Zombie Lending to U.S. Firms*

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Abstract

We provide the first empirical evidence that zombie firms—highly levered firms with weak growth prospects—are not a prominent feature of the U.S. economy and that U.S. banks do not lend to such firms. Using confidential supervisory data on firm-bank relationships during the 2014–19 period, we estimate that zombie firms are few in number and operate predominantly in declining industries. Banks—including the weakly capitalized ones—reduce their exposure to firms that transition into zombie status, charge zombie firms higher loan rates, and assess these firms as having higher default probability. Likely as a result, zombie firms exit the market through bankruptcy at a faster rate than other firms. To sharpen the causal interpretation of our findings, we exploit the sudden and sizable drop in global oil prices in 2014–15 as a natural experiment to identify levered firms that transition into zombie status and banks that suffer loan losses on their balance sheets. In contrast to existing findings for other countries, our evidence suggests that in the United States bank lending is not a key driver of zombie firms' proliferation and survival.

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1 Introduction

Governments' efforts to support the flow of credit to businesses in response to the COVID-19 pandemic have sparked a renewed interest in zombie firms—that is, unproductive firms that survive on cheap credit. A common concern is that expansionary policies aimed at preventing a surge in bankruptcies of solvent-but-illiquid firms could adversely affect the economic recovery by fueling the financing of zombie firms and crowding out lending to more productive enterprises. Concerns about the implications of zombie firms for the real economy have been the focus of a significant amount of empirical work in the context of the Japanese "lost decade" in the 1990s and the European sovereign debt crisis.[1] This literature shows that low-capital banks may have incentives to lend to insolvent and unproductive firms to avoid or delay credit losses; in turn, lending to zombie firms may undermine aggregate productivity by discouraging the entry and growth of productive firms.

Despite the importance of the zombie phenomenon in Japan and Europe, to date there is scant empirical evidence on the pervasiveness of zombie firms in the Unites States. The main objective of this paper is to advance our understanding of U.S. bank lending to zombie firms and these firms' exit through bankruptcy. Our main results are the following: (1) Zombie firms are not a prominent feature of the U.S. economy, (2) U.S. banks reduce their exposure to firms that transition into zombie status or continue financing such firms at very restrictive terms, and (3) zombie firms have a higher propensity of exiting the market through a reorganization and liquidation procedure than other financially impaired firms.

There are two distinct but related challenges to studying zombie firms. The first one is that there is neither a formal definition nor a standard metric to identify them. The second challenge is that zombie status is not randomly assigned to firms. Therefore, identifying zombie firms and whether these firms borrow from banks at favorable terms may be problematic if firms' zombie status and the terms of their lending relationships are jointly

[1] For example, for work on Japan, see Peek and Rosengren (2005) and Caballero, Hoshi and Kashyap (2008); for analyses of Europe, see Acharya, Eisert, Eufinger and Hirsch (2019), Schivardi, Sette and Tabellini (2020), and Blattner, Farinha and Rebelo (2022).

determined or if they are both driven by common factors.

To address these challenges, we begin the analysis with the universe of private and publicly listed firms in the Federal Reserve (FR) Y-14Q database—the most comprehensive coverage of U.S. firms with a banking relationship.[2] We classify firms as being in zombie status if they are highly levered and their profits are persistently low, as reflected in high interest expenses on outstanding debt relative to profits and negative sales growth. This heuristic classification is based on commonly-used criteria in the empirical literature that firms with a zombie status are close to insolvency and have persistent low profitability. The requirement that firms are close to insolvency captures the need for firms to obtain additional debt financing to continue operating, while the requirement that firms are not able to generate profits is at the core of the potential credit misallocation induced by zombie lending.

We find that over the 2014–19 period the share of zombie firms in the United States varies between 3 and 6% and is concentrated in a few declining sectors. Interestingly, the share is similar for listed firms and private firms, even though private firms rely more heavily on bank lending than public firms. While the definition of zombie firms and the sample period vary across studies, our estimated share of zombie firms in the United States is significantly lower than that reported in other countries (see Acharya, Crosignani, Eisert and Steffen (2021) for a recent historical perspective on zombie firms across countries). One likely explanation is that during our sample period U.S. banks were robustly capitalized, with most of their capital being in the form of loss-absorbing common equity. This explanation contrasts with the experience in other countries—most notably Japan and Europe—in which the proliferation of zombie firms was made possible by an undercapitalized banking sector that continued financing loss-making firms for fear of realizing losses and violating regulatory constraints.

[2]The FR Y-14Q, which is maintained by the Federal Reserve to assess, regulate, and supervise banks with at least $50 billion in total consolidated assets, excludes information on small banks and very small businesses, but it covers roughly three-fourths of total U.S. commercial and industrial lending (see Bidder, Krainer and Shapiro (2021); Favara, Ivanov and Rezende (2021); Chodorow-Reich, Darmouni, Luck and Plosser (2020)).

To investigate the role of banks in financing U.S. zombie firms, we leverage the FR Y-14Q data on new and outstanding commercial loans for each firm-bank pair. These data allow us to compare lending by one bank to multiple firms while controlling for firms' fundamentals and firms' zombie status. Since a firm's zombie status changes over time, our empirical strategy is akin to a difference-in-difference analysis that compares changes in bank lending to firms before and after they become zombie firms. Our identification assumption is that absent a transition to zombie status the dynamics of a firm-bank relationship would not be systematically related to the zombie firm classification.

The empirical analysis establishes that banks reduce lending to firms that transition to zombie status, at both the intensive and the extensive margins of lending. At the intensive margin, loan growth to zombie firms declines by 9 percentage points relative to other firms. This estimate is similar across alternative specifications that account for industry- and bank-specific shocks with the inclusion of industry×year and bank×year fixed effects. The response is also economically significant, as the average annual change in committed loan amount across banks during our sample period is 5%. At the extensive margin, the transition to zombie status does not lead to new loan originations, instead it raises by 4% the likelihood that a bank terminates its pre-existing lending relationship with a given firm. In addition, banks lend at more restrictive terms when firms transition to zombie status: Interest rates are higher, loan maturities are shorter, and firms' credit risk deteriorates. Taken together, these results suggest that bank lending to zombie firms decreases not because loan demand by these firms falls when they become less profitable, but rather because bank credit supply conditions become tighter.

Next we ask if banks' capital ratios affect these results. By and large, the empirical evidence on zombie lending across countries finds that undercapitalized banks breed zombie firms, as capital standards distort banks' incentives to keep unprofitable firms alive to avoid the recognition of losses and regulatory scrutiny. In our sample period, U.S. banks are highly capitalized and, thus, unlikely to face distorted incentives. Nonetheless, all banks

in our sample are subject to the Dodd-Frank Act supervisory stress-testing exercise, and those with low capital buffers may have incentives to evergreen loans or underreport the risk profile of firms to avoid penalties for violating capital requirements. We find no evidence that low-capital banks are more lenient with unprofitable firms than high-capital banks.

To strengthen the causal interpretation of our key result that banks cut lending to zombie firms, we refine the analysis with a quasi-random shock to firm productivity. This approach enables us to identify firms that transition from a highly leveraged status to a zombie status for reasons that are orthogonal to banks' lending decisions. One drawback of the evidence presented so far is that our classification of zombie and nonzombie firms may be endogenously determined by banks' lending practices. For example, a bank that scales down lending or raises standards for highly leveraged firms, may curtail these firms' ability to continue operating and force them into zombie status.

To overcome this challenge, we study how banks respond to the exogenous transition to zombie status of firms that were adversely affected by the decline in oil prices of 2014–15. The oil shock represents an ideal laboratory for three reasons. First, it is a plausible exogenous shock to firms' fundamentals, as the price of crude oil is influenced by global economic activity and not by firm-specific balance sheet conditions. Second, firms were differentially exposed to the sudden drop in oil prices in 2014–15, with the profitability and financial health of oil-dependent firms likely being more affected than those of other firms. This setting allows us to compare how highly levered firms that transitioned into zombie status after the oil shock fared in terms of bank borrowing relative to similar firms that borrowed from the same bank but did not become zombie firms. Third, banks were also affected by the persistent decline in oil prices, as the performance of loans to firms in the oil industry depends critically on the market value of oil (Bidder, Krainer and Shapiro, 2021). The variation in banks' potential losses due to an oil price decline offers an empirical setting that is close in spirit to the one used in the empirical literature on Japan and Europe linking fluctuations in asset prices to banks' net worth and zombie lending.

The estimates reveal that banks extended larger loans to creditworthy firms but reduced their exposure to distressed firms that became unprofitable after the oil shock. Banks also originated fewer loans at less favorable terms to zombie firms and assessed the risk of lending to such firms as higher than that of comparable nonzombie firms. We find no evidence of a differential lending response to zombie firms by either banks with different exposure to credit losses induced by the decline in oil prices or low-capital banks. Overall, this evidence corroborates our baseline results in the full sample of firms and suggests that in response to a real shock to firms' fundamentals, U.S. banks do not distort lending in favor of zombie firms; instead, they increase the supply of credit to healthy firms with profitable investment opportunities. Finally, the evidence also suggests that during our sample period U.S. zombie firms did not flourish even as some banks remained undercapitalized as a result of the oil price shock.

If banks do not lend to zombie firms at favorable rates, a natural question is whether they also force unprofitable firms to exit the market by initiating a bankruptcy procedure. An important view in the literature is that an efficient bankruptcy system that enables creditors to obtain a quick resolution of contract disputes in bankruptcy may enhance banks' incentives to recognize zombie firms (Ponticelli and Alencar, 2016; McGowan, Andrews and Millot, 2018). Using data on bankruptcy filings of both public firms and private firms with public debt, we find that U.S. zombie firms' probability of filing for bankruptcy is double that of distressed firms—that is, firms at imminent risk of default. The same results hold in the sample of firms that acquire a zombie status after the 2014–15 oil price decline. These findings point to the potentially beneficial role of U.S. bankruptcy laws, which, by improving lenders' payoff in bankruptcy through an efficient liquidation and corporate reorganization procedure, discourage zombie lending and ensure that zombie firms exit the market through competitive forces.

A number of papers study zombie lending in the context of the Japanese banking crisis of the 1990s (Peek and Rosengren (2005), Caballero, Hoshi and Kashyap (2008), Giannetti

and Simonov (2013)) and the European debt crisis in 2013–15 (Acharya, Eisert, Eufinger and Hirsch (2019), Schivardi, Sette and Tabellini (2020), and Blattner, Farinha and Rebelo (2022)). This literature shows that weakly capitalized banks lend to zombie firms to avoid writing bad loans off their balance sheets and that lending to these firms ultimately leads to credit misallocation that reduces aggregate productivity and investment.[3] We contribute to this literature by showing that zombie lending is not a typical feature of the U.S economy, as banks—including the undercapitalized ones—-do not appear to provide subsidized credit to insolvent and unproductive firms. While we do not explore the negative spillovers of zombie lending on nonzombie firms, our finding that zombie firms are not a dominant feature of the U.S. economy suggests that these firms have limited implications for aggregate productivity and credit misallocation in the United States.

Our findings that U.S zombie firms exit the market through bankruptcy also contribute to the small but growing literature arguing that reorganization-friendly insolvency regimes and efficient liquidation procedures foster lenders' incentives to initiate bankruptcy proceedings against insolvent borrowers, preventing the rise and survival of zombie firms (see, e.g., Andrews and Petroulakis (2019), Li and Ponticelli (2020), and Becker and Ivashina (2021)).

Our paper also adds to the literature relating low interest rates to capital misallocation and economic stagnation (Gopinath, Kalemli-Özcan, Karabarbounis and Villegas-Sanchez (2017), Aghion, Bergeaud, Cette, Lecat and Maghin (2019), and Caggese and Pérez-Orive (2022)). Our sample period, from 2014 to 2019, features low rates and accommodating credit conditions. However, we do not find a rise in zombie firms during this period nor do we detect any evidence that U.S banks allocate capital to low-productivity firms.

The paper is organized as follows. Sections 2 and 3 describe the data, introduce our definition of zombie firms, and provide descriptive statistics. Section 4 and Section 5 lay out our empirical strategy and present the main results on bank lending to zombie firms and

[3]Zombie lending has been observed in other developed and emerging economies with weakened banking sectors, see e.g., McGowan, Andrews and Millot (2018), Banerjee and Hofmann (2018), Kulkarni, Ritadhi, Vij and Waldock (2019), Chopra, Subramanian and Tantri (2021), Bonfim, Cerqueiro, Degryse and Ongena (2020), and Schmidt, Schneider, Steffen and Streitz (2020)).

firms that acquire a zombie status following a negative exogenous productivity shock in the oil and gas industry. Section 6 studies zombie firms and bankruptcy. Section 7 concludes.

2 Data

Our analysis requires detailed information on firms' balance sheet conditions and firm-bank credit relationships. We draw such information from the FR Y-14Q data collection effort, which provides confidential supervisory data on commercial and industrial (C&I) loans. These and other data sources are described in this section.

Federal Reserve's Y-14Q Our main data source is the FR Y-14Q H1 schedule, which, since 2012, has collected quarterly data on C&I loans with commitment amounts exceeding $1 million from banks that are subject to enhanced prudential standards under the Dodd-Frank Act.[4] The number of reporting bank holding companies (BHCs) in Y-14Q fluctuates between 32 and 36, and includes the largest U.S. banks with assets above $50 billion. Loans in Y-14Q account for nearly three-fourths of total U.S. (C&I) lending (Favara, Ivanov and Rezende, 2021; Bidder, Krainer and Shapiro, 2021) and close to 90% of total banking-sector assets (Weitzner and Howes, 2021). A key advantage of the Y-14Q data is the extensive coverage of private firms that borrow from the largest U.S. banks. In any given year between 2012 and 2019, we observe between 60,000 and 70,000 firms, of which about 3% are publicly listed.

We exploit the breadth of the Y-14Q data in two ways. First, we use the information on the annual balance sheet conditions of (public and private) firms that borrow from banks reporting in Y-14Q to identify zombie firms. Second, we use the loan-level information on C&I loans held by reporting banks to study bank lending to zombie firms. Our estimation sample starts in 2014 because our definition of zombie firms requires three consecutive years

[4]For public information about the Y-14Q data collection effort, see link. The data were downloaded on May 11, 2021.

of sales growth data. Our sample ends in 2019 to exclude from the analysis the COVID-19 shock, which triggered an unprecedented policy response that directly influenced bank lending to firms. We smooth out quarterly fluctuations in corporate lending by aggregating the data to the firm-bank-year level.

To measure the intensive and extensive margins of lending relationships, we compute for each year the total outstanding lending exposure from a bank to a firm (*Loan amount*) and the share of outstanding loan facilities that is new originations (*New origination*). Since we are able to track firm-bank relationships over time, we also identify the breakup of banking relationships (*Relationship exit*). To measure the terms of lending, we take the loan-weighted average of loan rates (*Interest rate*) and maturities (*Maturity*) across all the loans outstanding in a given year for a firm-bank pair. For each loan facility, banks also report their assessment of the probability that the firm defaults on that facility (*Probability of default*).

Panel A of Table A2 reports summary statistics for all firm-bank-year observations during the 2014–19 period. The volume of committed credit in each firm-bank pair has an average of $33 million and a large standard deviation ($86 million), reflecting in part the significant degree of heterogeneity in firm size and leverage in our sample. For the typical firm-bank pair, about 5% of credit outstanding is originated each year, and the likelihood of seeing a banking relationship terminated is 14%. The average interest rate is 3.4%, with a standard deviation of about 1.5%, and banks estimate that, on average, 20% of their borrowers have a default probability above 90%. Panel A also provides basic information on firms' characteristics. The average firm in our sample is relatively large, but there is high dispersion, with total assets ranging from $6 million at the 10th percentile to $6 billion at the 90th percentile. Leverage, interest coverage (IC) ratios, and sales growth—our main criteria to identify zombie firms—also exhibit significant heterogeneity across firms and years.

Firm bankruptcy data We use data on individual bankruptcy filings to assess ex-post firm performance and market exit. The data come from the S&P Capital IQ—U.S.

Bankruptcy Tracker (dated October 31 2021)—from which we extract bankruptcy announcements between January 1, 2013, and October 31, 2021. Data coverage is limited to public companies or private companies with public debt and either assets or liabilities at the time of the bankruptcy filing greater than or equal to $2 million. The data also cover private companies with either assets or liabilities at the time of the bankruptcy filing greater than or equal to $10 million. We cross-check these data and supplement them with several additional bankruptcy events for public firms using the Mergent FISD database. To examine zombie firm exit via bankruptcy, we construct a regression sample that retains, from the universe of borrowing firms in the Y-14Q data, those firms that meet the criteria for being included in the S&P Capital IQ Bankruptcy Tracker.[5] This sample comprises between 13,000 and 14,000 firms per year. We identify 202 bankruptcy events between 2014 and 2021; more than two-thirds of these events are reorganizations and liquidations, while the other events are announced bankruptcies (not completed).

Bank data In specifications that explore the role of bank capital, we use two measures of capital: the minimum bank-level common equity Tier 1 capital (CET1) ratio estimated under the adverse scenario (formally, the "Supervisory Severely Adverse" scenario) of the Dodd-Frank Act stress-tests (DFAST), available on the Federal Reserve's DFAST page, and the BHC-level regulatory CET1 capital ratio from the FR Y-9C form.

3 Zombie Firms in the U.S.

[5]Specifically, we ensure that the firms have public debt of at least $2 million and total assets of at least $10 million. Because we do not observe the amount of public debt of Y-14Q firms, we approximate it as the difference between total debt and total bank debt across Y-14Q reporting banks. Since this calculation omits bank debt from non-Y-14Q banks, we likely overestimate the amount of public debt, and, hence, the number of firms eligible to be included in the S&P Capital IQ Bankruptcy Tracker.

3.1 Defining Zombie Firms

There is no formal definition of zombie firms and, likely as a result, there are many criteria that the empirical literature uses to detect such firms (see Acharya, Crosignani, Eisert and Steffen (2021) for a recent review). Nevertheless, it is generally agreed that zombie firms are highly levered, unviable entities that stay afloat through bank credit.

Accordingly, we use a financial distress and a profitability requirement to identify zombie firms in our data. Specifically, we require that a firm is in zombie status if it is: (1) highly indebted (has leverage above the annual median), (2) struggles to service interest payments on existing debt (has IC ratio below one), and (3) its profitability is persistently impaired (has negative sale growth for at least three consecutive years).

The first and second requirements are standard in the literature; they select firms that are in financial distress and unable to produce enough revenues to meet payments on outstanding loans (see, e.g., McGowan, Andrews and Millot (2018) or Acharya, Eisert, Eufinger and Hirsch (2019). The third requirement is new and is introduced to identify firms that not only experience temporary liquidity shortfalls, but are also economically impaired. Keeping these firms alive with additional bank financing has the potential to generate negative spillovers to the real economy by misallocating credit and crowding out lending to productive firms.

The requirement that firms are persistently unable to generate positive sales growth is motivated by previous research showing that sales growth is a reliable indicator of future expected productivity for both private and publicly listed firms (Goyal and Yamada, 2004; Whited and Wu, 2006). Imposing this requirement also reduces the risk of incorrectly classifying temporarily unprofitable firms with good future growth prospects as zombies. [6]

Figure A1 shows that the selection of firms based only on their inability to generate

[6] In a similar vein, Schivardi, Sette and Tabellini (2020) identify firms as zombies if they have high leverage and low return on assets (ROA), while Banerjee and Hofmann (2018) require that publicly listed firms have high leverage and low Tobin's q. One drawback of using Tobin's q as an indicator of firms' growth potential is that it is available only for listed firms. In addition, the secular decline in the number of listed firms implies that the set of firms that become eligible for a zombie classification using Tobin's q shrinks over time.

internal resources for keeping the IC ratio above one is not sufficient to identify unprofitable firms. The figure plots the profitability distribution of firms that are classified as zombies according to the condition that the IC ratio is less than one for at least three consecutive years (as in McGowan, Andrews and Millot (2018)). As shown, many firms with an IC ratio below one have positive real sales growth, confirming that even a persistent liquidity problem may select firms with a favorable growth outlook into zombie status.

While our analysis identifies zombie firms based only on firms' balance sheet characteristics, a common alternative in the literature is to select firms into zombie status if they receive subsidized credit—that is, bank credit offered at advantageous interest rates (Caballero, Hoshi and Kashyap (2008), Giannetti and Simonov (2013), Acharya, Eisert, Eufinger and Hirsch (2019). We do not use this requirement, as subsidized credit helps identify credit misallocation induced by zombie lending but does not necessarily help identify unprofitable firms. As shown in Figure A1, the distribution of sales growth for firms with IC ratios below one is not different from that for firms that also receive credit at very low rates. More importantly, it is difficult to measure subsidized credit. Firms that borrow at low rates, for example, may also face other stringent lending conditions that make overall borrowing less advantageous than what can be gauged by looking at loan rates only.

Instead of sorting firms a priori based on the interest rates charged on their loans, in what follows we study how banks adjust overall lending policies, and not just interest rates, to unviable firms that transition into zombie status according to our leverage and profitability criteria.

3.2 Characteristics of Zombie Firms

Share of zombie firms Figure 1 plots the share over time of U.S. listed and private firms that, according to our filters, are in zombie status. We estimate that between 2014 and 2019, roughly 5% of public and private firms in our data can be classified as zombies (there are 6,442 zombie firms in total), suggesting that in recent years, based on our criteria, the

prevalence of zombie firms is not a defining feature of the U.S. economy.

Table 1 compares the share of zombie firms estimated using our criteria with the share of firms identified as zombies based on alternative definitions offered in the literature that, depending on data availability, use information on firms' balance sheet conditions, age, credit ratings, and access to subsidized credit. We consider three different measures. The first one selects firms as zombies if they are mature firms and have IC ratios below one for three consecutive years (as in McGowan, Andrews and Millot (2018)); the second measure identifies zombie firms if they are speculative-grade rated, and borrow from banks with which they are in an existing banking relationship at interest rates that are below those charged to the most creditworthy firms (as in Acharya, Eisert, Eufinger and Hirsch (2019)); and the third measure adds to the second one the requirement that firms have high leverage and low IC ratios (as in Acharya, Crosignani, Eisert and Eufinger (2020)).

As shown, there is substantial variation in the estimated share of zombie firms, underscoring that the assessment of the prevalence of zombie firms in the U.S. economy critically depends on the definition adopted. The four zombie definitions in Table 1 follow different dynamics, and our filters identify a much lower share of zombie firms than is estimated using some of the alternative criteria offered in the literature. One likely explanation is that we require firms to have bleak growth prospects to be considered zombie firms.

Distribution by industry and rating Figure 2(a) displays the industry distribution for U.S. firms that, based on our criteria, are classified as zombie firms in three representative years of our sample period: 2014, 2016, and 2019. There is considerable variation in the share of zombie firms both across industries and within industries over time. Unsurprisingly, reflecting structural changes in the economy as well as a secular decline in some industries' profitability, we estimate a large share of zombie firms, which is either constant or growing over time, in the industries of manufacturing and retail trade. In other industries, the share fluctuates year by year. For example, in the oil and gas (O&G) industry, which experienced

an adverse oil price shock in 2014–15, we estimate a rise in the share of zombie firms two years after the shock, but not in subsequent years.

Figure 2(b) presents another important stylized fact about the zombie firms in our sample. It reports banks' internal assessment of firm's risk, which is mapped into S&P credit ratings. Reflecting the nature of the criteria that we use to identify zombie firms, the distribution of credit ratings over time is concentrated around the speculative-grade bucket, with a large share of firms assessed by banks as being at risk of imminent default and with little prospect for recovery—that is, with a rating of CCC and below. About 1 in 10 zombie firms in our sample are also assessed BBB-rated, suggesting that our criteria select not only low-quality firms, but also risky firms on the cusp of the investment-grade cutoff.

Zombie firm balance sheet characteristics The means and the medians of key balance sheet characteristics of our sample of zombie firms are reported in Table 2. The statistics highlight a number of important differences relative to other firms. In our data, firms in zombie status are smaller in size, have lower return on assets, hold less cash, and have fewer tangible assets than viable firms. In addition, acquiring zombie status is as likely for a private firm as it is for a publicly listed entity. The lower part of the table reports the means and medians of our three main criteria to identify zombie firms—namely, IC ratios, leverage, and real sales growth. By construction, zombie firms in our sample have lower ability to cover debt interest payments from profits, are twice as levered, and have lower growth opportunities than their nonzombie counterparts. The p-values of equality of means and medians for zombie and nonzombie firms (Table 2, columns 3 and 6) further indicate that these differences are not only statistically significant, but also economically large.[7]

[7]Figure A2 reports the share of nonfinancial business credit that goes to zombie firms. Overall, investor exposure to zombie firms is small, with these firms playing a negligible role in both corporate bond issuance and bank credit. Between 2014 and 2019, corporate bond issuance by zombie firms and bank credit commitments to these firms accounted for less than 5%.

4 Bank Lending to U.S. Zombie Firms

4.1 Empirical Approach

We begin our empirical analysis by studying bank lending to firms that become zombies according to the three criteria described in Section 3.1—that is, an IC ratio below one, above-median leverage, and negative three-year average sales growth.

We use the following regression model with data aggregated at the firm-bank-year level:

$$y_{b,i,t} = \beta_1 Zombie_{i,t} + \beta_2 X_{i,t} + \alpha_i + \gamma_{j,t} + \delta_{b,t} + \epsilon_{b,i,t}, \tag{1}$$

where y is the outcome variable of interest in the lending relationship between bank b and firm i (in industry j) in year t. The six outcome variables we study measure the intensive and extensive margins of lending (*Loan amount*, *New originations*, and *Relationship exit*) and the terms of lending (*Interest rate*, *Maturity*, and *Probability of default*). $Zombie_{i,t}$ is a time-varying dummy variable that takes a value of one for firms in zombie status and zero otherwise, and $X_{i,t}$ is a vector of firm-specific controls, including size (log-assets), cash holdings, tangibility ratio, and an indicator variable for publicly listed firms. In robustness tests, we show that the main results are robust to including a more comprehensive set of control variables—notably, those that we use to classify zombie firms: IC ratio, leverage, and sales growth.

Our baseline specification includes an array of fixed effects, such as firm fixed effects (α_i), which capture unobserved time-invariant firm-level heterogeneity, and industry×year fixed effects ($\gamma_{j,t}$), which control for time-varying unobserved demand shocks that are specific to each industry and common across all banks lending to firms in the same industry. With the inclusion of bank×year fixed effects ($\delta_{b,t}$), our baseline specification also controls for time-varying unobserved heterogeneity across lenders, which implies comparing changes in lending conditions by the same bank to both zombie and nonzombie firms. These bank×year fixed effects also absorb unobserved year-by-year shocks to banks' balance sheets and capital

adequacy ratios. These fixed effects also control for aggregate financing conditions, including the stance of monetary policy. In some specifications we also add firm×bank fixed effects to further control for unobserved time-invariant factors that are specific to a firm-bank relationship, such as banks' private or soft information on borrower creditworthiness and banks' portfolio specialization in particular types of borrowers (Chodorow-Reich, 2014; Paravisini, Rappoport and Schnabl, 2015).

We estimate Equation (1) over the sample period 2014–19, with standard errors double-clustered at the firm and year level to account for dependence across firms in a given year and for serial correlation of residuals within firms.

Our regression framework is akin to a difference-in-differences setting that compares changes in bank lending to "treated" (zombie) and "untreated" (nonzombie) firms around the time of the change in firms' zombie status. Since firms' zombie status varies over time, our empirical framework also exploits this variation within the group of treated firms.

An important challenge in estimating the causal effects of zombie status on bank lending is that the assignment of zombie status to firms is not random. A potential concern is that unobserved lending policies and risk-management practices at banks may induce weak firm performance, introducing a reverse causality bias in our estimates of the effects of zombie status on bank lending. A second concern is that unobserved macroeconomic shocks may drive both banks' lending decisions and firms' balance sheet conditions. To mitigate these concerns, in Section 5 we refine our empirical framework by studying how bank lending policies respond to the quasi-random shock to the zombie status of firms that were adversely affected by the oil price decline in 2014. While this analysis reduces the sample of firms to those operating in the O&G industry, it enables us to identify highly leveraged firms that transition to zombie status for reasons that are orthogonal to banks' lending decisions.

The parameter of interest in our empirical framework is β_1, which measures the effect of zombie status on bank lending decisions. For the intensive and extensive margins of lending, a negative β_1 would be consistent with banks refraining from lending to zombie firms. Such

a result could follow from a standard firm balance sheet channel, whereby firms' borrowing capacity deteriorates as they acquire a zombie status. In contrast, an insignificant or positive β_1 would suggest that banks engage in zombie lending.

A key finding of the empirical literature on zombie lending is that banks' lending decisions are distorted by bank capitalization, with undercapitalized banks directing additional credit toward low-quality firms to avoid or delay loan defaults, as these defaults could trigger regulatory scrutiny or raise banks' provisioning requirements. While our baseline regression controls for variations in bank capital using bank×year fixed effects, we also estimate a version of the baseline regression that allows lending to zombie firms to vary with bank capital:

$$y_{b,i,t} = \beta_1 Zombie_{i,t} + \beta_{11} Zombie_{i,t} Cap_{b,t} + \beta_2 X_{i,t} + \alpha_i + \gamma_{j,t} + \delta_{b,t} + \epsilon_{b,i,t}, \tag{2}$$

where the interaction term $Zombie_{i,t}Cap_{b,t}$ measures how bank capital affects lending to zombie firms. For example, when the outcome variable $y_{b,i,t}$ is a measure of the intensive and extensive margins of lending, a negative β_{11} would indicate that undercapitalized banks originate more and larger loans to impaired borrowers, as the zombie lending literature suggests.

4.2 Lending to Zombie Firms

Table 3 reports coefficient estimates of the regression model in Equation (1), linking firms' zombie status to lending outcomes. Panel A shows estimates for the intensive and extensive margins of lending—namely, loan growth, new loan originations, and relationship exit.

In the first column, we estimate that banks' exposure to firms shrinks when firms acquire zombie status. The point estimate for β_1 implies that firms that become zombies experience a decline in the annual growth rate of bank lending of about 9 percentage points relative to nonzombie firms. This effect is sizable, as the average annual change in banks' loan commitments between 2014 and 2019 is only 5%. In column 2, the point estimate remains unchanged

after the inclusion of firm×bank fixed effects, which allow us to exploit variation in credit availability within a firm-bank pair over time. This estimate indicates that banks cut lending significantly to zombie firms even if they are in an existing banking relationship. Columns 3 to 6 present estimates of β_1 for the extensive margin of lending. We use *New originations* and *Relationship exit* to estimate, respectively, banks' incentives to originate new loans and terminate existing lending relationships. We find that banks are significantly less likely to originate new loans to firms that become zombies. At the same time, the likelihood that loans are terminated or not renewed increases significantly (by roughly 4%) for zombie firms relative to healthy firms. This increase is notable, given that approximately 14% of firm-bank loans are terminated each year.

Panel B in Table 3 examines whether banks offer credit to firms at more stringent conditions when they transition into zombie status. Irrespective of the specification used, we estimate that banks offer loans to zombie firms that are more expensive (by, on average, 20 basis points) and have shorter maturities than those offered to nonzombies, likely as a compensation for the higher credit risk associated with lending to zombie firms. Consistent with this interpretation, columns 5 and 6 show that, on average, the likelihood that a firm is assessed by banks as having an elevated (top decile) risk of default is 4 percentage points higher for zombie firms than for comparable firms that are not in zombie status.[8]

4.3 The Role of Bank Capital

A central finding of the zombie lending literature is that weakly-capitalized banks originate more and cheaper credit to zombie firms for fear that these firms' default would force regulatory pressure on banks to raise equity capital against loan losses.

To evaluate the role of bank capital in lending outcomes to U.S. zombie firms, we rank banks based on their post-stress CET1 capital ratio. Banks reporting in the FR Y-14Q are subject to annual stress-test exercises, which assess the resilience of banks to hypothetical

[8] In Table A3 we show that these baseline results are robust to including additional control variables—notably, those that we use to classify zombie firms: IC ratio, leverage, and sales growth.

severe economic downturns and determine the minimum CET1 capital ratio that they must hold to cushion losses in the most adverse scenario. Even if U.S. banks have generally maintained strong capital levels in recent years—in compliance with the strengthening of bank capital regulations introduced in the aftermath of the Global Financial Crisis—their resilience to hypothetical economic downturns has varied in each annual stress-test cycle, introducing considerable heterogeneity in the difference between banks' post-stress CET1 capital ratio and the regulatory minimum for that ratio. Table A2 shows that the CET1 stress-test capital ratio, over the 2014–19 period, ranges from 7.7 to 11.2% for banks that are in the bottom and top deciles of the CET1 stress-test distribution, respectively.

We use this variation in post-stress CET1 capital ratios to test whether the lending standards that low-capital banks apply to zombie firms are different than the ones applied by high-capital banks. We do so by estimating Equation (2), which includes bank×year fixed effects to control for additional unobserved capital heterogeneity among banks. Panel A of Table 4 shows that low-capital banks are as strict, or even stricter, with zombie borrowers than high-capital banks. In columns 1 through 6, estimates of the coefficient on the interaction term $Zombie_{i,t}Cap_{b,t}$ suggest that low-capital banks—defined as those with a post-stress CET1 capital ratio in the bottom quartile of its yearly distribution—offer similar or smaller loans to zombie firms. These firms are also less likely to originate new loans and more likely to terminate existing bank relationships than high-capital banks. Columns 1 to 4 of Panel B further show that low-capital banks do not charge lower rates on loans to zombie firms (if anything, slightly higher) and do not appear to lengthen loan maturities to these firms. These results provide little support for the view that low-capital U.S. banks may be relatively more lenient towards zombie firms.

As some banks in our sample are subject to the Advanced Approaches capital framework, which allows banks to use internal models to compute default probabilities and credit ratings on corporate loans, low-capital banks may also have incentives to reduce borrowers' risk parameters to avoid violating capital requirements. Columns 5 and 6 of Panel B show,

however, that this is not the case. Low-capital banks are as likely as high-capital banks to assign higher probabilities of default to zombie firms. In unreported results, we also find that low-capital banks do not reduce their estimates of borrower credit ratings more than high-capital banks.

Taken together, the results in Table 4 suggest that low-capital banks neither increase their exposure to zombie firms nor offer subsidized credit to these firms. In addition, there is no evidence that low-capital banks adjust their estimates of borrower risk to avoid raising additional equity per dollar of risk-weighted assets. We interpret these findings as indicating that zombie lending by low-capital banks does not appear to be a distinctive feature of the financial intermediation system in the United States.

To deal with any concern that our results so far might be driven by our definition of zombie firms, Table A7 shows the estimates from running the specification in Equation (2) on alternative definitions of zombie firms. The estimates suggest that the main result that low-capital banks do not apply relatively more flexible lending policies to zombie borrowers is robust to three alternative definitions that rely on information about firms' IC ratios (McGowan, Andrews and Millot (2018)), or credit ratings, leverage, and receipt of subsidized credit (Acharya, Eisert, Eufinger and Hirsch, 2019; Acharya, Crosignani, Eisert and Eufinger, 2020).

5 The 2014–15 Oil Price Shock and Zombie Firms

This section restricts the zombie lending analysis to firms in the O&G industry, exploiting a quasi-random shock to firms' profitability and banks' loan losses caused by the sharp decline in the global price of crude oil in 2014 and 2015.

This setting enables us to identify highly leveraged firms that transition to a zombie status for reasons that are orthogonal to banks' lending decisions, sharpening the causal interpretation of the findings presented so far. One concern with our classification of firms

into zombie status is that it may be influenced by preexisting bank lending conditions. For example, banks could tighten lending standards to highly leveraged firms, impairing their ability to generate profits. This setting represents also an ideal laboratory to test whether banks that were highly exposed to the oil sector or those that were weakly capitalized kept lending to existing borrowers that transitioned into zombie status.

5.1 The 2014–15 Oil Price Shock

The global price of crude oil experienced a sudden and sizable drop from mid-2014 to early 2015, resulting in one of the most dramatic declines in the price of oil in recent history (see Figure A3). This price decline was largely unanticipated and driven by a combination of factors, including excess supply and deteriorating global demand for oil (Baumeister and Kilian, 2016; Prest, 2018). While the price of oil recovered gradually by the end 2016, the cumulative drop of roughly 70% between 2014 and 2015 put severe stress on oil-producing firms and stifled the growth prospects of those firms that, amid the price decline, delayed investments in alternative drilling techniques. Baumeister and Kilian (2016) report that, reflecting these developments, the oil price decline caused a significant drop in investment spending in the oil sector, and Bidder, Krainer and Shapiro (2021) document that the fraction of O&G loans in default climbed substantially between 2014 and 2016, underscoring the role of the market value of oil in the performance of firms in this industry.

5.2 Firms Exposed to the Oil Price Shock

To identify the firms that were thrown into zombie status by the 2014–15 global oil price decline, we proceed in three steps. First, using six-digit NAICS industry classifications, we focus on the firms that operate in the following O&G sectors: O&G extraction, drilling O&G wells, and support activities for O&G operations.[9]

[9]Specifically we use firms in the following sectors: O&G Extraction (code 211), Drilling O&G Wells (code 213111), Support Activities for O&G Operations (code 213112), Natural Gas Distribution (code 2212), Pipeline Transportation (code 486), O&G Pipeline and Related Structures Construction (code 23712),

In the second step, we sort O&G firms based on their 2014–15 financial health and identify firms as distressed if they have above-median leverage and an IC ratio below one. In the third step, we run a linear probability model to predict the likelihood that O&G distressed firms experienced negative real sales growth during the 2016–19 period. Firms with a predicted probability of negative sales growth that is above the average probability across all firms are classified as firms that are pushed into zombie status by the oil price shock.[10] The two pre-shock requirements on firm leverage and IC ratios and the post-shock requirement on firm profitability are the analogs of the three criteria used in Section 3.1 to identify zombie firms, with the crucial difference that now the transition from distressed to zombie status is due to the realization of the oil price shock.

Panel B of Table A2 shows that one-third of the distressed firms in the O&G sector became zombies after the 2014–15 oil shock (there are 513 zombie firms in total). On average, these firms appear to rely significantly on bank credit and have similar balance sheet characteristics as those firms identified as zombies according to the criteria used in Section 3.1—they are smaller in size, have lower return on assets, and hold less cash than nonzombie firms. The lower part of the table also shows that firms pushed into zombie status by the oil shock have lower ability to cover debt interest payments from profits, are more levered, and have lower growth opportunities than their nonzombie counterparts.

Appendix A.1 discusses an alternative approach to identifying zombie firms—one that exploits, for a larger cross-section of firms than those operating in the O&G industry, variation in industries' (stock return) sensitivity to the exogenous oil supply shocks identified by Caldara, Cavallo and Iacoviello (2019). Table A8 shows that none of the main qualitative and quantitative results presented in the next section are affected by this alternative

Mining & O&G Field Machinery Manufacturing (code 33313), Petroleum Refineries (code 32411), Other Petroleum and Coal Products Manufacturing (code 32419), Petrochemical & Industrial Gas Manufacturing (codes 32511, 32512), and Petroleum & Petroleum Products Merchant Wholesalers (code 4247).

[10] These steps are illustrated in column 1 of Table A5, which shows that the average probability of a distressed firm before the oil shock incurring negative real sales growth after the oil shock is 29.5%. Thus, all firms for which the specification predicts a probability greater than 29.5% of being in zombie status post-oil shock are classified as zombies.

approach.

5.3 Zombie Lending to O&G Firms

Panel A of Table 5 repeats the analysis of Table 3 on the sample of O&G firms. It reports estimates of the intensive and extensive margins of lending and of other lending terms using a modified version of the benchmark regression model in Equation (2). Since firms' zombie status in this analysis is not time varying, we drop firm fixed effects and bank×firm fixed effects from the specifications.

We estimate that firms transitioning into zombie status following the oil price decline receive smaller and fewer loans than nonzombie firms. In addition, banks charge zombie firms higher loan rates and offer loans with shorter maturities, likely reflecting an increase in borrower risk. Supporting this interpretation, in column 6 we estimate that banks adjust the assessment of credit risk for zombie firms by increasing their estimates of default probabilities for such firms. These results confirm those in Table 3 and suggest that, regardless of the approach used to identify zombie firms, banks do not appear to provide additional credit at advantageous terms to these firms.

The 2014–15 oil shock affected not only firms' performance, but also the balance sheets of banks that were exposed to the O&G firms, with some banks experiencing larger shocks than others. Table A2 shows that at the end of 2013, just before the sharp and sustained decline in oil prices, the average O&G exposure (defined as the share of banks' total committed exposure to firms in the O&G industry) is 15%, with a standard deviation of 8%, indicating significant variation in loan book exposures to O&G firms and a sizable exposure for some banks.

In Panel B of Table 5, we test whether the unconditional estimates in Panel A hold when we control for banks' pre-shock O&G exposure. The estimates suggest that more exposed banks did not adjust loan amounts and lending standards favorably for zombie firms. Coefficient estimates of the interaction terms $Zombie \times Bank\ Exposure$ are insignificantly

different from zero at conventional statistical levels across all specifications, suggesting that impaired banks did not lend more to distressed and unprofitable firms following the shock. Instead, the estimates are supportive of a standard financial accelerator channel in the sense that banks, irrespective of their exposure to O&G loan losses, reduced lending to firms with weak fundamentals after the shock.

Table 6 sheds light on whether banks that remain undercapitalized following the oil price shock continue to provide credit to zombie firms in order to avoid the recognition of loan losses. As in Table 3, we rank banks based on their capital level, with high-capital banks defined as those with a post-stress CET1 capital ratio in the top quartile of its yearly distribution. In panel A of Table 6, we consider the intensive and the extensive margins of lending, and in panel B we report estimates for the terms of lending. In contrast to the prediction of the zombie lending literature, we estimate that low-capital banks do not evergreen loans to impaired firms after the oil shock, nor do they provide cheaper loans to such firms. Across almost all lending outcomes considered, the estimated coefficients on the interaction of the indicator variables for firms in zombie status and for high-capital banks are never statistically different from zero.[11] The only outcome variable for which we estimate a statistically significant interaction term is for the probability that a lending relationship is terminated (column 3). However, the sign of the estimated coefficient suggests that low-capital banks are more, not less, likely to end a bank relationship with zombie firms.

6 Zombie Firms and Bankruptcy

If U.S. banks do not lend to zombie firms, a natural question is whether such firms exit the market through bankruptcy at a faster rate than other firms. Absent insolvency frictions, bankruptcy should be the natural exit of firms that operate in a competitive setting and are no longer operationally viable. At the same time, a bankruptcy system that enables banks to

[11] We obtain similar results if we replace the stress-test capital level with the regulatory CET1 capital ratio, as shown in Table A4.

quickly resolve firm insolvency should increase banks' incentives to restructure or liquidate zombie firms instead of pursuing zombie lending.

In this section, we estimate the frequency at which firms in zombie status enter an insolvency procedure (either liquidation or restructuring) and compare it with those of distressed firms—that is, highly-levered firms that have difficulty servicing their debt while still being economically viable. We work with both the full sample of firms and the sample of oil firms, and we estimate the probability that firms file for bankruptcy in the first or second year after they acquire zombie status. We run a linear probability model in a firm-year panel:

$$Bankruptcy_{i,t|t+1} = \beta_1 Zombie_{i,t} + \beta_2 X_{i,t} + \alpha_i + \gamma_j + \delta_t + \epsilon_{i,k,t}, \tag{3}$$

where $Bankruptcy_{i,k,t|t+1}$ is a dummy variable that takes a value of one for firms filing for bankruptcy in year t or $t+1$ and $Zombie_{i,t}$ is the zombie firm dummy variable. A positive β_1 would indicate that zombie firms are relatively more likely to exit via bankruptcy. The specifications alternatively include the full matrix of firm-level controls $X_{i,t}$ from our baseline specifications in Equations (1)–(2) and firm, industry, and year fixed effects. The estimation period is 2014–21 to capture those firms in zombie status in 2019 that filed for bankruptcy in 2020 or 2021.

Tables 7 and 8 report the results. In Table 7, we focus on zombie firms identified based on the criteria of Section 3.1. In columns 1 and 2, the coefficient estimates indicate a positive and statistically significant relationship between zombie status and the likelihood of exit via bankruptcy: Zombie firms are more likely to file for bankruptcy by as much as 50 basis points relative to the average probability in the full sample (0.4%). The remaining specifications in columns 3–6 test whether zombie firms have a higher likelihood of filing for bankruptcy than distressed nonzombie firms. First, we re-estimate our specification of Equation (3) for distressed firms and find that the average distressed firm is more likely to file for bankruptcy than the average firm (columns 3–4). Second, we test whether bankruptcy filing rates among

distressed firms are more pronounced for those firms in zombie status. In columns 5 and 6, we estimate that zombies are twice as likely to exit via bankruptcy as their distressed nonzombie counterparts.

Table 8 repeats the analysis of Table 7 for the sample of zombie firms in the O&G industry. As shown, the results are largely comparable with those obtained for the full sample of firms, although the magnitude of the estimated coefficients for zombie firms in the oil industry is larger than in the full sample of firms. We estimate that, following the oil shock, zombie firms have a 6 to 11% higher probability of filing for bankruptcy, compared with the sample average probability of 5.4%. In addition, the last two specifications in Table 8 indicate that zombie firms are significantly more likely to exit through bankruptcy than their distressed nonzombie counterparts, similar to the results in the full sample of firms.

7 Conclusion

Using confidential supervisory data for the largest U.S. banks and their corporate borrowers, we estimate that during the 2014–19 period, zombie firms are not a pervasive feature of the U.S. economy, and that banks—even those with capital ratios close to the regulatory minimum—do not subsidize these firms by offering credit at advantageous conditions. Amid tighter bank lending conditions to zombie firms, firms that transition into zombie status file for bankruptcy at a higher rate than firms that are in financial distress but are economically viable.

Narrowing the analysis to O&G firms and banks with exposure to firms whose profitability was impaired by the unexpected decline in oil prices in 2014–15 yields similar conclusions—U.S. banks did not distort lending in favor of zombie firms; instead, they increased the supply of credit to firms with profitable investment opportunities while allowing zombie firms to exit the market through insolvency procedures.

These findings contrast with the evidence from other countries that weakly capitalized

banks lend to zombie firms to avoid loan losses, crowding out lending to more productive firms. Our study shows that such incentives are not at work in the U.S. banking system. It also adds a new perspective to the zombie lending literature by noting that the efficient resolution of financial distress in the U.S. bankruptcy code may contribute to weaken banks' incentives to keep insolvent firms alive.

References

Acharya, V. V., Crosignani, M., Eisert, T. and Eufinger, C. (2020). Zombie credit and (dis-) inflation: Evidence from Europe. *Journal of Finance (forthcoming)*.

—, —, — and Steffen, S. (2021). Zombie lending: Theoretical, international, and historical perspectives. *NYU Stern Business School WP*.

—, Eisert, T., Eufinger, C. and Hirsch, C. (2019). Whatever it takes: The real effects of unconventional monetary policy. *The Review of Financial Studies*, **32** (9), 3366–3411.

Aghion, P., Bergeaud, A., Cette, G., Lecat, R. and Maghin, H. (2019). Coase Lecture—The Inverted-U Relationship Between Credit Access and Productivity Growth. *Economica*, **86** (341), 1–31.

Andrews, D. and Petroulakis, F. (2019). Breaking the Shackles: Zombie firms, weak banks and depressed restructuring in Europe. *ECB Working Paper No. 2240*.

Banerjee, R. and Hofmann, B. (2018). The rise of zombie firms: Causes and consequences. *BIS Quarterly Review September*.

Baumeister, C. and Kilian, L. (2016). Lower oil prices and the u.s. economy: Is this time different? *Brookings Papers on Economic Activity*, **Fall**, 287–336.

Becker, B. and Ivashina, V. (2021). Corporate Insolvency Rules and Zombie Lending. *ECB Forum on Central Banking 2021*.

Bidder, R. M., Krainer, J. R. and Shapiro, A. H. (2021). De-leveraging or de-risking? How banks cope with loss. *Review of Economic Dynamics*, **39**, 100–127.

Blattner, L., Farinha, L. and Rebelo, F. (2022). When losses turn into loans: The cost of weak banks. *American Economic Review (forthcoming)*.

Bonfim, D., Cerqueiro, G., Degryse, H. and Ongena, S. (2020). On-site inspecting zombie lending. *Management Science (forthcoming)*.

Caballero, R. J., Hoshi, T. and Kashyap, A. K. (2008). Zombie lending and depressed restructuring in japan. *American Economic Review*, **98** (5), 1943–77.

Caggese, A. and Pérez-Orive, A. (2022). How stimulative are low real interest rates for intangible capital? *European Economic Review*, **142**, 103987.

Caldara, D., Cavallo, M. and Iacoviello, M. (2019). Oil price elasticities and oil price fluctuations. *Journal of Monetary Economics*, **103**, 1–20.

Chodorow-Reich, G. (2014). The employment effects of credit market disruptions: Firm-level evidence from the 2008–9 financial crisis. *The Quarterly Journal of Economics*, **129** (1), 1–59.

—, Darmouni, O., Luck, S. and Plosser, M. C. (2020). Bank liquidity provision across the firm size distribution. *NBER Working Paper No. 27945*.

Chopra, Y., Subramanian, K. and Tantri, P. L. (2021). Bank Cleanups, Capitalization, and Lending: Evidence from India. *The Review of Financial Studies*, **34** (9), 4132–4176.

Favara, G., Ivanov, I. and Rezende, M. (2021). GSIB surcharges and bank lending: Evidence from U.S. corporate loan data. *Journal of Financial Economics*, **142** (3), 1426–1443.

Giannetti, M. and Simonov, A. (2013). On the real effects of bank bailouts: Micro evidence from japan. *American Economic Journal*, **5** (5), 135–167.

Gopinath, G., Kalemli-Özcan, Ş., Karabarbounis, L. and Villegas-Sanchez, C.

(2017). Capital allocation and productivity in South Europe. *The Quarterly Journal of Economics*, **132** (4), 1915–1967.

Goyal, V. K. and Yamada, T. (2004). Asset price shocks, financial constraints, and investment: Evidence from Japan. *The Journal of Business*, **77** (1), 175–199.

Kulkarni, N., Ritadhi, S., Vij, S. and Waldock, K. (2019). Unearthing zombies. *Georgetown McDonough School of Business Research Paper*, (3495660).

Li, B. and Ponticelli, J. (2020). *Going bankrupt in China*. Tech. rep.

McGowan, M. A., Andrews, D. and Millot, V. (2018). The walking dead? Zombie firms and productivity performance in OECD countries. *Economic Policy*, **33** (96), 685–736.

Paravisini, D., Rappoport, V. and Schnabl, P. (2015). Specialization in bank lending: Evidence from exporting firms. *NBER Working Paper No. 21800*.

Peek, J. and Rosengren, E. S. (2005). Unnatural selection: Perverse incentives and the misallocation of credit in Japan. *American Economic Review*, **95** (4), 1144–1166.

Ponticelli, J. and Alencar, L. S. (2016). Court enforcement, bank loans, and firm investment: Evidence from a bankruptcy reform in Brazil. *The Quarterly Journal of Economics*, **131** (3), 1365–1413.

Prest, C. B. (2018). Explanations for the 2014 oil price decline: Supply or demand? *Energy Economics*, **74**, 63–75.

Schivardi, F., Sette, E. and Tabellini, G. (2020). Identifying the real effects of zombie lending. *The Review of Corporate Finance Studies*, **9** (3), 569–592.

Schmidt, C., Schneider, Y., Steffen, S. and Streitz, D. (2020). Capital misallocation and innovation. *Available at SSRN 3489801*.

Weitzner, G. and Howes, C. (2021). Bank information production over the business cycle. *Available at SSRN*.

Whited, T. M. and Wu, G. (2006). Financial constraints risk. *The Review of Financial Studies*, **19** (2), 531–559.

Figure 1: Share of Zombie Firms

Notes: The figure shows the share of publicly listed and private firms in zombie status during 2014–19. Source: FR Y-14Q.

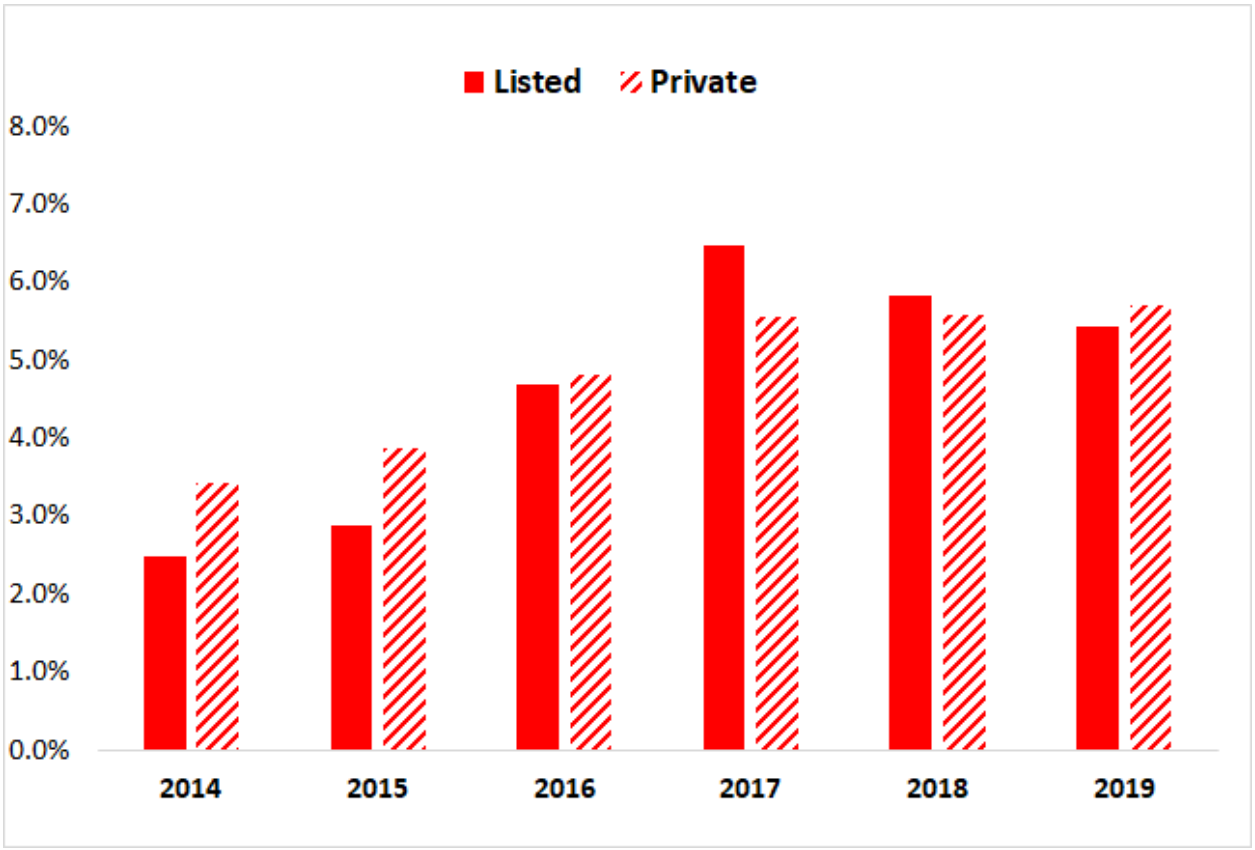
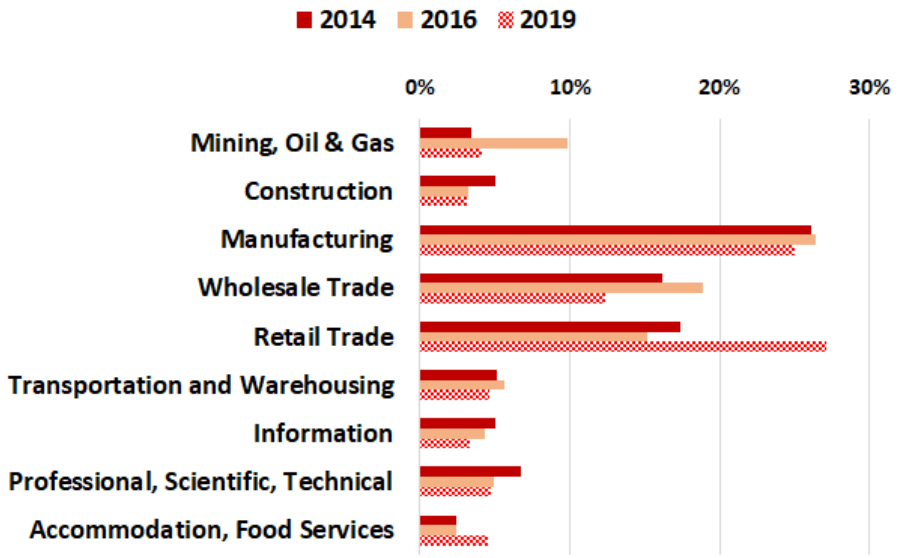
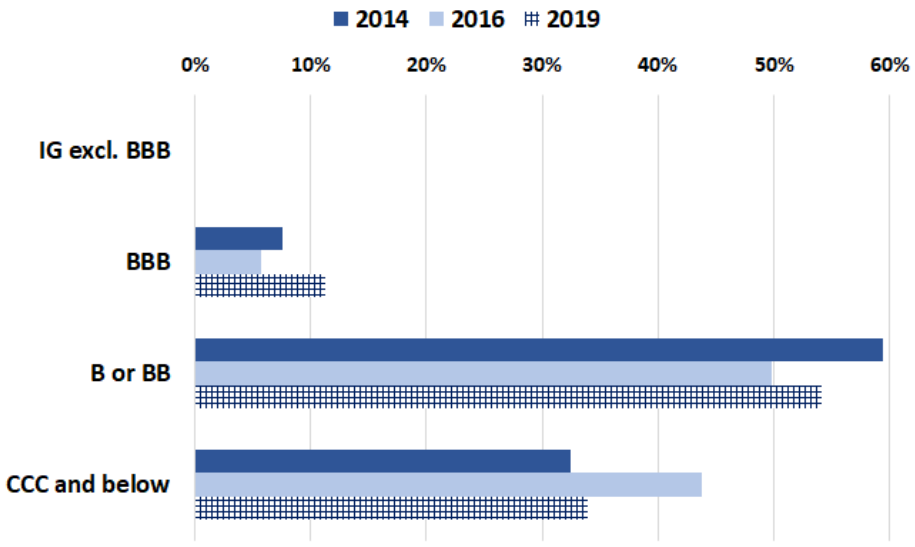


Figure 2: Industry and Ratings Distributions of Zombie Firms

Notes: This figure plots the industry distribution of firms in zombie status in Panel (a) and the ratings distribution of firms in zombie status in Panel (b) for 2014, 2016, and 2019. The industry classification is based on 2-digit NAICS classification and industries with shares of zombie firms lower than 4% are not shown. Ratings are based on the internal risk rating assigned by banks and mapped to the standard S&P scale. Source: FR Y-14Q.



(a) Industry Classification



(b) Rating Distribution

Table 1: Share of U.S. Zombie Firms—Alternative Definitions

This table reports the share of zombie firms during 2014–19 based on alternative definitions. These definitions are (i) our benchmark definition (IC ratio<1, above-median leverage and negative three-year average sales growth, column 1); (ii) a definition similar to McGowan, Andrews and Millot (2018) which requires that the IC ratio is below 1 for three consecutive years (column 2), (iii) the definition from Acharya, Eisert, Eufinger and Hirsch (2019) according to which a firm is classified as a zombie firm if it receives subsidized credit (at interest rates lower than the prevailing interest rate on loans extended to investment-grade firms), has a speculative grade rating (BB or below), and has an existing relationship with a given bank (column 3), and (iv) the definition of Acharya, Crosignani, Eisert and Eufinger (2020) according to which a firm is classified as a zombie firm if it receives subsidized credit, is rated speculative grade, and has above-median leverage and below-median IC ratio (where the medians are computed at the year-industry level, using 2-digit NAICS industry classification) (column 4). Source: FR Y-14Q.

	Share of zombie firms according to:			
	Our definition	**McGowan *et al.* (2018)**	**Acharya *et al.* (2019)**	**Acharya *et al.* (2020)**
	[1]	[2]	[3]	[4]
2014	3.4%	17.4%	18.6%	7.8%
2015	3.8%	10.8%	19.0%	7.9%
2016	4.8%	10.3%	19.4%	8.0%
2017	5.6%	10.3%	19.5%	7.6%
2018	5.6%	10.2%	16.5%	6.2%
2019	5.7%	10.5%	14.5%	6.0%

Table 2: Characteristics of U.S. Zombie Firms—All Firms

This table reports sample means and medians of key firm characteristics for nonfinancial firms in zombie and nonzombie status, respectively, during the 2014–19 period, with a p-value for tests of equality of means and medians (columns 3 and 6). Source: S&P Global Compustat, FR Y-14Q.

	(1)	(2)	(3)	(4)	(5)	(6)
	MEANS			***MEDIANS***		
	Zombie	Nonzombie	p-value (1)=(2)	Zombie	Nonzombie	p-value (4)=(5)
Size (assets in $ mn)	462.21	1,447.5	0.00	25.5	24.7	0.10
Return on assets	1.63	17.4	0.00	2.1	12.6	0.00
Cash (% assets)	6.48	11.0	0.00	2.7	5.7	0.00
Tangibility	85.52	89.7	0.00	98.1	99.4	0.00
Age	10.8	11.7	0.00	9.0	10.0	0.00
Public	5%	4%	0.32	0.0	0.0	0.32
Zombie characteristics						
IC ratio	-2.3	38.6	0.00	-1.1	7.9	0.00
Leverage (debt/assets)	63.4	32.5	0.00	56.5	27.9	0.00
Real sales growth	-5.2	10.1	0.00	-6.5	4.6	0.00

Table 3: Bank Lending to Zombie Firms—All Firms

The table shows coefficient estimates from regressions that link firms' zombie status to lending outcomes and firm riskiness. The outcome variables are loan growth, a dummy variable for loans that are new originations, a dummy variable for exit from a firm-bank relationship (Panel A), loan interest rate, maturity, and a dummy variable for firms with high probability of default (in the top decile) (Panel B). Regressions include the following firm characteristics: firm size (log-assets), cash (share of cash and marketable securities in total assets), and tangibility (share of tangible assets in total assets). The sample contains all firms. The data are at the firm-bank-year level during the 2014–19 period. Industry FE are based on 3-digit NAICS classification. Standard errors are double clustered on firm and year. Significance: *** 1%, **5%, *10%. See Sections 2 and Tables A1–A2 for variable definitions, sources, and descriptive statistics. Source: FR Y-14Q.

	(1)	(2)	(3)	(4)	(5)	(6)
	A. Intensive and extensive margins of lending					
	Loan growth		**New origination**		**Relationship exit**	
Zombie	-0.0879***	-0.0867***	-0.0034	-0.0016	0.0423***	0.0448***
	(0.010)	(0.011)	(0.002)	(0.002)	(0.007)	(0.007)
Observations	312,455	299,980	312,455	299,980	293,160	282,675
R^2	0.436	0.653	0.207	0.348	0.285	0.374
	B. Terms of lending					
	Interest rate		**Maturity**		**Probability of default**	
Zombie	0.1948***	0.1786***	-0.1633***	-0.1568***	0.0380**	0.0256**
	(0.032)	(0.032)	(0.028)	(0.026)	(0.010)	(0.009)
Observations	251,127	239,731	312,455	299,980	312,455	299,980
R^2	0.802	0.888	0.752	0.841	0.766	0.893
Firm characteristics	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y
Industry×year FE	Y	Y	Y	Y	Y	Y
Bank×year FE	Y	Y	Y	Y	Y	Y
Firm×bank FE		Y		Y		Y

Table 4: Role of Bank Capital in Lending to Zombie Firms—All Firms

The table shows coefficient estimates from regressions that link firms' zombie status to bank lending outcomes in interaction with bank capital. The outcome variables are: loan growth, a dummy variable for loans that are new originations, a dummy variable for exit from a firm-bank relationship, loan interest rate, maturity, and a dummy variable for firms with high probability of default (in the top decile). The data are at the firm-bank-year level during the 2014–19 period. High bank capital is a dummy variable for banks with post-stress CET1 capital in the top quartile. The sample includes all firms. Industry FE are based on 3-digit NAICS classification. Standard errors are double clustered on firm and year. Significance: *** p<0.01, ** p<0.05, * p<0.1. See Sections 2 and Tables A1–A2 for variable definitions, sources, and descriptive statistics. Source: FR Y-14Q and FR DFAST.

	(1)	(2)	(3)	(4)	(5)	(6)
	A. Intensive and extensive margins of lending					
	Loan growth		**New origination**		**Relationship exit**	
Zombie	-0.0925***	-0.0923***	-0.0052**	-0.0032	0.0420***	0.0463***
	(0.010)	(0.010)	(0.002)	(0.002)	(0.008)	(0.007)
Zombie×High bank capital	0.0606*	0.0527*	0.0115	0.0039	-0.0154	-0.0493**
	(0.029)	(0.023)	(0.008)	(0.010)	(0.016)	(0.017)
Observations	281,227	267,244	281,227	267,244	271,397	259,090
R^2	0.425	0.642	0.216	0.355	0.292	0.379
	B. Terms of lending					
	Interest rate		**Maturity**		**Probability of default**	
Zombie	0.1986***	0.1813***	-0.1661***	-0.1634***	0.0377**	0.0253**
	(0.037)	(0.036)	(0.029)	(0.027)	(0.010)	(0.008)
Zombie×High bank capital	-0.1247*	-0.0428	0.0301	0.0674	0.0032	0.0101
	(0.056)	(0.047)	(0.067)	(0.074)	(0.016)	(0.010)
Observations	225,006	212,178	281,227	267,244	281,227	267,244
R^2	0.800	0.886	0.754	0.841	0.747	0.877
Firm characteristics	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y
Industry×year FE	Y	Y	Y	Y	Y	Y
Bank×year FE	Y	Y	Y	Y	Y	Y
Firm×bank FE		Y		Y		Y

Table 5: Bank Lending to Zombie Firms—Oil Sector

The table shows coefficient estimates from regressions that link firms' zombie status to lending outcomes and firm riskiness, for firms in the oil and gas sector. The outcome variables are loan growth, a dummy variable for loans that are new originations, a dummy variable for exit from a firm-bank relationship, loan interest rate, maturity, and a dummy variable for firms with high probability of default (in the top decile). The sample includes firms in the oil and gas sector defined in Section 5.2. The data are at the firm-bank-year level during the 2016–19 period. Industry FE are based on 3-digit NAICS classification. Standard errors are double clustered on firm and year. Significance: *** p<0.01, ** p<0.05, * p<0.1. See Sections 2 and Tables A1–A2 for variable definitions, sources, and descriptive statistics. Source: FR Y-14Q.

	(1)	(2)	(3)	(4)	(5)	(6)
	A. Terms of lending to zombies in oil sector					
	Log amount	**New origination**	**Relationship exit**	**Interest rate**	**Maturity**	**Probability of default**
Zombie	-0.2386**	-0.0361***	0.0424	0.0045**	-0.2847*	0.2403**
	(0.044)	(0.003)	(0.023)	(0.001)	(0.096)	(0.029)
Observations	11,389	11,389	10,743	9,483	11,389	11,389
R^2	0.086	0.039	0.037	0.178	0.101	0.256
	B. Interactions with bank exposure to oil shock					
	Log amount	**New origination**	**Relationship exit**	**Interest rate**	**Maturity**	**Probability of default**
Zombie	-0.1981	-0.0395***	0.0125	0.0048*	-0.2150	0.2230**
	(0.069)	(0.001)	(0.019)	(0.001)	(0.131)	(0.041)
Zombie×Bank exposure	-0.2832	0.0190	0.1953	-0.0021	-0.4775	0.1000
to oil sector	(0.254)	(0.018)	(0.117)	(0.005)	(0.408)	(0.158)
Observations	11,144	11,143	11,144	9,294	11,143	11,143
R^2	0.077	0.087	0.014	0.175	0.100	0.256
Industry×year FE	Y	Y	Y	Y	Y	Y
Bank×year FE	Y	Y	Y	Y	Y	Y

Table 6: Role of Bank Capital in Lending to Zombie Firms—Oil Sector

The table shows coefficient estimates from regressions that link firms' zombie status to bank lending outcomes in interaction with bank capital, for firms in the oil and gas sector. The outcome variables are: loan growth, a dummy variable for loans that are new originations, a dummy variable for exit from a firm-bank relationship, loan interest rate, maturity, and a dummy variable for firms with high probability of default (in the top decile). The sample includes firms in the oil and gas sector defined in Section 5.2. The data are at the firm-bank-year level during the 2016–19 period. High bank capital is a dummy variable for banks with post-stress CET1 capital in the top quartile. Industry FE are based on 3-digit NAICS classification. Standard errors are double clustered on firm and year. Significance: *** p<0.01, ** p<0.05, * p<0.1. See Sections 2 and Tables A1–A2 for variable definitions, sources, and descriptive statistics. Source: FR Y-14Q and FR DFAST.

	(1)	(2)	(3)	(4)	(5)	(6)
	Log amount	**New origination**	**Relationship exit**	**Interest rate**	**Maturity**	**Probability of default**
Zombie	-0.2445**	-0.0369***	0.0388	0.0046**	-0.2575	0.2472**
	(0.047)	(0.004)	(0.022)	(0.001)	(0.105)	(0.032)
Zombie×High bank capital	0.0759	0.0104	-0.0991*	0.0018	-0.0833	-0.0925
	(0.077)	(0.011)	(0.034)	(0.003)	(0.221)	(0.104)
Observations	9,158	9,158	9,041	7,520	9,158	9,158
R^2	0.084	0.028	0.037	0.182	0.092	0.210
Industry×year FE	Y	Y	Y	Y	Y	Y
Bank×year FE	Y	Y	Y	Y	Y	Y

Table 7: Zombie Firm' Exit Through Bankruptcy—All Firms

The table shows OLS coefficient estimates from regressions that link firms' zombie status to the probability of filing for bankruptcy (chapter 7 or chapter 11). In order to ensure comparability between the bankruptcy data and the FR Y-14Q sample of firms, we keep firms with at least $2 million in public debt (measured as the difference between total debt and CCAR bank loans) and $10 million in total assets. The dependent variable is a dummy for firms that file for bankruptcy in the first or second year of zombie status. The variable Distressed in columns 3-6 takes value one for the firms with IC ratio<1 and above-median leverage during 2014–15. Regressions include the following firm characteristics: firm size (log-assets), cash (share of cash and marketable securities in total assets), and tangibility (share of tangible assets in total assets). Industry FE are based on 3-digit NAICS classification. The sample period is 2014–21 to capture those firms in zombie status in 2019 that filed for bankruptcy in 2020 or 2021. Two-year bankruptcy rate in the regression sample is 0.4%. Standard errors are double clustered on firm and year. Significance: *** p<0.01, ** p<0.05, * p<0.1. See Sections 2 and Tables A1–A2 for variable definitions, sources, and descriptive statistics. Source: FR Y-14Q and and S&P Capital IQ Bankruptcy Tracker.

	(1)	(2)	(3)	(4)	(5)	(6)
	Firm Files for Bankruptcy in First or Second Year of Zombie Status					
Zombie	0.0097**	0.0096**				
	(0.003)	(0.003)				
Distressed			0.0073***	0.0074***		
			(0.002)	(0.002)		
Distressed×Zombie [1]					0.0113**	0.0112**
					(0.003)	(0.003)
Distressed×Nonzombie [2]					0.0050**	0.0052**
					(0.002)	(0.002)
Observations	76,981	74,635	76,981	74,635	76,981	74,635
R^2	0.509	0.512	0.509	0.512	0.509	0.512
pvalue t-test Ha: coeff [1]>coeff [2]	-	-	-	-	0.041	0.048
Firm controls		Y		Y		Y
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y

Table 8: Zombie Firm' Exit Through Bankruptcy—Oil Sector

The table shows OLS coefficient estimates from regressions that link firms' zombie status to the probability of filing for bankruptcy (chapter 7 or chapter 11). In order to ensure comparability between the bankruptcy data and the Y-14 sample of firms, we keep firms with at least $2 million in public debt (measured as the difference between total debt and CCAR bank loans) and $10 million in total assets. The dependent variable is a dummy for firms that file for bankruptcy in the first or second year of zombie status. The variable Distressed in columns 3–6 takes value one for the firms with IC ratio<1 and above-median leverage. The sample includes firms in the oil and gas sector as defined in Section 5.2. Regressions include the following firm characteristics: firm size (log-assets), cash (share of cash and marketable securities in total assets), and tangibility (share of tangible assets in total assets). Industry FE are based on 3-digit NAICS classification. The sample period is 2014–21 to capture those firms in zombie status in 2019 that filed for bankruptcy in 2020 or 2021. Two-year bankruptcy rate in the regression sample is 5.4%. Standard errors are double clustered on firm and year. Significance: *** p<0.01, ** p<0.05, * p<0.1. See Sections 2 and Tables A1–A2 for variable definitions, sources, and descriptive statistics. Source: FR Y-14Q and and S&P Capital IQ Bankruptcy Tracker.

	(1)	(2)	(3)	(4)	(5)	(6)
	Firm Files for Bankruptcy in First or Second Year of Zombie Status					
Zombie	0.0588**	0.0661**				
	(0.029)	(0.029)				
Distressed			0.0832***	0.0915***		
			(0.026)	(0.025)		
Distressed×Zombie					0.0995***	0.1101**
					(0.036)	(0.033)
Distressed×Nonzombie					0.0518	0.0564
					(0.036)	(0.030)
Observations	2,492	2,413	2,267	2,204	2,267	2,204
R^2	0.067	0.080	0.077	0.092	0.079	0.094
Firm controls		Y		Y		Y
Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y

INTERNET APPENDIX

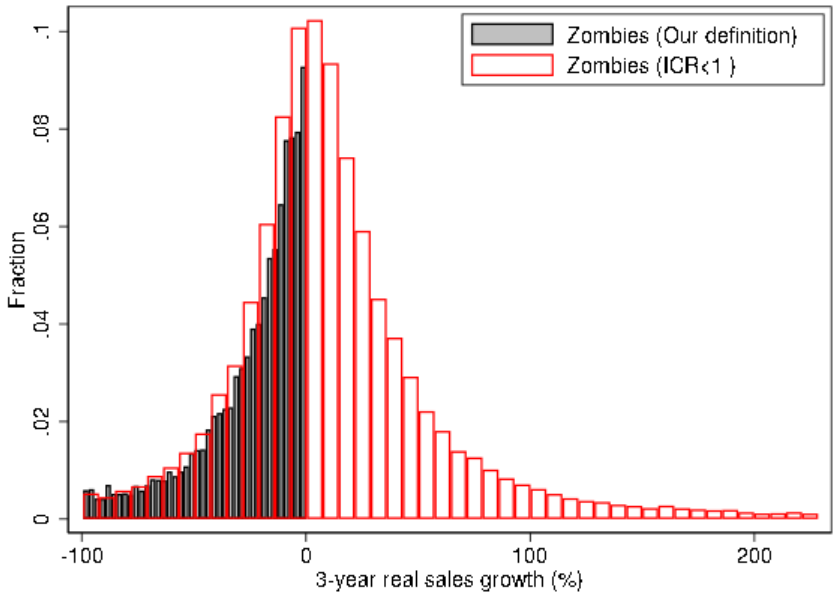
A.1 Alternative Approach of Identifying Zombies after the 2014–15 Oil Price Shock

In this Appendix we describe an alternative approach to the one described in Section 5.2 to identify zombie firms. We proceed in two steps. In the first step we measure an industry's sensitivity to oil price shocks by estimating betas of firms' monthly stock returns to changes in the oil supply shock index of Caldara, Cavallo and Iacoviello (2019). We estimate the betas between 1990 and 2010 (that is, just before the beginning of the our estimation sample) controlling for three Fama-French factors and after dropping industries with fewer than 1,000 observations. We then compute the average beta at the 3-digit NAICS level. In a second step, we assign to the "oil sector" industries with betas in the top decile of its cross-sectional distribution.

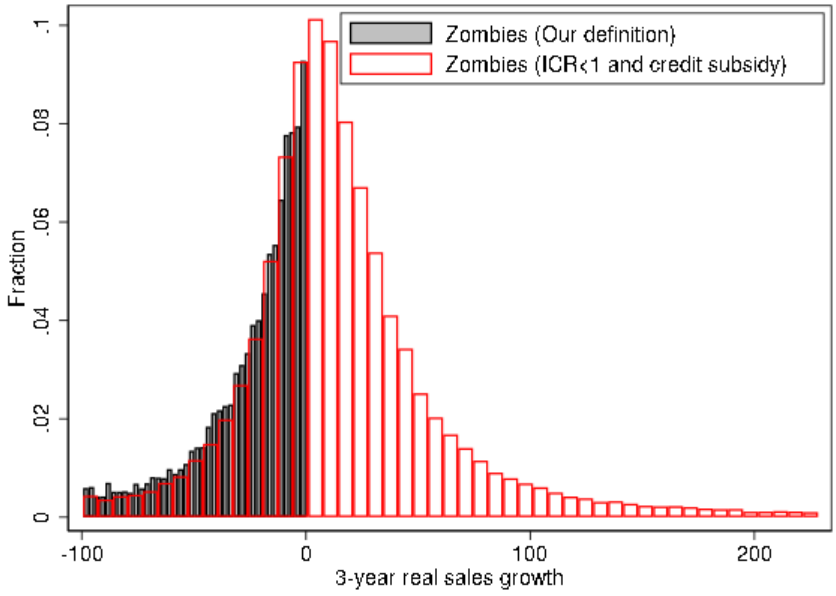
Figure A4 shows the distribution of sector-level betas to the oil supply shocks. Sectors with negative betas (Oil & Gas Pipelines, Oil & Gas Support, and Oil & Gas Extraction) benefit from oil prices increases. At the other extreme, sectors with a positive betas (Gas Station Convenience Stores, Trucking, and Construction) suffer from oil prices increases. These estimates are consistent with those of Bidder, Krainer and Shapiro (2021), who use a different method to estimate oil price exposures and rely on the Bureau of Economic Analysis classification of sectors according to the degree to which they are 'net makers' or 'net users' of oil-related products.

Figure A1: Distribution of Real Sales Growth Among Zombie Firms based on Alternative Definitions

Notes: The figure depicts the distribution of the real sales growth in the population of zombie firms based on alternative definitions. Our definition requires that zombie firms have IC ratio<1, above-median leverage, and negative three-year real sales growth. The alternative definitions require IC ratio< 1 (Panel a) and IC ratio<1 together with subsidized credit (at interest rates lower than the prevailing interest rate on loans extended to investment-grade firms) and poor rating (BB or below). Source: FR Y-14Q.



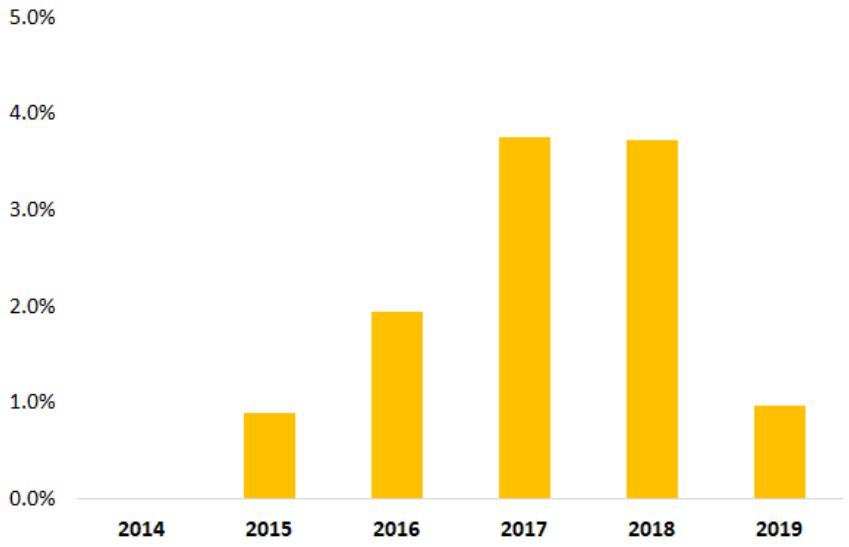
(a) Our definition vs. IC ratio<1



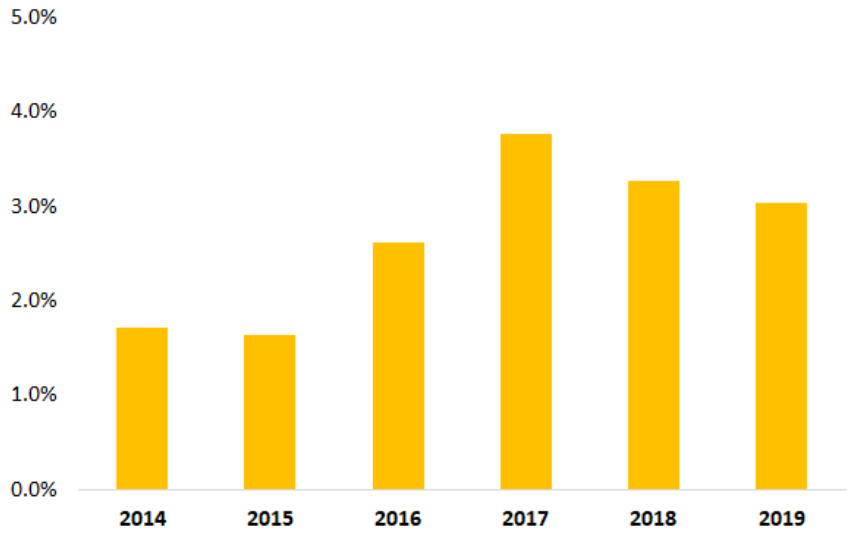
(b) Our definition vs. IC ratio<1 and credit subsidy

Figure A2: Share of Zombie Firms' Bond and Bank Loan Issuance

Notes: This figure reports the share of total bond issuance volume by public firms in zombie status (Panel a) and the share of bank credit commitments to public and private firms in zombie status (Panel b) during 2014–19. Sources: S&P Global Compustat, FR-Y14Q.



(a) Bond Issuance (% of total)



(b) Bank Loan Commitments (% of total)

Figure A3: Oil Price, 2012–19

Notes: The figure plots the Spot Crude Oil Price West Texas Intermediate (WTI) (FRED series WTISPLC retrieved on December 13, 2021) on a monthly basis during 2012–19. Source: Federal Reserve Bank of St. Louis.

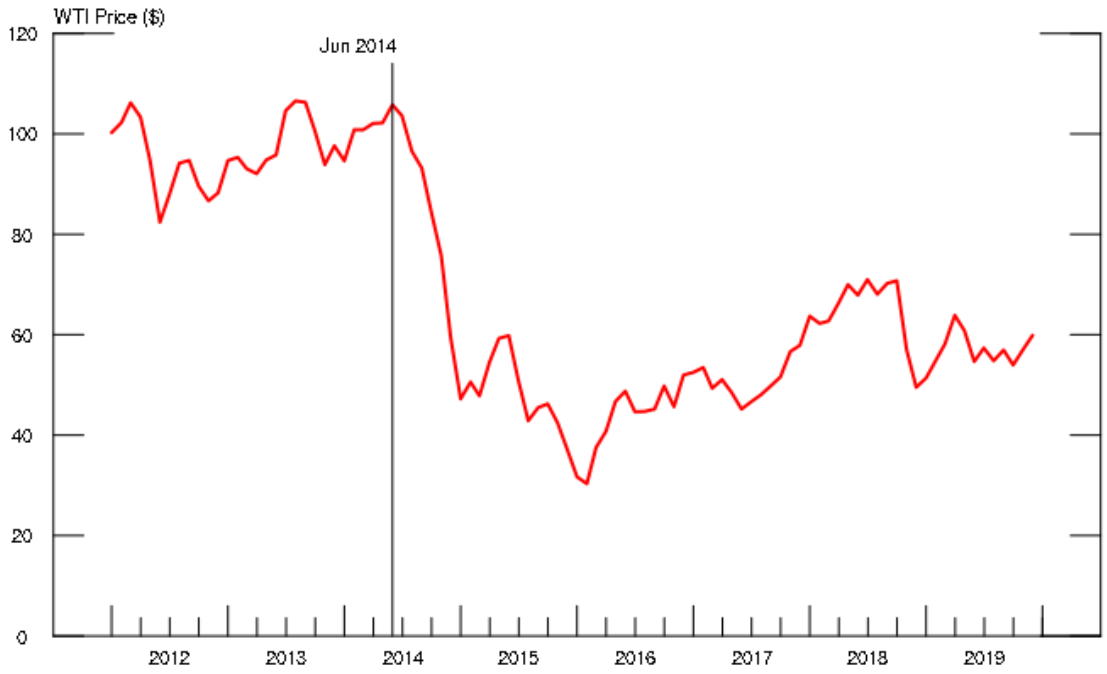


Figure A4: Sensitivity to Oil Supply Shocks

Notes: The figure plots the sensitivity of different sectors to exogenous shocks to oil supply. The sensitivity is computed as the average elasticity of the share price to oil supply shocks across public firms in 3-digit NAICS sectors. Positive values of the elasticity indicate that firms in that sector respond negatively, on average, to negative oil supply shocks (i.e., oil price increases). Source: S&P Global Compustat, Center for Research in Security Prices (CRSP), and Caldara, Cavallo and Iacoviello (2019).

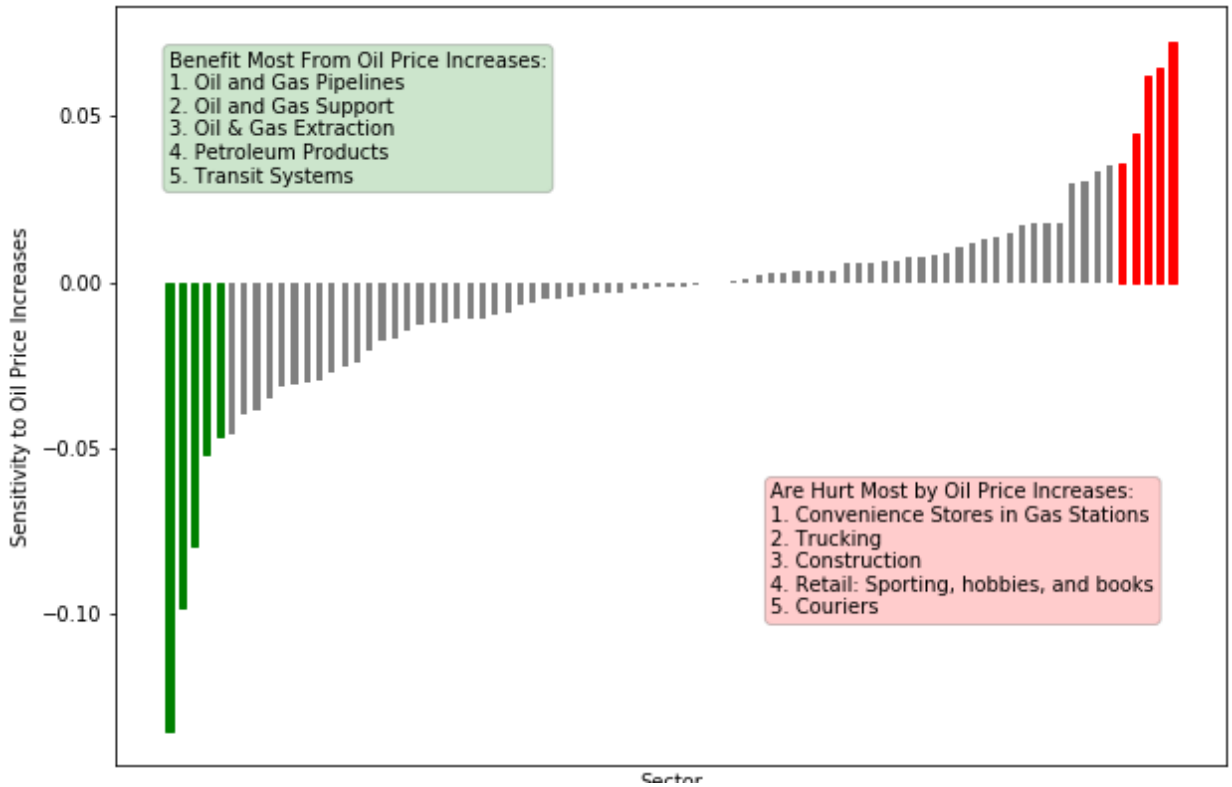


Table A1: Variable Definitions and Sources

This table presents the definition and the data source of the variables used throughout the paper. Section 2 provides a detailed description of our data sources and Table A2 presents descriptive statistics.

Variable	Definition	Source
Panel A: Firm level variables		
Interest coverage ratio	Operating income (EBIT) over interest expenses	FR-Y14Q
Real sales growth	Annual growth of firm sales net of PCI inflation over the past three years	FR-Y14Q
Leverage ratio	The firm's total debt scaled by lagged total assets.	FR-Y14Q
Distressed	Dummy variable that is equal to one if a firm has a leverage above the median in the sample that year and an IC ratio below one	FR-Y14Q
Zombie	Dummy variable that is equal to one if a firm is distressed and has negative three-year real sales growth	FR-Y14Q
Size	Natural logarithm of total assets	FR-Y 9C
Cash to assets ratio	The firm's cash and short-term equivalents scaled by lagged total assets.	FR-Y14Q
Tangibility	The firm's tangible assets scaled by lagged total assets.	FR-Y14Q
Age	The difference between the current year and the oldest origination year of any loan to that firm in the entire sample	FR-Y14Q
Public	Dummy variable that is equal to one if a firm's equity is traded in a public stock exchange	S&P Global Compustat
Bankruptcy	Dummy variable that is equal to one if a firm files for bankruptcy (chapter 7 or 11)	S&P Capital IQ Bankruptcy Tracker
Panel B: firm-bank level variables		
Loan growth	Growth rate of loan commitment, computed as the logarithm of the sum of all loan commitments to a firm in a given year divided by beginning-of-period loan commitment	FR-Y14Q
New origination	Fraction of loans that are flagged as new originations for a given firm-bank pair	FR-Y14Q
Relationship exit	Dummy variable that is equal to one if a firm-bank pair has at least one outstanding loan in a given year but no outstanding loans the following year	FR-Y14Q
Interest rate	Average interest rate on all loan commitments for each firm-bank pair, weighted by the commitment amount of each loan for the same firm-bank pair	FR-Y14Q
Maturity	Average loan maturity in years on all loan commitments for each firm-bank pair, weighted by the commitment amount of each loan for the same firm-bank pair	FR-Y14Q
Probability of default	Bank assessesment of a firm's default probability. Probability of default is calculated according to the bank's internal risk models.	FR-Y14Q
Panel C: Bank-level variables		
Post-stress CET1 ratio	Common equity Tier-1 ratio in the adverse DFAST scenario.	FR DFAST

Table A2: Selected Descriptive Statistics

This table reports summary statistics of variables used in the analysis over the sample period running from 2014 to 2019. The summary statistics of are for the loan-level data, based on the FR Y-14Q corporate loan schedule, aggregated at the firm-bank-year level. The probability of default (PD) is defined in the loan-level data as a dummy variable for loans in the top decile of the PD distribution, and aggregated at the firm-bank-year level. The high bank capital variables are dummy variables for banks with capital levels in the top quartile of the distribution. Section 2 and Table A1 provide variable definitions and sources.

	(1)	(2)	(3)	(4)	(5)	(6)
				A. All Firms		
	obs	mean	sd	p10	p50	p90
(1) firm-bank Variables						
Committed amount ($millions)	317354	33.7	86.2	1.5	11.5	80.0
Loan growth	317354	0.05	0.52	-0.35	0.00	0.53
New origination	317354	0.05	0.16	0.00	0.00	0.00
Relationship exit	310376	0.14	0.35	0.00	0.00	0.00
Interest rate	257452	3.39	1.48	1.67	3.36	5.19
Maturity	317354	2.28	1.69	0.50	1.96	4.47
Probability of default	317354	0.20	0.40	0.00	0.00	1.00
(2) Firm Characteristics						
Zombie	317354	0.04	0.20	0.00	0.00	0.00
Distressed	317354	0.11	0.31	0.00	0.00	1.00
Firm size (total assets, $millions)	313619	3825	20843	6	83	6038
Firm size (log-assets)	313619	18.67	2.76	15.54	18.23	22.52
Firm liquidity (cash/assets)	313581	9.97	13.06	0.18	5.03	26.21
Firm tangibility	312880	84.23	23.04	45.07	97.17	100.00
Firm real sales growth	311908	9.02	33.49	-11.74	4.08	28.95
Firm IC ratio (EBIT/interest expense)	306642	30.73	67.74	-0.63	6.35	82.52
Firm leverage (debt/assets)	312842	34.15	27.22	1.77	30.26	68.42
(3) Bank Characteristics						
Post-stress CET1 capital	287967	9.58	1.80	7.70	8.50	11.20
High post-stress CET1 capital	287967	0.05	0.22	0.00	0.00	0.00
Regulatory CET1 capital	307852	10.77	2.89	9.48	11.07	12.53
High regulatory CET1 capital	307852	0.10	0.30	0.00	0.00	1.00
Bank exposure to O&G sector	11144	0.15	0.08	0.07	0.14	0.31
				B. Oil Firms		
	obs	**mean**	**sd**	**p10**	**p50**	**p90**
Zombie	11392	0.28	0.45	0	0	1
Committed amount ($millions)	11392	50.2	65.6	4.7	31.8	108.0
Log committed amount	11392	17.12	1.23	15.35	17.28	18.50
New origination	11392	0.10	0.24	0	0	0
Relationship exit	10745	0.20	0.40	0	0	1
Interest rate	9495	0.04	0.01	0.03	0.04	0.06
Maturity	11392	2.84	1.45	0.75	2.88	4.63
Probability of default	11392	0.36	0.48	0	0	1

Table A3: Bank Lending to Zombie Firms—Baseline Results with Additional Firm Controls

The table shows coefficient estimates from regressions that link firms' zombie status to lending outcomes and includes a more comprehensive set of firm controls. The outcome variables are loan growth, a dummy variable for loans that are new originations, a dummy variable for exit from a firm-bank relationship (Panel A), loan interest rate, maturity, and probability of default (Panel B). Regressions include the following firm characteristics: firm size (log-assets), cash (share of cash and marketable securities in total assets), and tangibility (share of tangible assets in total assets). In addition, they include the variables used to define zombie firms in Section 3.1—leverage, IC ratio, and the three-year average real sales growth rate. The sample contains all firms. The data are at the firm-bank-year level during the 2014–19 period. Industry FE are based on 3-digit NAICS classification. Standard errors are double clustered on firm and year. Significance: *** p<0.01, ** p<0.05, * p<0.1. See Sections 2 and Tables A1–A2 for variable definitions, sources, and descriptive statistics. Source: FR Y-14Q.

	(1)	(2)	(3)	(4)	(5)	(6)
	A. Intensive and extensive margins of lending					
	Loan growth		**New origination**		**Relationship exit**	
Zombie	-0.0974***	-0.0984***	0.0011	0.0032	0.0430***	0.0465***
	(0.012)	(0.013)	(0.003)	(0.002)	(0.008)	(0.007)
Observations	300,986	288,513	300,986	288,513	282,527	271,989
R^2	0.432	0.653	0.208	0.351	0.287	0.377
	B. Terms of lending					
	Interest rate		**Maturity**		**Probability of default**	
Zombie	0.1709***	0.1632***	-0.1564***	-0.1460***	0.0350**	0.0244**
	(0.030)	(0.030)	(0.030)	(0.027)	(0.010)	(0.009)
Observations	244,139	232,725	300,986	288,513	300,986	288,513
R^2	0.801	0.888	0.748	0.839	0.762	0.892
Firm characteristics	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y
Industry×year FE	Y	Y	Y	Y	Y	Y
Bank×year FE	Y	Y	Y	Y	Y	Y
Firm×bank FE		Y		Y		Y

Table A4: Role of Bank Capital in Lending to Zombie Firms—Alternative Measure of Capital—Regulatory Common Equity Tier1 (CET1) Capital

The table examines the robustness of our baseline findings for the role of bank capital to an alternative way of measuring capital using the BHC-level regulatory CET 1 capital (defined as CET1 capital divided by risk-weighted assets). High bank capital is a dummy variable for banks with regulatory CET1 capital in the top quartile. The table shows coefficient estimates from regressions that link firms' zombie status to lending outcomes and firm riskiness. The outcome variables are loan growth, a dummy variable for loans that are new originations, a dummy variable for exit from a firm-bank relationship, loan interest rate, maturity, and probability of default. Panel A refers to all firms (defined in Section 3.1) and Panel B refers to oil firms (defined in Section 5.2). The data are at the firm-bank-year level during the 2014–19 period in Panel A and 2016–19 period in Panel B. Standard errors are double clustered on firm and year. ignificance: *** p<0.01, ** p<0.05, * p<0.1. See Sections 2 and Tables A1–A2 for variable definitions, sources, and descriptive statistics. Source: FR Y-14Q and FR Y-9C.

	(1)	(2)	(3)	(4)	(5)	(6)
			A. All firms			
	Log amount	**New origination**	**Relationship exit**	**Interest rate**	**Maturity**	**Probability of default**
Zombie	-0.0915***	-0.0021	0.0473***	0.1765***	-0.1691***	0.0253**
	(0.013)	(0.002)	(0.008)	(0.031)	(0.028)	(0.009)
Zombie×High bank capital	0.0484	0.0047	-0.0255	0.0610	0.1119	0.0100
	(0.031)	(0.012)	(0.018)	(0.043)	(0.058)	(0.007)
Observations	292,084	292,084	281,367	233,580	292,084	292,084
R^2	0.652	0.348	0.373	0.887	0.839	0.889
Firm characteristics	Y	Y	Y	Y	Y	Y
Industry×year FE	Y	Y	Y	Y	Y	Y
Bank×year FE	Y	Y	Y	Y	Y	Y
Firm×bank FE	Y	Y	Y	Y	Y	Y
			B. Oil firms			
	Log amount	**New origination**	**Relationship exit**	**Interest rate**	**Maturity**	**Probability of default**
Zombie	-0.2536**	-0.0408***	0.0503	0.0043*	-0.2913	0.2401**
	(0.048)	(0.002)	(0.026)	(0.001)	(0.105)	(0.031)
Zombie×High bank capital	0.1194	0.0197*	-0.0595	0.0015	-0.0394	0.0269
	(0.044)	(0.006)	(0.027)	(0.002)	(0.127)	(0.036)
Observations	11,135	11,135	10,734	9,272	11,135	11,135
R^2	0.087	0.040	0.038	0.176	0.099	0.239
Industry×year FE	Y	Y	Y	Y	Y	Y
Bank×year FE	Y	Y	Y	Y	Y	Y

Table A5: Identifying Zombies Created by the 2014–15 Oil Shock

The table shows coefficient estimates from OLS regression that links firm status pre- and-post oil shock. The sample is limited to oil and gas firms as defined in Section 5.2 (column 1) or alternatively in Section A.1 (column 2). The outcome variables is a dummy variable for firms that are in zombie status during 2016–19 based on our main definition (IC ratio<1, above-median leverage, and negative three-year real sales growth rate). The variable Distressed takes value one for the firms with IC ratio<1 and above-median leverage during 2014–15. The variable Post takes value one during 2016–19 and zero during 2014–15. Regressions include the following firm characteristics: firm size (log-assets), cash (share of cash and marketable securities in total assets), tangibility (share of tangible assets in total assets), age (the difference between the current year and the oldest origination year of any loan to a given firm in the Y-14 dataset) and a dummy variable for public firms. The data are at the firm-year level during the 2014–19 period. Standard errors are double clustered on firm and year. Significance: *** p<0.01, ** p<0.05, * p<0.1. See Sections 2 and Tables A1–A2 for variable definitions, sources, and descriptive statistics. Source: FR Y-14Q, S&P Global Compustat, Center for Research in Security Prices (CRSP), and Caldara, Cavallo and Iacoviello (2019).

	(1)	(2)
	Firm is a zombie	
	Based on industry classification (baseline)	**Based on oil beta (robustness)**
Distressed×Post Oil Price Shock	0.2950**	0.2227***
	(0.079)	(0.039)
Distressed	0.3155***	0.3572***
	(0.037)	(0.036)
Observations	12,390	30,789
R^2	0.691	0.680
Firm FE	Y	Y
Firm controls	Y	Y
Firm controls×Post	Y	Y

Table A6: Characteristics of U.S. Zombie Firms—Oil Firms

This table reports sample means and medians of key firm characteristics for nonfinancial firms in zombie and nonzombie status in the oil and gas sector (as defined in Section 5.2) during the 2016–19 period, with a p-value for tests of equality of means and medians (columns 3 and 6). Source: S&P Global Compustat, FR Y-14Q.

	(1)	(2)	(3)	(4)	(5)	(6)
	MEANS			***MEDIANS***		
	Zombie	Nonzombie	p-value (1)=(2)	Zombie	Nonzombie	p-value (4)=(5)
Size (assets in $ mn)	3336.23	8,773.0	0.00	377.7	380.1	0.88
Return on assets	7.60	11.1	0.00	6.7	8.2	0.00
Cash (% assets)	4.19	7.1	0.03	1.8	2.6	0.00
Tangibility	91.21	89.7	0.00	99.9	100.0	0.54
Age	8.5	7.5	0.00	8.0	6.0	0.00
Public	15%	11%	0.00	0.0	0.0	0.00

Table A7: Bank Lending to Zombie Firms—Results for Alternative Zombie Definitions

The table shows coefficient estimates from regressions that link firms' zombie status to bank lending outcomes in interaction with bank capital. The outcome variables are loan growth, a dummy variable for loans that are new originations, and a dummy variable for exit from a firm-bank relationship. Zombie firm definitions as follows: (i) a definition similar to McGowan, Andrews and Millot (2018) which requires that the IC ratio is <1 for three consecutive years (Panel A); (ii) the definition in Acharya, Eisert, Eufinger and Hirsch (2019) which requires zombie firms to receive subsidized credit (at interest rates lower than the prevailing interest rate on loans extended to investment-grade firms), to be rated speculative-grade (BB and below), and to have an existing banking relationship with a given bank; and (iii) the definition in Acharya, Crosignani, Eisert and Eufinger (2020) which requires zombie firms to receive subsidized credit, to be rated speculative-grade, and to have above-average leverage and below-average IC ratio, where the averages are for each year-industry (using the 2-digit NAICS industry classification). High bank capital is a dummy variable for banks with post-stress CET1 capital in the top quartile. Regressions include the following firm characteristics: firm size (log-assets), cash (share of cash and marketable securities in total assets), and tangibility (share of tangible assets in total assets). The sample includes all firms. The data are at the firm-bank-year level during the 2014–19 period. Industry FE are based on 3-digit NAICS classification. Significance: *** p<0.01, ** p<0.05, * p<0.1. See Sections 2 and Tables A1–A2 for variable definitions, sources, and descriptive statistics. Source: FR Y-14Q.

	(1)	(2)	(3)
Dependent variable:	**Log amount**	**New origination**	**Relationship exit**
	A. Zombie definition: McGowan *et al.* (2018)		
Zombie	-0.0975***	-0.0106	0.0739***
	(0.022)	(0.009)	(0.007)
Zombie×High bank capital	0.1143**	0.0181	-0.0664***
	(0.034)	(0.012)	(0.014)
Observations	309,315	309,315	300,676
R-squared	0.700	0.397	0.412
	B. Zombie definition: Acharya *et al.* (2019)		
Zombie	0.0195**	-0.0483***	0.0139**
	(0.007)	(0.005)	(0.005)
Zombie×High bank capital	0.0087	0.0060	0.0071
	(0.010)	(0.008)	(0.013)
Observations	373,082	373,082	362,160
R-squared	0.606	0.380	0.388
	C. Zombie definition: Acharya *et al.* (2020)		
Zombie	0.0056	-0.0211***	-0.0017
	(0.007)	(0.003)	(0.005)
Zombie×High bank capital	0.0053	0.0061	0.0012
	(0.012)	(0.007)	(0.013)
Observations	367,781	367,781	357,035
R-squared	0.611	0.377	0.388
Firm characteristics	Y	Y	Y
Industry×year FE	Y	Y	Y
Bank×year FE	Y	Y	Y
Firm×bank FE	Y	Y	Y

Table A8: Bank Lending to Zombie Firms—Alternative Oil Sector Classification

The table examines the robustness of our baseline findings for firms in the oil and gas sector (shown in Tables 5-6) to an alternative way of identifying firms that would be adversely affected by an oil supply shock—that is, firms in industries with high sensitivity to oil supply shocks (top decile), as defined in Section A.1. The table shows coefficient estimates from regressions that link firms' zombie status to lending outcomes and firm riskiness. The outcome variables are loan growth, a dummy variable for loans that are new originations, a dummy variable for exit from a firm-bank relationship, loan interest rate, maturity, and probability of default. High bank capital is a dummy variable for banks with post-stress CET1 capital in the top quartile. The data are at the firm-bank-year level during the 2016–19 period. Standard errors are double clustered on firm and year. Significance: *** p<0.01, ** p<0.05, * p<0.1. See Sections 2 and Tables A1–A2 for variable definitions, sources, and descriptive statistics. Source: FR Y-14Q, S&P Global Compustat, Center for Research in Security Prices (CRSP), and Caldara, Cavallo and Iacoviello (2019).

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	**Log amount**	**New origination**	**Relationship exit**	**Interest rate**	**Maturity**	**Probability of default**
			A. Terms of lending to zombies in oil sector			
Zombie	-0.2099**	-0.0265**	0.0527	0.0044**	-0.2377	0.2302**
	(0.034)	(0.003)	(0.022)	(0.001)	(0.115)	(0.029)
Observations	25,328	25,328	23,516	19,679	25,328	25,328
R-squared	0.078	0.024	0.052	0.204	0.169	0.357
			B. Interactions with bank exposure to oil shock			
Zombie	-0.1638	-0.0057	0.0450*	0.0056**	-0.0239	0.2579**
	(0.067)	(0.009)	(0.013)	(0.001)	(0.122)	(0.051)
Zombie×Bank exposure	-0.3590	-0.1306	0.0667	-0.0075	-1.3058*	-0.1593
	(0.303)	(0.053)	(0.102)	(0.004)	(0.389)	(0.190)
Observations	23,886	23,886	22,570	18,679	23,886	23,886
R-squared	0.078	0.024	0.055	0.201	0.174	0.360
			C. Interactions with bank capital			
Zombie	-0.2171**	-0.0234**	0.0479	0.0046**	-0.2039	0.2429**
	(0.035)	(0.003)	(0.024)	(0.001)	(0.144)	(0.032)
Zombie×High bank capital	0.1538	-0.0287**	-0.0104	-0.0001	-0.4451	-0.1497
	(0.061)	(0.004)	(0.038)	(0.002)	(0.308)	(0.077)
Observations	20,570	20,570	20,008	15,830	20,570	20,570
R-squared	0.076	0.019	0.057	0.211	0.171	0.301
Industry×year FE	Y	Y	Y	Y	Y	Y
Bank×year FE	Y	Y	Y	Y	Y	Y