81
12	2.47	10.28
13	2.84	13.13
14	2.51	15.64
15	3.08	18.72
16	2.7	21.43
17	3.04	24.47
18	3.22	27.69
19	3.34	31.04
20	4	35.04
21	3.36	38.39
22	5.3	43.69
23	3.43	47.12
24	4.4	51.52
25	5.96	57.48
26	26.82	84.3
27	2.17	86.48
28	1.6	88.07
29	1.99	90.06
30	2	92.06
31	1.56	93.63
32	0.92	94.55
33	0.91	95.46
34	2.94	98.4
35	1.6	100

Table 2: Correlations between zombie definitions

	Adalet McGowan et al (2017)	Schivardi et al (2021)a	Schivardi et al (2021)b	Storz et al (2017)	Nurmi et al (2022)
Adalet McGowan et al (2017)	1				
Schivardi et al (2021)a	0.2822***	1			
Schivardi et al (2021)b	0.3165***	0.8546***	1		
Storz et al (2017)	0.3429***	0.1795***	0.1915***	1	
Nurmi et al (2022)	0.705***	0.2607***	0.2897***	0.3453***	1

***, ** and * indicates statistical significant at 1, 5 and 10 percent level, respectively.

Table 3: Characteristics of zombie and non-zombie firms (all funder types)

Variable	Description	Non-zombie		Zombie		p-value*	St. Error
		Mean	St. Dev.	Mean	St. Dev.		
Survey data							
FunderChange	1 if firm did not change its main funding source in the past three years; 0 otherwise.	0.92	0.28	0.85	0.36	0.00	0.01
Demand	1 if the firm applied for new credit in the past 12 months; 0 otherwise.	0.26	0.44	0.43	0.50	0.00	0.02
AppliedBank	1 if the firm applied for new credit in the past 12 months from a bank; 0 otherwise.	0.20	0.40	0.34	0.47	0.00	0.01
AppliedOther	1 if the firm applied for new credit in the past 12 months from non-bank source; 0 otherwise.	0.14	0.35	0.27	0.44	0.00	0.01
Supply	1 if the firm applied for new credit and was granted it in the past 12 months; 0 otherwise.	0.26	0.44	0.42	0.49	0.00	0.02
Constrained	1 if the firm experienced a deterioration in their access to finance in the past 12 months; 0 otherwise.	0.10	0.30	0.23	0.42	0.00	0.01
Volume	1 if the firm was granted a smaller loan or of shorter maturity than applied for in the past 12 months; 0 otherwise.	0.02	0.14	0.07	0.25	0.00	0.01
Conditions	1 if other loan terms and conditions became less favourable in the past 12 months; 0 otherwise.	0.04	0.19	0.09	0.29	0.00	0.01
Cost	1 if the firm's margins or fees were increased in the past 12 months; 0 otherwise.	0.07	0.25	0.16	0.36	0.00	0.01
Subsidised	1 if the firm was in receipt of subsidised funding over the past 12 months; 0 otherwise.	0.14	0.00	0.21	0.01	0.00	0.01
Denied	1 if the firm had applied for credit but not granted it in the past 12 months; 0 otherwise.	0.03	0.00	0.08	0.01	0.00	0.01
Purpose1: new investment	1 if an application for new credit in the past 12 months was for the purposes of undertaking new investment; 0 otherwise.	0.18	0.38	0.26	0.44	0.00	0.01
Purpose2: cash flow	1 if an application for new credit in the past 12 months was for cash flow reasons; 0 otherwise.	0.10	0.30	0.22	0.42	0.00	0.01
Purpose3: replace existing credit	1 if an application for new credit in the past 12 months was to replace existing credit; 0 otherwise.	0.03	0.18	0.12	0.32	0.00	0.01
Purpose4: strengthen balance sheet	1 if an application for new credit in the past 12 months was to strengthen the firm's balance sheet; 0 otherwise.	0.02	0.14	0.08	0.27	0.00	0.00
Purpose5: other	1 if an application for new credit in the past 12 months was for another purpose; 0 otherwise.	0.05	0.21	0.10	0.30	0.00	0.01
Banking relationships	Actual number of banking relationships (domestic and foreign).	2.02	1.40	2.97	2.47	0.00	0.07
One relationship	1 if the firm reported to have only one banking relationship; 0 otherwise.	0.43	0.50	0.28	0.45	0.00	0.02
Few relationships	1 if the firm reported to have one or two banking relationships; 0 otherwise.	0.76	0.43	0.61	0.49	0.00	0.02
Financial statement data							
Altman Z-score	Measure of firm creditworthiness.	0.46	0.14	0.62	0.14	0.00	0.00
Return on equity	The ratio of net profit to the sum of equity, value adjustment and optional reserves.**	0.08	42.12	-1.49	20.59	0.00	0.44
Debt to equity ratio	The ratio of non-current creditors to the sum of equity, value adjustment and optional reserves.**	4.21	18.86	1.46	10.86	0.00	0.20

*P-value for the test for equality of the means of the variable between zombie and non-zombie firms.

**Calculated by Statistics Finland.

Table 4: Characteristics of zombie and non-zombie firms (internally funded firms)

Variable*	Non-zombie		Zombie		p-value**	St. Error
	Mean	St. Dev.	Mean	St. Dev.		
Survey data						
FunderChange	0.96	0.20	0.93	0.25	0.21	0.02
Demand	0.07	0.25	0.13	0.34	0.02	0.03
AppliedBank	0.04	0.21	0.08	0.27	0.01	0.01
AppliedOther	0.05	0.21	0.06	0.23	0.57	0.02
Supply	0.07	0.25	0.15	0.36	0.00	0.03
Constrained	0.04	0.20	0.07	0.26	0.02	0.01
Volume	0.01	0.09	0.01	0.10	0.84	0.01
Conditions	0.01	0.09	0.02	0.15	0.17	0.01
Cost	0.01	0.11	0.05	0.23	0.00	0.01
Subsidised	0.09	0.00	0.12	0.02	0.22	0.02
Denied	0.02	0.00	0.03	0.01	0.26	0.01
Purpose1: new investment	0.05	0.22	0.09	0.29	0.01	0.02
Purpose2: cash flow	0.03	0.18	0.06	0.24	0.02	0.01
Purpose3: replace existing credit	0.01	0.08	0.02	0.14	0.03	0.01
Purpose4: strengthen balance sheet	0.00	0.07	0.01	0.10	0.36	0.01
Purpose5: other	0.02	0.15	0.02	0.15	0.95	0.01
Banking relationships	1.83	1.22	2.15	1.58	0.01	0.13
One relationship	0.50	0.50	0.42	0.50	0.10	0.05
Few relationships	0.81	0.40	0.75	0.44	0.16	0.04
Financial statement data						
Altman Z-score	0.47	0.15	0.65	0.15	0.00	0.01
Return on equity	0.33	9.48	-1.60	17.54	0.01	0.70
Debt to equity ratio	7.21	25.63	1.50	11.05	0.00	1.77

*Variables as defined in Table 3.

**P-value for the test for equality of the means between zombie and non-zombie firms.

Table 5: Characteristics of zombie and non-zombie firms (bank funded firms)

Variable*	Non-zombie		Zombie		p-value**	St. Error
	Mean	St. Dev.	Mean	St. Dev.		
Survey data						
FunderChange	0.90	0.30	0.82	0.38	0.00	0.02
Demand	0.36	0.48	0.52	0.50	0.00	0.03
AppliedBank	0.32	0.47	0.45	0.50	0.00	0.02
AppliedOther	0.17	0.38	0.30	0.46	0.00	0.02
Supply	0.36	0.48	0.50	0.50	0.00	0.03
Constrained	0.13	0.34	0.25	0.43	0.00	0.01
Volume	0.03	0.16	0.07	0.25	0.00	0.01
Conditions	0.05	0.23	0.10	0.30	0.00	0.01
Cost	0.09	0.29	0.19	0.39	0.00	0.02
Subsidised	0.15	0.00	0.20	0.02	0.00	0.01
Denied	0.03	0.00	0.07	0.01	0.00	0.01
Purpose1: new investment	0.25	0.44	0.28	0.45	0.15	0.02
Purpose2: cash flow	0.15	0.35	0.27	0.44	0.00	0.01
Purpose3: replace existing credit	0.05	0.22	0.15	0.36	0.00	0.01
Purpose4: strengthen balance sheet	0.03	0.17	0.10	0.30	0.00	0.01
Purpose5: other	0.06	0.25	0.13	0.33	0.00	0.01
Banking relationships	2.08	1.42	3.19	2.64	0.00	0.08
One relationship	0.41	0.49	0.25	0.43	0.00	0.03
Few relationships	0.74	0.44	0.58	0.49	0.00	0.02
Financial statement data						
Altman Z-score	0.48	0.11	0.59	0.12	0.00	0.00
Return on equity	-0.99	49.48	-0.80	7.77	0.92	1.97
Debt to equity ratio	4.33	19.40	1.42	9.91	0.00	0.78

*Variables as defined in Table 3.

**P-value for the test for equality of the means between zombie and non-zombie firms.

Table 6: Characteristics of zombie and non-zombie firms (firms funded by public sources)

Variable*	Non-zombie		Zombie		p-value**	St. Error
	Mean	St. Dev.	Mean	St. Dev.		
Survey data						
FunderChange	0.90	0.30	0.81	0.40	0.16	0.06
Demand	0.47	0.50	0.69	0.47	0.03	0.10
AppliedBank	0.19	0.39	0.27	0.45	0.11	0.05
AppliedOther	0.35	0.48	0.59	0.50	0.00	0.06
Supply	0.48	0.50	0.65	0.49	0.09	0.10
Constrained	0.22	0.42	0.56	0.50	0.00	0.05
Volume	0.05	0.21	0.08	0.27	0.52	0.04
Conditions	0.06	0.25	0.35	0.49	0.00	0.06
Cost	0.12	0.33	0.35	0.49	0.00	0.07
Subsidised	0.40	0.02	0.60	0.06	0.00	0.06
Denied	0.08	0.01	0.17	0.05	0.02	0.04
Purpose1: new investment	0.31	0.46	0.51	0.50	0.00	0.06
Purpose2: cash flow	0.17	0.38	0.37	0.49	0.00	0.05
Purpose3: replace existing credit	0.02	0.15	0.13	0.34	0.00	0.02
Purpose4: strengthen balance sheet	0.02	0.15	0.09	0.28	0.00	0.02
Purpose5: other	0.08	0.27	0.14	0.35	0.07	0.03
Banking relationships	1.98	1.44	3.35	2.35	0.00	0.31
One relationship	0.44	0.50	0.12	0.33	0.00	0.10
Few relationships	0.79	0.41	0.54	0.51	0.00	0.09
Financial statement data						
Altman Z-score	0.50	0.16	0.63	0.13	0.00	0.02
Return on equity	1.83	51.81	-0.34	2.49	0.73	6.20
Debt to equity ratio	8.31	26.80	2.08	13.44	0.06	3.24

*Variables as defined in Table 3.

**P-value for the test for equality of the means between zombie and non-zombie firms.

Table 7: Characteristics of zombie and non-zombie firms (firms funded by non-bank private financial institutions)

Variable*	Non-zombie		Zombie		p-value**	St. Error
	Mean	St. Dev.	Mean	St. Dev.		
Survey data						
FunderChange	0.84	0.36	1.00	0.00	0.39	0.18
Demand	0.29	0.45	0.25	0.50	0.87	0.23
AppliedBank	0.17	0.38	0.32	0.48	0.05	0.07
AppliedOther	0.31	0.46	0.43	0.50	0.17	0.09
Supply	0.30	0.46	0.25	0.50	0.85	0.23
Constrained	0.13	0.34	0.23	0.43	0.20	0.08
Volume	0.04	0.19	0.00	0.00	0.70	0.09
Conditions	0.05	0.23	0.00	0.00	0.63	0.11
Cost	0.11	0.32	0.00	0.00	0.48	0.16
Subsidised	0.12	0.01	0.04	0.04	0.18	0.06
Denied	0.03	0.01	0.07	0.05	0.15	0.03
Purpose1: new investment	0.33	0.47	0.29	0.46	0.61	0.09
Purpose2: cash flow	0.09	0.28	0.18	0.39	0.10	0.06
Purpose3: replace existing credit	0.04	0.19	0.11	0.31	0.08	0.04
Purpose4: strengthen balance sheet	0.03	0.18	0.11	0.31	0.04	0.04
Purpose5: other	0.05	0.22	0.11	0.31	0.17	0.04
Banking relationships	2.44	1.66	1.75	0.96	0.41	0.83
One relationship	0.30	0.46	0.50	0.58	0.40	0.23
Few relationships	0.66	0.48	0.75	0.50	0.70	0.24
Financial statement data						
Altman Z-score	0.47	0.10	0.58	0.11	0.00	0.02
Return on equity	0.28	5.52	0.56	4.57	0.79	1.06
Debt to equity ratio	8.11	26.85	0.35	4.29	0.13	5.08

*Variables as defined in Table 3.

**P-value for the test for equality of the means between zombie and non-zombie firms.

Table 8: Characteristics of zombie and non-zombie firms (equity funded firms)

Variable*	Non-zombie		Zombie		p-value**	St. Error
	Mean	St. Dev.	Mean	St. Dev.		
Survey data						
FunderChange	0.90	0.29	0.90	0.30	0.93	0.05
Demand	0.14	0.35	0.20	0.41	0.29	0.06
AppliedBank	0.04	0.20	0.18	0.39	0.00	0.03
AppliedOther	0.15	0.35	0.22	0.42	0.13	0.05
Supply	0.15	0.35	0.25	0.44	0.07	0.06
Constrained	0.06	0.24	0.28	0.45	0.00	0.04
Volume	0.01	0.08	0.18	0.38	0.00	0.02
Conditions	0.01	0.12	0.05	0.22	0.08	0.02
Cost	0.03	0.16	0.03	0.16	0.94	0.03
Subsidised	0.10	0.01	0.22	0.05	0.00	0.04
Denied	0.01	0.00	0.13	0.04	0.00	0.02
Purpose1: new investment	0.10	0.30	0.25	0.44	0.00	0.04
Purpose2: cash flow	0.08	0.27	0.18	0.39	0.00	0.04
Purpose3: replace existing credit	0.02	0.15	0.10	0.30	0.00	0.02
Purpose4: strengthen balance sheet	0.01	0.08	0.07	0.25	0.00	0.01
Purpose5: other	0.03	0.17	0.05	0.22	0.36	0.02
Banking relationships	2.23	1.60	2.83	2.44	0.03	0.27
One relationship	0.38	0.49	0.30	0.46	0.28	0.08
Few relationships	0.69	0.46	0.65	0.48	0.60	0.08
Financial statement data						
Altman Z-score	0.49	0.10	0.62	0.14	0.00	0.01
Return on equity	0.11	4.36	-0.32	3.28	0.45	0.57
Debt to equity ratio	7.97	26.61	0.58	4.52	0.03	3.44

*Variables as defined in Table 3.

**P-value for the test for equality of the means between zombie and non-zombie firms.

Table 9: Baseline regression, funding relationships and subsidies

Model	(1)	(2)	(3)	(4)
Dependent variable: Zombie				
Bank	0.000 (0.007)	0.001 (0.007)	0.030 (0.026)	0.000 (0.007)
Public	-0.008 (0.018)	-0.007 (0.019)	0.000 (0.080)	-0.005 (0.017)
NonBank	-0.001 (0.012)	0.003 (0.011)	-0.008 (0.025)	0.001 (0.012)
Equity	0.030*** (0.011)	0.032*** (0.012)	0.062* (0.034)	0.029*** (0.011)
FunderChange			0.022 (0.025)	
Bank X FunderChange			-0.039 (0.027)	
Public X FunderChange			-0.001 (0.076)	
NonBank X FunderChange			-0.012 (0.029)	
Equity X FunderChange			-0.038 (0.031)	
Subsidied				0.015 (0.015)
Bank X Subsidised				0.000 (0.017)
Public X Subsidised				-0.015 (0.029)
NonBank X Subsidised				-0.021 (0.019)
Equity X Subsidised				0.008 (0.026)
Constant	-0.010 (0.012)	-0.002 (0.014)	-0.008 (0.026)	-0.011 (0.013)
Estimator	OLS	OLS	OLS	OLS
Cluster	Firm	Firm	Firm	Firm
Firm controls	No	Yes	No	No
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	18,278	17,173	10,705	18,278
R-squared	0.025	0.032	0.015	0.025
Number of firms	8,536	7,945	3,372	8,536

Models (1) and (2) show the results of the estimation of equation (1) and models (3) and (4) show the results of the estimation of equations (3) and (4) respectively.

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 10: Zombie status and bank characteristics - without firm control variables

Model	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent variable: Zombie								
Tier1 capital	-0.010 (0.012)	-0.004 (0.022)	-0.007 (0.023)	-0.011 (0.024)	-0.015 (0.024)	-0.016 (0.026)	-0.008 (0.029)	-0.008 (0.029)
Total equity to assets		-0.012 (0.039)	-0.008 (0.041)	-0.002 (0.041)	-0.002 (0.041)	-0.001 (0.044)	-0.003 (0.045)	-0.003 (0.045)
Return on assets			-0.003 (0.005)	-0.002 (0.005)	0.001 (0.007)	0.001 (0.007)	-0.003 (0.010)	-0.003 (0.011)
Deposit-to-asset ratio				-0.020 (0.054)	-0.029 (0.055)	-0.032 (0.058)	-0.013 (0.069)	-0.016 (0.076)
Loan-to-deposit ratio					-0.010 (0.017)	-0.010 (0.017)	-0.001 (0.021)	-0.002 (0.022)
Liquidity ratio						0.015 (0.183)	-0.000 (0.186)	-0.003 (0.189)
Net interest income							-0.054 (0.063)	-0.054 (0.063)
Cost-to-income ratio								0.006 (0.075)
Constant	0.026* (0.013)	0.029* (0.015)	0.031** (0.015)	0.039 (0.027)	0.057 (0.039)	0.057 (0.040)	0.066* (0.039)	0.065 (0.040)
Estimator	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Firm controls	No	No	No	No	No	No	No	No
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,911	5,911	5,911	5,911	5,911	5,911	5,911	5,911
R-squared	0.015	0.015	0.015	0.015	0.015	0.015	0.016	0.016
Number of firms	2,132	2,132	2,132	2,132	2,132	2,132	2,132	2,132
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1								

Table 11: Zombie status and bank characteristics - with firm control variables

Model	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Dependent variable: Zombie								
Tier1 capital	-0.016 (0.012)	-0.014 (0.023)	-0.016 (0.023)	-0.021 (0.024)	-0.027 (0.024)	-0.024 (0.027)	-0.018 (0.030)	-0.019 (0.030)
Total equity to assets		-0.005 (0.039)	-0.002 (0.041)	0.006 (0.042)	0.007 (0.042)	0.003 (0.045)	0.002 (0.045)	0.002 (0.045)
Return on assets			-0.002 (0.005)	-0.001 (0.005)	0.002 (0.007)	0.001 (0.008)	-0.002 (0.010)	-0.001 (0.012)
Deposit-to-asset ratio				-0.028 (0.054)	-0.039 (0.054)	-0.028 (0.060)	-0.016 (0.070)	-0.020 (0.077)
Loan-to-deposit ratio					-0.013 (0.018)	-0.013 (0.018)	-0.007 (0.022)	-0.008 (0.023)
Liquidity ratio						-0.066 (0.184)	-0.077 (0.187)	-0.080 (0.190)
Net interest income							-0.036 (0.063)	-0.036 (0.063)
Cost-to-income ratio								0.008 (0.074)
Constant	0.032** (0.015)	0.034** (0.017)	0.035** (0.016)	0.046* (0.028)	0.070* (0.041)	0.071* (0.042)	0.077* (0.041)	0.076* (0.042)
Estimator	OLS	OLS	OLS	OLS	Firm	OLS	OLS	OLS
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,730	5,730	5,730	5,730	5,730	5,730	5,730	5,730
R-squared	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
Number of firms	2,067	2,067	2,067	2,067	2,067	2,067	2,067	2,067
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1								

Table 12: Cox proportional hazards model results

	Exit		Recovery			
	(21)	(22)	(23)	(24)	(25)	(26)
_t						
Bank	-0.548*** (0.156)	-0.595*** (0.178)	-0.538*** (0.156)	-0.496*** (0.160)	-0.490*** (0.180)	-0.482*** (0.160)
Public	-1.217** (0.510)	-1.256** (0.512)	-1.169** (0.520)	-1.142** (0.516)	-1.135** (0.520)	-1.072** (0.526)
NonBank	0.045 (0.439)	-0.052 (0.459)	0.048 (0.442)	0.267 (0.394)	0.266 (0.415)	0.274 (0.397)
Equity	-1.247** (0.605)	-1.302** (0.612)	-1.239** (0.604)	-1.179** (0.601)	-1.183* (0.607)	-1.168* (0.600)
FunderChange		0.164 (0.347)			0.104 (0.328)	
Subsidies			-0.099 (0.194)			-0.154 (0.201)
Estimator	MLE	MLE	MLE	MLE	MLE	MLE
χ^2 p-value*	0.7956	0.8882	0.8399	0.872	0.9352	0.9356
Observations	580	557	580	607	584	607
χ^2 p-value*	0.7956	0.8882	0.8399	0.872	0.9352	0.9356

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

*P-value for proportional-hazards assumption test based on Schoenfeld residuals.

Table 13: Sensitivity analysis

Dependent variable	(27)	(28)	(29)	(30)	(31)	(32)
	Zombie	Zombie	Zombies awarded credit	Zombies awarded credit	Zombies non-investment credit	Zombies non-investment credit
Bank	0.000 (0.007)	0.001 (0.007)	-0.001 (0.007)	-0.001 (0.007)	-0.004 (0.06)	-0.003 (0.006)
Public	-0.008 (0.018)	-0.007 (0.019)	-0.010 (0.016)	-0.009 (0.017)	-0.016 (0.012)	-0.013 (0.013)
NonBank	-0.001 (0.012)	0.003 (0.011)	-0.002 (0.012)	0.003 (0.011)	-0.005 (0.012)	0.000 (0.011)
Equity	0.030*** (0.011)	0.032*** (0.012)	0.023** (0.010)	0.025** (0.011)	0.018* (0.010)	0.019* (0.011)
Constant	-0.010 (0.012)	-0.002 (0.014)	-0.009 (0.012)	-0.002 (0.013)	-0.005 (0.011)	0.000 (0.012)
Estimator	OLS	OLS	OLS	OLS	OLS	OLS
Cluster	Firm	Firm	Firm	Firm	Firm	Firm
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	No	Yes	No	Yes
Observations	18,278	17,173	18,278	17,173	18,278	17,173
R-squared	0.025	0.032	0.023	0.031	0.0178	0.024
Number of firms	8,536	7,945	8,536	7,945	8,536	7,945

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 14: Robustness checks - alternative definitions

Model	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)
Dependent variable: <i>Zombie*</i>	Adalet	McGowan et al (2017)	Storz et al (2017)		Nurmi et al (2022)		Schivardi et al (2021a)		Schivardi et al (2021b)	
Bank	0.000 (0.007)	0.001 (0.007)	0.008** (0.004)	0.005 (0.004)	0.011 (0.008)	0.011 (0.008)	0.052 (0.050)	0.008 (0.006)	0.001 (0.007)	-0.001 (0.007)
Public	-0.008 (0.018)	-0.007 (0.019)	0.030*** (0.012)	0.024* (0.012)	0.018 (0.018)	0.021 (0.018)	0.071 (0.053)	0.024 (0.016)	-0.008 (0.018)	-0.008 (0.018)
NonBank	-0.001 (0.012)	0.003 (0.011)	0.012** (0.006)	0.008 (0.006)	0.013 (0.011)	0.012 (0.011)	0.074 (0.051)	0.030** (0.014)	0.023 (0.015)	0.021 (0.014)
Equity	0.030*** (0.011)	0.032*** (0.012)	0.015** (0.007)	0.014** (0.007)	0.033** (0.013)	0.032** (0.013)	0.053 (0.051)	0.009 (0.011)	0.015 (0.012)	0.012 (0.012)
Constant	-0.010 (0.012)	-0.002 (0.014)	-0.020*** (0.007)	-0.009 (0.008)	-0.005 (0.014)	0.007 (0.015)	0.002 (0.051)	0.088*** (0.017)	0.048*** (0.011)	0.077*** (0.015)
Estimator	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,278	17,173	17,405	14,578	14,925	14,673	16,963	16,629	14,434	14,289
R-squared	0.025	0.032	0.008	0.022	0.012	0.019	0.005	0.047	0.005	0.032
Number of firms	8,536	7,945	8,077	6,188	7,204	7,035	7,868	7,670	6,695	6,613
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1										

Bank of Finland Research Discussion Papers 2023

ISSN 1456-6184, online

1/2023 Gonçalo Faria – Fabio Verona
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ISBN 978-952-323-430-7, online

2/2023 Saara Tuuli
Who funds zombie firms: banks or non-banks?
ISBN 978-952-323-431-4, online