Zombie Lending: Theoretical, International, and Historical Perspectives*

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Abstract

This paper surveys the theory on zombie lending incentives and the consequences of zombie lending for the real economy. It also offers a historical perspective by reviewing the growing empirical evidence on zombie lending along three dimensions: (i) the role of under-capitalized banks, (ii) effects on zombie firms, and (iii) spillovers and distortions for non-zombie firms. We then provide an overview of how zombie lending can be attenuated. Finally, we use a sample of U.S. publicly listed firms to compare various measures proposed in the literature to classify firms as "zombies." We identify definitions of zombie firms that are adequate to investigate real sector competitive distortions of zombie lending. We find that only definitions that are based on interest rate subsidies are able to detect these spillovers.

credit misallocation, capital misallocation, bank capital, subsidy, spillovers

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1 Introduction

In response to the Covid-19 crisis, policy makers around the world have adopted several measures, such as regulatory forbearance towards banks, to help borrowing firms navigate the pandemic (Group of Thirty, 2020). These interventions helped firms maintain their productive capacity, especially in sectors severely hit by the pandemic. Given the scale and the swift adoption of these policies, firm defaults are in many economies at record lows—a striking contrast with typical recessions. An inevitable consequence of, and at a minimum a significant risk arising from, this generalized support to the productive sector is the proliferation of zombie firms, namely firms that are known to be in distress but manage to avoid default only thanks to the support of their lenders.

A few historical episodes can provide some guidance to understand and address the zombie lending phenomenon. The extension of credit to borrowers known to be in distress is a regular feature in both advanced and emerging economies. The first evidence dates back at least to Japanese firms in the Nineties, a phenomenon that likely contributed to the subsequent "lost decades" in Japan, as shown in Hoshi (2000) and Caballero et al. (2008). More recent episodes have been documented in other economies such as China, Europe, and India. While these episodes differ based on the characteristics of each empirical context, the literature has shown several recurring themes: (i) the occurrence of zombie lending is usually the consequence of large economic shocks (e.g., the real estate shock in Japan and the global financial crisis (GFC) followed by the sovereign debt crisis in Europe), (ii) regulatory forbearance and an under-capitalized banking sector, and (iii) long-term aggregate consequences such as low economic growth. These observations have spurred researchers to develop theoretical frameworks that model zombie lending as an equilibrium phenomenon.

Zombie firms have been typically identified in the data as firms that are in distress (according to income statement and balance sheet characteristics) and in some identifications as receiving subsidized credit. This second criterion, at times hard to measure (e.g., lenders can subsidize their credit through amortizations or other concessions), is at the core of the credit misallocation induced by zombie lending. If zombie firms receive credit at advantageous terms, firms competing with zombie firms suffer from so-called "congestion" effects, such

as increased competition for inputs and excessive supply of goods produced and services provided.

We review the theoretical and empirical literature on zombie lending and discuss different methods to identify zombie firms in the data, focusing on the role of the interest rate subsidy. In particular, we present various definitions that have been used in the literature and compare them in two ways. First, we compare the share of zombie firms and their characteristics. Second, we document to what extent these measures capture spillover effects of zombie firms on non-zombie firms. Properly identifying spillover effects created by zombie firms is crucial for empirical research and policy design, since these spillover effects can accumulate to aggregate macroeconomic effects. Our analysis highlights the importance of considering whether impaired firms obtain debt financing at subsidized rates when investigating the real economic consequences of zombie lending.

Section 2 discusses the theoretical framework supporting the existence of zombie lending. Section 3 presents the international and historical empirical evidence. Section 4 discusses ways to identify zombie lending in the data. Section 5 concludes.

2 Theoretical framework

What causes financial institutions, and banks in particular, to provide subsidized credit to borrowers they know to be insolvent, a practice also known as "evergreening" or "extending and pretending"? Why are these loans, effectively negative net present value projects, extended?

The main explanation for zombie lending centers around limited liability and the level of bank capital. Bruche and Llobet (2014) show that weakly capitalized banks have an incentive to "gamble for resurrection" by trying to keep their insolvent borrowers alive to avoid realizing losses on their balance sheets. By allowing banks to choose whether to modify, foreclose, or sell loans, the authors extend the debt overhang problem in Bhattacharya and Nyborg (2013). In this richer setup, they show that banks holding many bad loans have an incentive to engage in evergreening as their limited liability constraint binds in the bad state of the world. Policy, in the form of regulatory forbearance towards banks, can also induce zombie lending. Acharya et al. (2021c) consider heterogeneous firms and banks in general

equilibrium, and show that forbearance interventions towards under-capitalized banks lead to zombie lending and a "diabolical sorting" characterized by low-capital banks extending existing loans to low-productivity firms.

The consequence of zombie lending is the misallocation of credit from high-quality firms to low-quality firms. The macro literature on factor misallocation (e.g., Hsieh and Klenow (2009), Midrigan and Xu (2014)) is based on generic financial frictions such as incentive compatibility and collateral constraints. Tracey (2021) more directly and quantitatively analyzes the effect of "forbearance" lending on financial decisions of firms. The model shows that zombie lending reduces firms' growth, investment rates, and total factor productivity, leading the author to conclude that zombie lending likely contributed to lower output in the euro area from 2011 to 2014. These results are consistent with the seminal formalization in Caballero et al. (2008) that show that zombie lending causes a congestion of firms that, in turn, leads to some more productive firms and projects not receiving capital. Acharya et al. (2021c) consider such spillovers in a dynamic model of policy, where the role of bank capital is key to generate loan evergreening. The authors show these spillovers can lead to policy traps of repeated forbearance, transforming transitory shocks into permanent output losses (which they refer to as "economic sclerosis" from zombie lending).

Another recent explanation for the existence of zombie lending centers around the coexistence of market-based lenders and private lenders. According to this view, zombie lending is inevitable. Based on the idea that private lenders have an information advantage over market-based lenders, Hu and Varas (2021) show that even well-capitalized banks might engage in zombie lending. Private lenders, such as banks, gather information about their borrowers and thus liquidate bad loans early. Hence, long borrower-bank relationships improve borrowers' reputation with market-based lenders, inducing banks to extend zombie loans to help the bad borrowers obtain market financing. However, this explanation is only consistent with indirect evidence from the pricing of debt securities in the U.S. in 1993–95 (presented in Gande et al. (1997)) and some anecdotal evidence, but is at odds with the banking literature that does not find zombie lending being undertaken by well-capitalized banks.

3 Empirical evidence

The empirical literature started with investigating the causes and consequences of the "lost decades" in Japan. It has become more prominent following the European sovereign debt crisis and, very recently, focused on the possible effects of government measures during the COVID-19 pandemic. We focus on the empirically documented implications of zombie lending for (i) bank balance sheets and lending decisions; (ii) firms productivity, employment, and investment decisions; (iii) possible spillovers to the real sector and their consequences for growth; and, (iv) mechanisms to attenuate zombie lending.

3.1 Lending by under-capitalized banks to zombie firms

We focus below on the empirical literature on zombie lending in Japan and Europe. The key notion in this literature is that—following a large economic shock—some banks remain under-capitalized (e.g., because of regulatory forbearance) and continue to provide credit towards zombie firms in order to avoid the recognition of loan losses (the so-called "evergreening" of loans). An important empirical exercise is to define and measure the existence of zombie firms and, in particular, to isolate zombie lending from the alternative that banks extend loans to risky firms but at risk-adjusted pricing. Thus, most of this literature tries to estimate a subsidy to those firms as evidence for zombie lending.

3.1.1 Evidence from Japan

Peek and Rosengren (2005) investigate bank lending in Japan over the 1993 to 1999 period and document that firms are more likely to receive bank loans if bank balance sheets are weak. Specifically, they show that particularly low-quality firms (measured by deteriorating return on assets and net working capital) obtain more credit. Banks appear to be more engaged in zombie lending if their capital ratios get closer to the regulatory minimum. Furthermore, they highlight that the effect is only measurable if the borrower is a member of the same business group (a *keiretsu* affiliate).

Caballero et al. (2008) highlight that the share of zombie firms among publicly listed firms in the manufacturing, construction, retail, real estate, wholesale, and service sector almost tripled to about 30% between the early 1990s and 2000. In contrast to previous studies,

Caballero et al. (2008) classify firms as zombies only if they receive subsidized credit, which they base on the comparison of the interest rate paid by the borrower relative to the interest rate expected to be paid by the highest quality borrowers (the prime rate).

Giannetti and Simonov (2013) classify zombies following the same approach and provide consistent evidence investigating the effect of capital injections on loan supply during the 1998 to 2004 period. They document that capital injections during this time were insufficient to fully address the debt overhang problem in the Japanese banking sector. Importantly, they find that banks that remain under-capitalized after the capital injections (in stark contrast to those banks that become well-capitalized) even increase zombie lending.[1]

3.1.2 Evidence from Europe

A series of papers investigates zombie lending in the aftermath of the global financial crisis and the subsequent sovereign debt crisis in Europe.[2] A common notion in these papers is the weakness of the European banking sector following the GFC of 2008 to 2009. Indeed, Acharya et al. (2021a) show that particularly fiscally-constrained European governments (e.g., Italy and Spain) had been "kicking the can down the road," providing banks with guarantees rather than equity during the GFC. Consequently, large parts of the banking sector remained under-capitalized at the end of 2009 (i.e., before the start of the sovereign debt crisis in the fall of 2010). Over the 2009 to 2012 period, under-capitalized banks lost further equity capital, reduced lending, but increased their loan-loss provisions compared to their better-capitalized peers. They also relied more on the support by the European Central Bank (ECB). Importantly, they increased (subsidized) zombie lending and increased

[1] Related papers document an increase in bank credit to underperforming industries such as the real estate sector (e.g., Hoshi, 2000) and that loan rates do not appear to be high enough given the riskiness of the loans (e.g., Smith, 2003; Schaede, 2005).

[2] Anecdotal evidence suggests that Europe's weak economic recovery may be a repeat of Japan's "zombie lending" experience in the 1990s. In Portugal, Spain, and Italy, 50%, 40%, and 30% of debt, respectively, was owed by firms which were not able to cover their interest expenses out of their pretax earnings at the end of 2013. In those countries, about 12%, 8%, and 18% of total bank loans in 2014, respectively, were non-performing according to data from the World Bank.

investments in risky domestic sovereign debt.[3]

To address the weakness of the European banking sector, the European Banking Authority (EBA) unexpectedly increased capital requirements in their capital exercise in 2011.[4] Blattner et al. (forthcoming) investigate lending by Portuguese banks over the 2009 to 2015 period and exploit this experiment to study the effects of reduced bank capital adequacy on bank lending. Affected banks significantly decreased lending following the capitalization exercise. Importantly and consistent with evergreening of loans to zombie firms, they find that these banks reallocate credit to firms in financial distress with previously underreported loan-loss provisioning. Relatedly, Bonfim et al. (2021) analyze data on firm-bank lending relationships in Portugal during the 2005 to 2015 period and show that Portuguese banks were more likely to provide credit to zombie firms if their profitability deteriorated, they had a longer relationship with the firm, and if borrowers had previously defaulted on their loans.

At the peak of the sovereign debt crisis in summer 2012, the ECB launched the Outright Monetary Transactions (OMT), which marked the turning point of this crisis.[5] The OMT announcement significantly lowered spreads of sovereign bonds issued by distressed European countries, thereby increasing these bonds prices. As a result, banks with significant holdings of these bonds experienced substantial windfall capital gains. Acharya et al. (2019) analyze bank lending during the 2009 to 2014 period and investigate the effect of the OMT on lending by banks with high vs. low windfall capital gains. Consistent with evidence from Japan, some banks still remained under-capitalized after the OMT announcement. Acharya et al. (2019) show that these banks extended new subsidized loans to provide their impaired borrowers

[3] Acharya and Steffen (2015) identify a risk-shifting or "carry trade" incentive of under-capitalized banks as the primary motive for sovereign bond purchases during this period. See also Crosignani et al. (2020) for a discussion of the role of ECB interventions in supporting domestic sovereign bond purchases. Storz et al. (2017) also document an increase in zombie lending in peripheral European countries during the 2010 to 2014 period.

[4] The capital exercise required a subset of banks to reach and maintain a 9% core Tier 1 capital ratio by the end of June 2012.

[5] Once activated toward a specific country, the OMT program allows the ECB to buy a theoretically unlimited amount of the country's government bonds in secondary markets. Even though the OMT program has not been activated yet, the sole announcement of its introduction has lowered spreads of sovereign bonds issued by the distressed European countries.

with the liquidity necessary to meet payments on other outstanding loans. Thereby, these banks avoided (or at least deferred) realizing immediate loan losses in the hope that the respective borrowers would eventually regain solvency. They show that about 8% of the loans extended to firms in their sample in the post-OMT period were such zombie loans. Consistent with Acharya et al. (2021a), they also find a significant increase in non-performing loans relative to total loans for zombie lending banks compared to other banks.

Schivardi et al. (forthcoming) take the hypotheses of evergreening by weak banks to Italian data studying the 2008 to 2013 period. They find that Italian banks that became under-capitalized during the financial crisis were more likely to cut credit to healthy firms and to evergreen loans to zombie firms compared to better capitalized banks. Notably, they do not classify zombies according to the existence of subsidized credit, but rather as firms that are highly indebted and for which the returns on assets have been systematically below the cost of capital of the safest firms.

3.1.3 Evidence from emerging markets

Other papers study zombie lending in emerging markets. Chopra et al. (2021) find evidence consistent with a debt overhang on bank balance-sheets after an Asset Quality Review in India in 2015 (outside of financial crises), which required banks to fully provision their loans by March 2017 as regulators were concerned with evergreening by banks. They find that banks that were under-capitalized after the AQR increased loans to zombie firms. Li and Ponticelli (forthcoming) provide evidence for the existence of zombie lending and zombie-intensive industries in China in areas with less specialized courts. Relatedly, Charoenwong et al. (2021) argue that Chinese banks conceal non-performing assets from regulators, which might further weaken bank health and affect loan supply.

In summary, this literature spanning historical episodes in Japan, Europe, and emerging markets provides consistent and robust findings that in the aftermath of large shocks, banks that remain under-capitalized evergreen loans to zombie firms in order to avoid the recognition of loan losses. Consequently, bank health and balance sheets continue to deteriorate when capitalization declines and non-performing loans increase.

3.2 Implications for zombie firms

A common result in the literature appears to be that bank lending to zombie firms does not translate in a subsequent better economic performance of zombie firms. This literature has mainly focused on the effects of zombie lending on employment, financing and investment policies, and profitability of zombie firms.

The evidence suggests that employment effects are limited. For example, Giannetti and Simonov (2013) analyze the effects of bank recapitalizations on firm outcomes in Japan and find no evidence that firms changed their employment decisions following a recapitalization of the banks with which they had a strong lending relationship. During the European sovereign debt crisis, Acharya et al. (2019) do not find evidence for employment effects of zombie vis-à-vis non-zombie firms. Blattner et al. (forthcoming) document a temporary employment and wage growth by zombie firms borrowing from under-capitalized banks. Schivardi et al. (forthcoming) also do not find significant employment effects.

Researchers have also investigated financing and investment policies of zombie firms. Giannetti and Simonov (2013), for example, find that zombie firms more exposed to banks that benefited from capital injections and that remained under-capitalized appear to invest more, consistent with financial constraints of these firms in the absence of zombie banks. Zombie firms borrowing from well-capitalized banks, on the other hand, invest less. Acharya et al. (2019) show that zombie firms, on average, increase leverage but do not use the loans to build up cash reserves (in contrast to other low quality non-zombie firms), likely because they had to service interest payments on existing debt. They also do not find evidence that zombie firms increase or decrease investments (measured as capital expenditures). Consistently, Acharya et al. (2019) also find a sharp increase in the default rate of zombie vis-à-vis non-zombie firms from 2015 onwards contributing also to the increase in non-performing loans on bank balance sheets as documented above. Acharya et al. (2021a) provide similar evidence for Europe. Over the 2013 to 2016 period, zombie firms that borrowed from under-capitalized banks increased leverage, had lower (and even, on average, negative) interest coverage ratios, reduced cash holdings as well as tangible assets relative to zombie firms borrowing from better capitalized banks.

The literature also does not find evidence that zombie firms have become more profitable after receiving credit. Acharya et al. (2019), for example, do not find an effect on the profitability of zombie firms. Acharya et al. (2021a) show that zombie firms that have borrowed from under-capitalized banks experienced a decline in operating earnings, had a lower and on average negative return on assets, lower sales and cash flows relative to zombie firms borrowing from better-capitalized banks.

Overall, this literature provides evidence that bank lending to zombie firms does not translate into a subsequent better economic performance of zombie firms, suggesting credit misallocation, i.e., that credit might be allocated away from healthy firms that might employ it in more efficient ways. We investigate potential spillovers from such misallocation in the next subsection.

3.3 Spillovers to competition, inflation, and innovation

By keeping zombie firms alive, banks indirectly allow these firms to distort competition throughout the rest of the economy. These distortions might come in many ways, including distorted market prices, wages, and more generally, a congestion of markets in which zombie firms operate. This prevents the normal competitive outcome, or "creative destruction," whereby the zombies would exit the market and more productive firms enter to fill in their space. Importantly, the distortions might reduce profits and collateral of non-zombie firms, reducing their entry and weakening their incentives to invest. Several studies on Japan and Europe have put these hypotheses to the data and found corroborating evidence.

Caballero et al. (2008) analyze the congestion effects caused by zombie firms in Japan and provide evidence that the increase in the presence of zombie firms in an industry reduces employment growth and investments of non-zombie firms in the same industry. Moreover, the productivity gap between zombie and non-zombie firms increases significantly. Schivardi et al. (2020), on the other hand, argue that these effects might not be driven by the presence of zombies *per se*, but rather by an overall deterioration of industry quality.

However, the literature on zombie lending in Europe and related cross-country studies has documented similar spillover effects as in Caballero et al. (2008). For example, Acharya et al. (2019) document a reduction in employment growth and investment of non-zombie firms

in industries with a high presence of zombie firms after the OMT announcement. Acharya et al. (2021b) find consistent evidence in a panel of 11 European countries; Blattner et al. (forthcoming) show consistent evidence for Portuguese non-zombie firms; and Banerjee and Hofmann (2020) and Adalet McGowan et al. (2018) provide evidence for these spillovers in international cross-country samples.

Some authors also study implications of competitive distortions on prices and markups in industries with a high presence of zombie firms. Acharya et al. (2021b), for example, find that healthy firms that face competition from a growing number of zombie firms have lower markups, profitability, and sales growth, as well as higher input costs using a sample of 11 European countries over the 2009 to 2016 period. Importantly, they find that industry-country pairs that experience a stronger increase in the share of zombie firms subsequently have a lower inflation. This finding suggests that zombie lending can affect macroeconomic variables of direct interest to policy setting.

Schmidt et al. (2021) investigate the effects of zombie lending in a sample of Spanish firms over the 2010 to 2016 period. They find evidence for competitive distortions in industries with a high share of zombie firms and under-capitalized banks such as lower entry rates of healthy firms, lower material costs, and higher markups consistent with a decline in competition. More importantly, they study the effect zombie lending on corporate innovation as key driver of economic growth. Using both patent as well as survey data, they find a significant reduction in innovation in industries with a large share of zombie firms and under-capitalized banks.

Overall, this literature emphasises significant negative externalities of zombie lending on non-zombie firms and the economy. These distortions manifest in different ways but are usually associated with potentially long-term implications for economic growth and help us understand asymmetric economic developments across countries with a large or small presence of zombie firms.

3.4 Attenuating zombie lending

Given these distortions caused by zombie lending, what measures can regulators and governments adopt to prevent and tackle this practice? The literature has mostly focused on three areas: the role of bank supervision and stress tests, the role of bank capital, and the role of

restructuring and bankruptcy laws.

Angelini et al. (2020) and Bonfim et al. (2021) use granular data to assess the effectiveness of regulatory on-site inspection in curbing zombie lending in the context of Italy and Portugal, respectively. Angelini et al. (2020) analyze bank inspections conducted by the Bank of Italy and find that audited banks are more likely to reclassify loans as "nonperforming" and more likely to increase loan loss provisions after audits. Inspections also cause a reallocation of credit supply from impaired borrowers to productive firms. Bonfim et al. (2021) analyze two inspections in mid-2012 and mid-2013 and find that audited banks are 20% less likely to refinance a zombie firm, in turn causing these borrowers to default more.

Stress testing and subsequent recapitalizations are possible ways to attenuate zombie lending as differences in the European and U.S. stress test experience suggest. In contrast to Europe, the U.S. implemented the so-called Supervisory Capital Assessment Program (SCAP) in 2009. This program involved a much more rigorous stress test than the European stress tests. Moreover, U.S. authorities required banks with a capital shortfall to recapitalize. This program proved successful in stabilizing the U.S. banking sector (Greenlaw et al., 2012) and keeping the share of zombie firms below the level in most European countries (Favara et al., 2021).

Several aforementioned papers propose bank recapitalizations as the key tool to tackle zombie lending. Once again, the first evidence of the effectiveness of recapitalizations comes from Japan, where Giannetti and Simonov (2013) document that capital injections, if large enough to meet bank capital requirements, have a positive effect on credit and investment. The fact that recapitalizations have to be sufficiently large to avoid a binding limited liability constraint is consistent with Blattner et al. (forthcoming) that show how a policy that caused banks to fall below the regulatory capital ratios induced zombie lending by affected banks. Acharya et al. (2021a) argue that the limited bank recapitalizations in Europe during the 2008–09 crisis caused banks to "gamble for resurrection" buying risky sovereign debt and engaging in zombie lending. Moreover, analyzing the 2015 Indian bank asset quality review, Chopra et al. (2021) show that bank cleanups without capital-injection plans are ineffective in spurring market recapitalizations and in curbing zombie lending by low-capital banks.

Finally, the literature has emphasized the importance of efficient restructuring and

bankruptcy processes. This is motivated by theories arguing that zombie lending can be prevented by introducing a subsidy to incentivize foreclosure and modifications by banks, or alternatively, by having the regulator buy bad loans from banks (Bruche and Llobet, 2014). The empirical evidence seems mixed. On the one hand, Kulkarni et al. (2021) analyze the introduction of a new bankruptcy law in 2016 in India and find that the reform had muted effects on zombie lending because of weakly-capitalized and state-owned banks. On the other hand, Li and Ponticelli (forthcoming) find that the introduction of more efficient courts in China helped reallocate labor and capital away from zombie firms. Jorda et al. (2021) analyze 17 advanced economies since the 19^{th} century and find that the costs of corporate debt booms rise when inefficient debt restructuring and liquidation impede the resolution of corporate financial distress. Becker and Ivashina (2021) find that European countries with better insolvency regimes make more use of private debt markets that heavily rely on functioning insolvency frameworks.

4 Measurement and consequences of zombie lending: Evidence from the U.S.

4.1 Motivation

As emphasized above, Caballero et al. (2008) provide a comprehensive theory of the effects of zombie firms on real economic activity. At the core of this theory is the insight that by receiving subsidized credit, non-viable firms are kept alive instead of defaulting and exiting the market. Hence, the presence of zombies distorts the normal creation and destruction patterns that are otherwise operative in the economy. This distortion negatively affects productivity and, importantly, as the share of zombie companies rises, larger competitive distortions will arise for healthy (non-zombie) companies. Hence, a key prediction of the zombie lending channel is that healthy firms will be negatively affected by the presence of zombie companies in their industry. Moreover, Acharya et al. (2021c) show theoretically that these negative spillover effects can lead to forbearance policy traps that result in permanently lower growth and productivity in the economy, thereby prolonging recoveries even after transitory shocks.

Despite a clear theoretical underpinning for the significance of these spillovers from zombie

lending, empirical research of both academics and practitioners has not yet settled on a clear definition of what constitutes a zombie firm in the first place. In the following analysis, we compare for various definitions of zombie firms the share of zombie firms, their characteristics, and their competitive spillover effects on healthy firms. Consistent with the theoretical prediction that credit misallocation is key for detecting spillover effects, we find that only definitions of zombies that rely on an interest rate subsidy are able to identify spillover effects.

4.2 Data and zombie firm definitions

We will focus our analysis on some widely used definitions of zombie firms in the academic literature. These definitions stem from Acharya et al. (2019) (which builds on Caballero et al. (2008)), Adalet McGowan et al. (2018), and Banerjee and Hofmann (2020). In order to compare these different approaches of defining zombie firms, we construct a sample of U.S. publicly traded companies for the period 2004–2020 from the Compustat-CapitalIQ database. We will first describe each of these definitions briefly.

Adalet McGowan et al. (2018) focus their analysis on a profitability based measure to identify zombie firms. More precisely, they define zombies as firms with an interest coverage ratio below one for three consecutive years and an age of at least ten years.

Banerjee and Hofmann (2020) refine this definition, that is mainly based on profitability, by considering whether a firm has a low future profit potential in the eyes of investors as reflected in a relatively low Tobin's q. More precisely, Banerjee and Hofmann (2020) define zombies as firms with (i) an interest rate coverage ratio (ICR), defined as earnings before interest and taxes (EBIT) over interest payments, below one; and (ii) a Tobin's q below the median within the firm's sector. To obtain persistence in the zombie classification, both criteria have to be satisfied for two consecutive years and either of the two criteria has to be violated for two consecutive years before a firm leaves the zombie classification.

Both of these widely used definitions focus primarily on the quality of the respective firms. In contrast, Caballero et al. (2008) argue that quality should not be the (sole) determinant of a firm's zombie status, especially if the goal is to evaluate the effect of zombies on the economy. The key distortion created by zombies stems from their subsidized financing, i.e., the fact that they receive debt funding at highly advantageous interest rates. Caballero et al.

(2008) thus define zombie companies as firms that obtain credit at an interest rate below the relevant prime rate in the economy. A similar approach has been employed by Giannetti and Simonov (2013) and Acharya et al. (2019).

Thus, our third zombie definition follows Acharya et al. (2019) and defines a firm as zombie if it obtained subsidized debt financing and has an interest-coverage ratio implied rating of BB or worse.

We follow Caballero et al. (2008) and Acharya et al. (2019) and classify a firm as receiving subsidized credit if in a given year the firm's interest expense scaled by total debt is below the expense paid by the most creditworthy firms in the economy. To determine the benchmark we consider the median interest rate r_t^B paid by firms with a median rating of at least AA issued by S&P, Moody's, or Fitch. That is, we formally define for each firm i a hypothetical lower bound for its interest expenses:

$$R_{it}^* = r_t^B * Debt_{it} \tag{1}$$

We then compare the actual interest payments of our sample firms with this hypothetical lower bound by defining the interest expense gap as:

$$x_{it}^* = R_{it} - R_{it}^* \tag{2}$$

We classify a firm as receiving subsidized credit if its interest rate gap x_{it}^* is negative. This leads us to the following zombie definitions we consider in our analysis:

1. $Zombie_1$: Three-year average interest coverage ratio implied rating of BB (IC ratio cutoff: 2.5) or lower and $x_{it}^* < 0$ (Acharya et al., 2019).

2. $Zombie_{2a}$: Interest coverage ratio below one for three consecutive years and an age of at least ten years (Adalet McGowan et al., 2018).

3. $Zombie_{2b}$: $Zombie_{2a}$ and $x_{it}^* < 0$.

4. $Zombie_{3a}$: Two consecutive years with (i) interest rate coverage ratio below one and (ii) a Tobin's q below the median within the firm's sector (Banerjee and Hofmann , 2020).

5. $Zombie_{3b}$: $Zombie_{3a}$ and $x_{it}^* < 0$.

Additionally, we follow Acharya et al. (2019) and compare the firms classified as zombies under our first definition ($Zombie_1$) to firms that satisfy that low interest coverage criterion, but do not receive subsidized credit. We refer to these firms as $low - quality_1$ firms.

4.3 Results

In a first step, we document the time-series evolution of the share of zombie firms for each zombie definition (**Figure 1**).

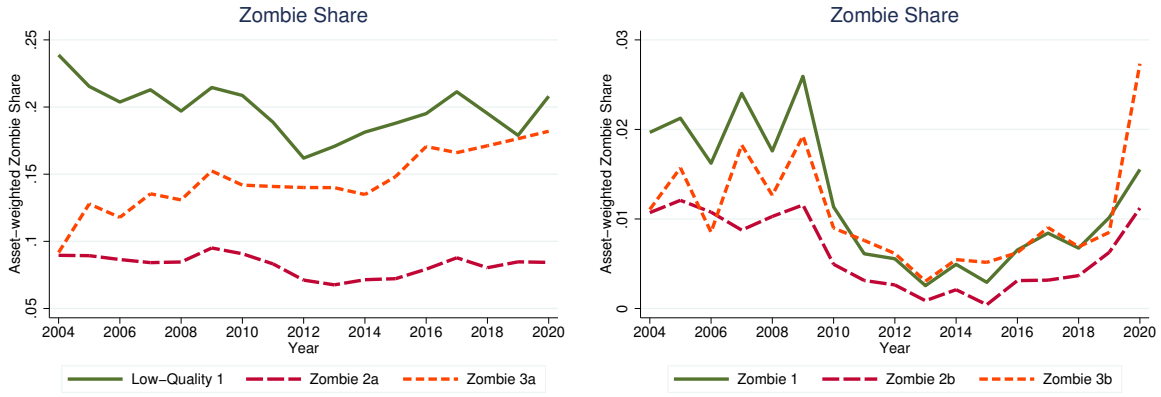

Figure 1: This figure shows the asset-weighted share of low-quality and zombie firms for various definitions of zombie firms. The top panel considers classifications that focus only on the quality aspect of the respective zombie definitions. The bottom panel additionally considers whether the respective low-quality firms receive subsidized credit.

The top panel shows that if zombie firms are solely defined based on their quality, the share of zombie firms in the U.S. economy varies between 10% and 20%, with some definitions suggesting a substantial increase in the share of zombie companies. In contrast, the bottom panel shows that once the additional criterion of firms receiving subsidized credit is introduced, the share of zombie firms in the U.S. economy is significantly lower—consistent with the analysis of Favara et al. (2021). Moreover, all three zombie definitions including the subsidized credit criterion closely track each other. This suggests that while the share of poorly performing companies has been at relatively high levels—and increasing according to some definitions—many of these companies did not obtain debt financing at subsidized

	(1) $NonZombie$	(2) $LowQuality_1$	(3) $Zombie_1$	(2)-(3)
EBITDA/Assets	2.8	-10.8	-17.6	6.8***
IC Ratio	7.2	-3.1	-10.5	7.4***
Emp. Growth	3.1	0.0	-3.5	3.5**
CAPX/Assets	6.2	5.0	3.3	1.7***
Int. Expenses/Debt	7.0	10.9	3.3	7.6***
Tangibility	31.7	29.3	18.5	10.8***
Exit	3.4	8.2	12.0	−3.8***
	$NonZombie$	$Zombie_{2a}$	$Zombie_{2b}$	
EBITDA/Assets	2.4	-12.1	-17.5	5.4**
IC Ratio	6.0	-3.2	-9.6	6.4***
Emp. Growth	2.9	-2.0	-4.5	2.5
CAPX/Assets	6.1	4.8	3.0	1.8***
Int. Expenses/Debt	7.5	10.9	3.2	7.7***
Tangibility	31.7	31.0	20.1	10.9***
Exit	3.5	7.8	14.9	−7.1***
	$NonZombie$	$Zombie_{3a}$	$Zombie_{3b}$	
EBITDA/Assets	1.8	-2.2	-5.0	2.8***
IC Ratio	6.8	-0.3	-2.2	1.9***
Emp. Growth	3.3	-2.6	-5.5	2.9**
CAPX/Assets	5.9	4.8	3.8	1.0**
Int. Expenses/Debt	7.5	9.6	3.1	6.5***
Tangibility	29.1	34.5	23.4	11.1***
Exit	3.8	8.4	12.0	−3.6***

Table 1: Descriptive Statistics This table provides descriptive statistics separately for high-quality (non-zombie) firms (Column 1), firms that satisfy only the low-quality criterion of the respective zombie definition (Column 2), and firms that additionally obtain subsidized debt financing (Column 3). Column 4 provides a t-test for the significance of the difference between firms in Columns (2) and (3).

rates.[6]

Table 1 presents descriptive statistics for our sample firms, split into non-zombie (high-

[6]Under our preferred zombie definition ($Zombie_1$), the industry-years with the highest zombie share were: General Building Contractors in 2007, Motor Freight Transportation and Warehousing in 2008, Amusement and Recreation Services in 2009, Eating and Drinking Places in 2020, and Electronic and Other Electric Equipment in 2008.

	Empl Growth	CAPEX
$NonZombie_1$	0.020***	0.018***
	(0.002)	(0.003)
$NonZombie_1 \times ShareLow - Quality_1$	-0.005	-0.001
	(0.004)	(0.003)
Observations	34,764	36,149
R-squared	0.174	0.299
$NonZombie_1$	0.023***	0.019**
	(0.004)	(0.007)
$NonZombie_1 \times ShareZombies_1$	-0.018***	-0.013**
	(0.004)	(0.005)
Observations	34,764	36,149
R-squared	0.169	0.292
$NonZombie_{2a}$	0.018***	0.019***
	(0.002)	(0.002)
$NonZombie_{2a} \times ShareZombies_{2a}$	-0.001	-0.000
	(0.002)	(0.003)
Observations	34,764	36,149
R-squared	0.175	0.301
$NonZombie_{2b}$	0.007***	0.007**
	(0.001)	(0.003)
$NonZombie_{2b} \times ShareZombies_{2b}$	-0.020***	-0.018**
	(0.005)	(0.008)
Observations	34,764	36,149
R-squared	0.169	0.292
$NonZombie_{3a}$	0.026***	0.026***
	(0.003)	(0.003)
$NonZombie_{3a} \times ShareZombies_{3a}$	-0.005	-0.002
	(0.004)	(0.003)
Observations	34,764	36,149
R-squared	0.177	0.303
$NonZombie_{3b}$	0.010***	0.010***
	(0.001)	(0.002)
$NonZombie_{3b} \times ShareZombies_{3b}$	-0.013***	-0.021***
	(0.003)	(0.004)
Observations	34,764	36,149
R-squared	0.169	0.293
Industry-Year FE	YES	YES
Firm-level controls	YES	YES

Table 2: Spillover Effects of Zombie Firms: This table presents results from estimating **Equation 3**. The dependent variables are employment growth and investment. *NonZombie* is an indicator variable equal to one if a firm is not classified as zombie in year t and zero else. For zombie definitions $Zombie_1$, $Zombie_{2b}$, and $Zombie_{3b}$, we classify a firm as *Non-Zombie* if it is not classified as a zombie under any of the three definitions. We proceed in the same way with the other three (non-interest rate subsidy based) zombie measures. *ShareZombies* represents the asset-weighted share of zombie firms in a two-digit SIC industry. Additional firm-level controls include the log of total assets, firm leverage (debt/assets), and net worth. Moreover, we add an indicator variable for firms that are not classified as zombie under the respective definition, but are a zombie under of the other two related zombie classifications. All specifications include industry-year fixed effects. Standard errors are double-clustered at the industry- and year-level.

quality firms; Column (1)), firms that satisfy the low-quality criterion of the respective zombie definition (Column (2)), and firms that additionally obtain debt financing at advantageous interest rates (Column (3)). Importantly, the only difference between firms in Columns (2) and (3) is whether a firm receives debt at subsidized rates, i.e., both groups of firms satisfy the same quality criteria in each panel. The last column of **Table 1** highlights that firms obtaining subsidized financing are significantly worse along several dimensions, even when compared to other low-quality firms. In particular, low-quality firms that additionally obtain subsidized credit have a lower profitability, interest coverage ratio, employment growth, and investment. Additionally, they have a lower share of tangible assets, suggesting they might have less collateral to pledge. Moreover, these firms have a higher propensity of an exit event (defined as either filing for Chapter 7 or 11 bankruptcy or being acquired) over the four-year horizon after they were first classified as zombie.

A key and distinct prediction of the zombie channel is that the presence of weak firms that receive subsidized credit has negative competitive spillover effects on healthy firms. By negatively affecting the performance of healthy firms, zombie lending can contribute to negative macroeconomic outcomes, such as lower growth and inflation.[7]

To investigate whether the difference between the various zombie definitions matters for spillover effects on healthy companies, we follow Caballero et al. (2008) and Acharya et al. (2019) and estimate the following specification:

$$\begin{aligned} Y_{ijt} &= \beta_1 \times NonZombie_{ijt} \\ &+ \beta_2 \times NonZombie_{ijt} \times Share\ Zombies_{jt} + \eta_{jt} + \epsilon_{ijt}, \end{aligned} \tag{3}$$

where Y_{ijt} represents the employment growth or investment of firm i in industry j at time t. $NonZombie_{ijt}$ is an indicator for whether a firm is classified as zombie in year t. For zombie definitions $Zombie_1$, $Zombie_{2b}$, and $Zombie_{3b}$, we classify a firm as *Non-Zombie* if it is not

[7] Our analysis focuses on competitive distortions (spillovers). In general there could also be other sources of spillovers at play, for instance, demand or agglomeration spillovers. For a detailed discussion of these various spillover effects, see Berg et al. (forthcoming).

classified as a zombie under any of the three definitions. We proceed in the same way with the other three (non-interest rate subsidy based) zombie measures. $Share\ Zombies_{jt}$ is the asset-weighted share of zombie firms in industry j at time t. Industry-year fixed effects η_{jt} allow us to control for any industry-specific shock that might affect the employment growth or investment of healthy firms.

Our coefficient of interest is β_2, that is, whether non-zombie firms that are active in industries with a higher share of zombie firms have different employment or investment behavior than non-zombie firms in industries with a lower share of zombie firms. Results are presented in **Table 2**. Several observations are noteworthy. First, under each of the zombie definitions, non-zombie firms perform better than zombie firms, suggesting that each definition is identifying weaker performing firms. Second, we find that the negative spillover effects first documented in Caballero et al. (2008) are only present in definitions that consider the subsidized lending criterion. Conversely, zombie firms identified primarily based on their quality do not seem to exert negative spillover effects on non-zombie public U.S. companies.

These results highlight that inefficiencies in terms of negative spillover effects arise primarily when considering firms that receive subsidized credit. This misallocation of credit helps otherwise non-viable firms to stay afloat in the short run and thus creates economic distortions.

5 Conclusion

In this paper, we provide a theoretical, historical and international perspective on "zombie lending." We discuss the theoretical and empirical literature on the causes and consequences of zombie lending and highlight the role of under-capitalized banks, the effects of zombie lending on zombie borrowers, and, importantly, spillovers and competitive distortions on non-zombie firms. Using data on U.S. firms, we contrast different definitions of zombie borrowers that differ in one key dimension, i.e., whether they include an interest rate subsidy for the borrower. Importantly, we show that, while all definitions identify low-quality borrowers, only when we identify zombies based on an interest rate subsidy, we are able to detect negative spillovers on non-zombie borrower such as lower employment growth and capital expenditures. Based on our discussion of the literature and our empirical analysis, we conclude that both

under-capitalization of banks and interest rate subsidies are necessary conditions to investigate the consequences of zombie lending. This is an important result both for academics and policy makers.

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