Zombie Credit and (Dis-)Inflation: Evidence from Europe

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ABSTRACT

We show that "zombie credit"—subsidized credit to non-viable firms—has a disinflationary effect. By keeping these firms afloat, zombie credit creates excess aggregate supply, thereby putting downward pressure on prices. Granular European data on inflation, firms, and banks confirm this mechanism. Markets affected by a rise in zombie credit experience lower firm entry and exit, capacity utilization,

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markups, and inflation, as well as a misallocation of capital and labor, which results in lower productivity, investment, and value added. If weakly-capitalized banks were recapitalized in 2009, inflation in Europe would have been up to 0.21pp higher post-2012.

In response to the global financial crisis and the European sovereign debt crisis, the European Central Bank (ECB) and other European central banks provided substantial monetary stimulus, including longer-term refinancing operations, negative deposit rates, and large-scale asset purchase programs. However, even post-stimulus, Europe's economic growth and inflation have remained depressed. In the words of former ECB President Mario Draghi, *"although we have seen the successful transmission of monetary policy to financing conditions, and from financing conditions to GDP and employment, the final legs of the transmission process to wages and inflation have been slower than we expected. Wage growth is now strengthening as slack in the labor market diminishes. But the pass-through from wages to prices remains weak."*[1]

Europe's "missing inflation puzzle" in the years between its sovereign debt crisis and the Covid-19 pandemic bears a striking resemblance to Japan's "lost decade". Like Japan's economy in the 1990s, Europe's economy has been characterized, besides a deflationary pressure, by a highly accommodative and lenient central bank policy and a rise in the share of zombie firms (see Figure 1).[2] In Europe, political constraints led to a hesitant introduction

[1]See Mario Draghi's speech "Twenty Years of the ECB's monetary policy" at the ECB Forum on Central Banking in Sintra on June 18, 2019. The speech is available at www.ecb.europa.eu.

[2]See, for example, Caballero, Hoshi, and Kashyap (2008), Giannetti and Simonov

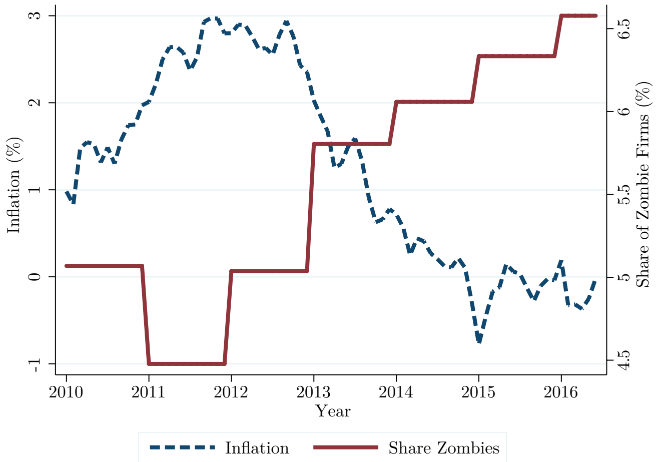

Figure 1. Zombie credit and inflation. This figure shows the year-over-year (yoy) growth of the CPI on the left axis and the asset-weighted share of zombie firms in our sample on the right axis. A firm is classified as zombie if it is low-quality (i.e., above median leverage and below median interest coverage ratio) and receives subsidized credit (interest expenses/debt lower than that of AAA-rated industry peers in a given year). See Section II.B for a detailed explanation of how we identify zombie firms in the data. Sources: Eurostat, Amadeus.

of recapitalization measures in the aftermath of the 2008 global financial crisis, leaving many banks weakly-capitalized and, in turn, creating zombie lending incentives (see Acharya et al. (2018a)). By extending subsidized loans to non-viable borrowers, weakly-capitalized banks can avoid regulatory repercussions and "gamble for resurrection".

Building on Caballero, Hoshi, and Kashyap (2008), we illustrate in a simple model that by keeping non-viable firms artificially alive, this *zombie credit* can create excess supply, which puts downward pressure on prices. In equilibrium, this zombie credit channel can cause a decrease in firm entry and exit rates, markups, capacity utilization, and CPI growth, as well as

(2013), Acharya et al. (2019), Bonfim et al. (2023), Schivardi, Sette, and Tabellini (2022), and Blattner, Farinha, and Rebelo (2023).

a misallocation of capital and labor, which results in lower productivity, investment, and value added.[3]

In this paper, we quantify the contribution of the zombie credit channel to Europe's disinflationary episode after its sovereign debt crisis. Our results show that, if weakly-capitalized banks were decisively recapitalized in 2009, inflation in Europe would have been up to 0.21pp higher post-2012. Hence, while the zombie credit channel has a meaningful disinflationary effect, it leaves a substantial share of Europe's missing inflation puzzle unexplained.

In our analysis, we combine product-country level CPI data with industry-country-level information from Eurostat and detailed firm-level information from Bureau van Dijk's Amadeus for 1.1 million firms from 12 European countries across 65 industries. Using linking tables, we calculate changes in consumer prices at the industry-country level from the CPI data. Using Amadeus data, we identify zombies as firms that meet two criteria: (i) they are of low-quality, that is, their interest coverage (IC) ratio is below the median and their leverage ratio is above the median, and (ii) their borrowing costs are lower than the costs paid by their most creditworthy industry peers.

[3]The Italian concrete and cement industry offers a textbook example of this mechanism at work. Following the 2008 crisis, many firms in this sector relied on their banks to remain alive. The CEO of Cementir, one of the industry leaders in Italy, stated in 2017 that "*in Italy, in the cement industry, we have zombies kept alive by banks. [...] Banks do everything they can to keep these zombies alive to avoid realizing losses on their balance sheets.*" In a 2017 Senate hearing, industry representatives stated that "*the excessive production capacity caused an unprecedented price competition that, in turn, caused firms to realize large losses*" (audizione di AITEC, 2017). In 2015, the price of cement in Italy was 22% below the EU average.

Post-zombification, the (low) profitability of the firms classified as zombies does not improve, their leverage increases, and they are more likely to default in the long-term—suggesting that their access to cheap credit is not due to a positive outlook and/or relationship lending.

In the cross-section of countries and industries, we find that industry-country pairs (henceforth called "markets") that experience a 2.2 percentage point (pp) increase in the share of zombies (i.e., the observed zombie share increase from 2012 to 2016) subsequently have a 5.3 basis point (bp) lower CPI growth. In our most stringent specification, we include industry-country, country-year, and industry-year fixed effects, which absorb time-invariant industry-country characteristics as well as industry- and country-specific shocks (most importantly demand shocks). Moreover, we control for the share of low-quality firms to capture industry-country-year specific demand factors that affect firm quality. We also show that our results are robust to using an array of alternative zombie classifications and to measuring price changes with the producer price index (PPI) instead of the CPI.

To mitigate concerns that the negative correlation between the zombie share and CPI growth could be driven by demand shocks, we conduct a robustness check where we consider three additional criteria to identify zombies that are unrelated to demand effects. For the first more stringent zombie share measure, we exclude firms that already enjoyed low interest rates and then turned into a zombie because their quality deteriorated. In addition, we then further restrict the zombie share measure to instances where firms are connected to (i) weak banks and (ii) to a single weak bank, respectively. The estimated effects of zombie credit on CPI growth are larger for these more stringent zombie measures than in our baseline OLS specification, suggesting that our estimates are not materially driven by demand-side effects.

To further address potential omitted variable biases, we instrument a market's zombie share exploiting that weaker banks have stronger zombie lending incentives. In particular, we employ a Bartik-style shift-share instrument (see Bartik (1991)) based on the ex-ante capitalization of the banks connected to the firms in the respective market and aggregate loan growth, where loan growth is a proxy for time-varying country-level bank shocks (we also use non-performing loan growth as a robustness test).

The idea is that the average bank health differs across markets at the beginning of the sample period and markets linked to ex-ante weaker banks are more likely to see an increase in zombie lending when the banking system experiences a negative shock.[4] Our instrument thus gets all of the cross-sectional variation in exposure to weak banks from *pre-existing* lending shares, and all of its time-series variation from country-level loan growth. Our instrumental variable (IV) regression estimates confirm the negative effect of zombie credit on CPI growth. Our calculations suggest that in the hypothetical case where weakly-capitalized banks were recapitalized in 2009 to a 9% Tier-1 capital ratio, the annual CPI growth in Europe would have been on average 0.21pp higher between 2012 and 2016.

Consistent with the insights of our theoretical framework about the inner

[4]Our plausibility checks confirm that the relation between a market's exposure to weak banks and its zombie prevalence is stronger in markets that should conceptually be more prone to zombie lending (i.e., markets that are depressed, uncertain, or characterized by lenient bank supervision).

workings of the zombie credit mechanism, we also find that, in the cross-section of countries and industries, markets that experience a stronger increase in the share of zombie firms subsequently have: (i) more active firms and aggregate sales growth, (ii) lower firm default and entry rates, (iii) higher average idle capacity, (iv) lower average markups, and (v) higher average material and labor costs. The positive correlation between zombie credit and sales growth provides further evidence that the negative correlation between zombie credit and CPI growth is not demand driven (as lower demand would *lower* sales). The positive correlation between zombie credit and firm input costs is consistent with relatively more firms demanding the same inputs sustaining their prices. In line with this finding, we confirm, using PPI data and input-output tables from the World Input-Output database, that the zombie credit mechanism also affects prices along the supply chain.

At the firm-level, we show that the market-level outcomes are at least partly caused by negative spillover effects to non-zombie firms. In particular, healthy firms that face competition from a growing number of zombies have lower markups, profitability, and sales growth, as well as higher input costs.

We present a set of tests that provide further evidence for the zombie credit channel. Specifically, we show that the effect of an increase in the zombie prevalence on CPI growth is driven by (i) high fixed cost industries and (ii) national markets for nontradable goods and supranational markets for tradable goods. We also show that the zombie credit mechanism appears to be a short- to medium-term phenomenon.

Finally, our results show that the zombie credit channel affects investment and employment. Markets with a stronger increase in the zombie share subsequently experience a higher misallocation of capital and labor—measured as the dispersion of the marginal revenue product of capital and labor, respectively. The lower allocative efficiency in these markets results in lower average net investment, productivity, and value added.

Our findings show that a central bank that implements policy measures that contribute to a persistent zombification of the economy with the objective of restoring inflation and growth might end up working against its own objectives. Conversely, accommodative monetary policy might be more effective in times of a weakening financial sector, if accompanied by a targeted bank recapitalization program.

Literature Review. We contribute to three strands of literature. First, we contribute to the literature on zombie credit, starting with the evidence from Japan in the 90s (see Peek and Rosengren (2005), Caballero, Hoshi, and Kashyap (2008), and Giannetti and Simonov (2013)).[5] More recent evidence suggests that zombie credit has increased globally (Banerjee and Hofmann (2018); McGowan, Andrews, and Millot (2018)) and, in particular, in Europe. In the European context, Blattner, Farinha, and Rebelo (2023) shows that zombie lending in Portugal increased input misallocation across firms reducing firm productivity; Schivardi, Sette, and Tabellini (2022) shows

[5]Peek and Rosengren (2005) documents that weakly-capitalized banks extended credit to their weak borrowers to avoid realizing losses on outstanding loans; Caballero, Hoshi, and Kashyap (2008) shows that this zombie lending behavior affected healthy firms, reducing their investment and employment; and Giannetti and Simonov (2013) shows that large capital injections can prevent zombie lending.

that non-viable Italian firms obtained favorable bank credit; and Acharya et al. (2019) links zombie lending to the ECB's OMT program.[6] We build on this literature and show that, by allowing non-viable firms to stay afloat, zombie lending elevates aggregate production, affecting product prices.

Second, we contribute to the literature on the effects of financial frictions on inflation. Chevalier and Scharfstein (1996) suggests that liquidity-constrained firms might raise prices to increase cash flows—the "liquidity squeeze channel." Gilchrist et al. (2017) and de Almeida (2015) show that this mechanism helps to explain the pricing behavior of U.S. and European firms following the financial crisis. Barth III and Ramey (2001) proposes the "cost channel," arguing that firms' marginal costs depend on their funding costs, which implies an increase (decrease) in inflation after a monetary tightening (loosening). Christiano, Eichenbaum, and Trabandt (2015) shows that the cost channel helps to explain the modest disinflation in the U.S. during the Great Recession. Our results draw further attention to the impact of supply-side financial frictions on inflation, showing that the zombie credit channel, by hampering supply adjustments, contributed to the disinflationary trend in Europe after its sovereign debt crisis.

Third, we contribute to the literature on resource misallocation.[7] Most

[6] Angelini et al. (2021), Kulkarni et al. (2021), and Bonfim et al. (2023) find that banks became less likely to engage in zombie lending after regulatory bank inspections and in presence of stricter supervision.

[7] Hsieh and Klenow (2009) shows that resource misallocation reduces productivity. Extending this work, Whited and Zhao (2021) analyzes the misallocation of debt and equity in the U.S. and China. Midrigan and Xu (2014) shows that financial frictions

related to our work, Bertrand, Schoar, and Thesmar (2007) analyzes a French banking deregulation in the 80s, which curbed subsidized lending that created implicit entry and exit barriers. They find that, once banks cut back on "(cheap) credit to poorly performing firms" entry and exit rates rose, improving the allocative efficiency across firms and raising employment. Peters (2020) shows that when entry and exit is hampered, incumbents have time to gain market power, which increases markups and misallocation, reducing productivity. Relatedly, Liu, Mian, and Sufi (2022) shows that low interest rates can trigger a relatively stronger investment response by market leaders, which can create entry barriers and lower productivity growth. Gopinath et al. (2017) shows that an interest rate reduction led to capital misallocation in Southern Europe in the 90s.

I. Mechanism of the Zombie Credit Channel

In this section, we define the zombie credit concept and lay out the intuition of the zombie credit mechanism and its testable predictions. In Internet Appendix I, we present two formal models. First, an extensive margin model in which firms' production scales are exogenously set, and where we focus on the impact of zombie credit on prices through its effect on the number of active firms, and, in turn, aggregate supply. Second, an intensive margin extension where, in addition, we consider the effect on firms' individual production scale choices.

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distort entry and technology adoption, causing productivity losses.

Zombie Definition and Zombie Credit. We consider a firm to be a zombie if (i) the net present value (NPV) of its operating profits is negative and (ii) it is kept alive by a bank with zombie lending incentives. While providing more debt to a zombie firm has a negative NPV on a standalone basis (i.e., just considering the debt interest and debt principal payments) and from a welfare perspective, such incentives might make it privately optimal for weakly-capitalized banks to extend zombie credit.

The theoretical zombie lending literature (see, e.g., Bruche and Llobet (2014), Homar and van Wijnbergen (2017), Begenau et al. (2023), and Acharya, Lenzu, and Wang (2022)) has highlighted two different zombie lending incentives: avoidance of regulatory costs and risk-shifting.

The avoidance of regulatory costs incentive has three necessary ingredients. First, the bank is weak, which puts it at risk of violating minimum capital requirements. Second, violating these requirements is costly (e.g., it might trigger a costly recapitalization). Third, the bank has a preexisting exposure to a non-viable borrower. By providing subsidized credit, the bank can then make continuing operating for this borrower positive NPV and help it meet its loan payments, which lowers the bank's likelihood of incurring a loan loss and regulatory costs in the short-term. Zombie lending thus allows the bank to "buy time" in the hopes that it recovers financially. Blattner, Farinha, and Rebelo (2023) provides empirical evidence for this zombie lending incentive.

The risk-shifting incentive also has three necessary ingredients. First, the bank has a non-negligible default probability. Second, lending to a non-viable firm yields a higher expected return in the bank's solvency states than its outside investment options (e.g., because the bank has a material preexisting exposure to the firm or its industry). Third, the bank's debt is not appropriately priced for risk (e.g., due to bailout guarantees). The bank then has an incentive to "shift" returns in solvency states and potential losses in insolvency states by further increasing its exposure to this non-viable (zombie) firm. If the gamble succeeds, the bank wins. If it fails, the bank creditors and/or the government lose. Again, the zombie loan needs to include a subsidy (i.e., advantageous interest rate) such that the firm's NPV of continuing business is positive. Chopra, Subramanian, and Tantri (2021) provides empirical evidence for this driver of zombie lending.

We provide a more detailed discussion of both zombie lending incentives in Internet Appendix I. Acharya et al. (2019), Bonfim et al. (2023), Schivardi, Sette, and Tabellini (2022), and Blattner, Farinha, and Rebelo (2023) provide evidence for zombie lending behavior in Europe after its sovereign debt crisis.

Extensive Margin Model. Since our focus is the analysis of the effect of zombie credit on CPI growth, we include zombie credit in our model as an exogenous force that prevents some (zombie) firms from defaulting, and compare changes in product prices in an economy with zombie credit versus an economy without zombie credit.

We consider an environment with imperfect competition among firms that produce a single good, with fixed and marginal costs. The firms' production scales are drawn from a random distribution, and firms simultaneously set prices. Incumbent firms that draw a low production scale might be forced to exit and entrant firms that draw a high scale might enter the market. The

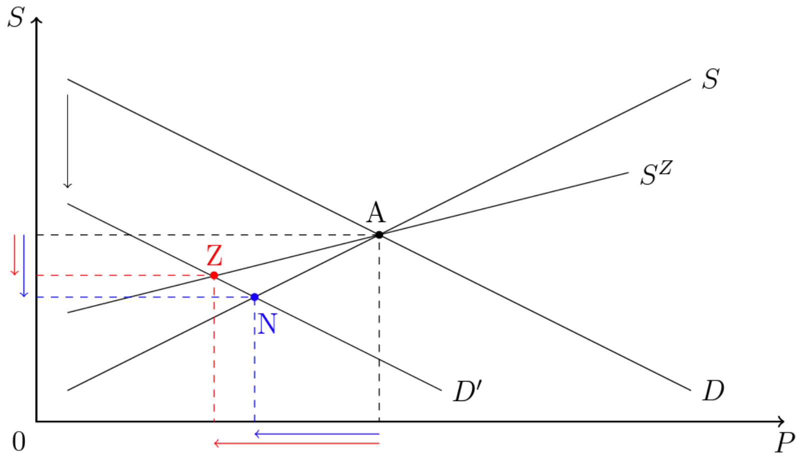

Figure 2. Intuition. This figure shows how zombie credit affects the equilibrium quantity and price.

demand for the good is exogenous and its aggregate supply is the sum of the production by incumbent and entrant firms.

Suppose the economy is in a steady state, namely the number of firms defaulting each period is exactly offset by the number of entrants. The equilibrium is illustrated by point A in Figure 2, where the exogenous demand is equal to the production by the constant number of incumbent firms. To show the effect of zombie credit, we analyze how the economy transitions to a new equilibrium following a demand shock that reduces the demand to D'.

In the case without zombie credit, the demand shock causes the price and quantity to decrease along the supply curve S to the new equilibrium N. The shock causes a drop in price, making the economy less attractive for both entrant and incumbent firms. More incumbent firms default and fewer potential entrant firms enter. The lower number of active firms has a positive effect on price, but not enough to offset its initial decline.

In the case with zombie credit, the adjustment in aggregate supply through firm exits is hampered as zombie credit keeps some incumbent firms afloat that would otherwise default, which results in a higher number of active firms (each with an exogenously set production scale) and, in turn, a higher aggregate supply. The result is a flatter supply curve S^Z: aggregate supply is elevated compared with the case without zombie credit, leading to a relatively lower equilibrium price level (Z).

Intensive Margin Model. In our intensive margin model, we extend our extensive margin framework by allowing firms to choose their individual production scales.

Now, firms face a negative production shock with some probability. When this shock occurs, the NPV of continuing the production turns negative. The likelihood of this shock increases with the chosen production scale. Distressed firms (i.e., firms with a high operating and/or financial leverage), however, have a positive likelihood of being "bailed out" by their lenders when they experience the negative shock. When being bailed out, these (zombie) firms receive subsidized zombie credit that makes continuing the production economically viable, allowing them to avoid defaulting, which would involve bankruptcy costs. By lowering the expected costs associated with choosing a higher output quantity, zombie credit incentivizes these firms to "overproduce"—lifting aggregate supply also through the intensive margin, in addition to the extensive margin effect (i.e., by keeping zombies afloat).

The elevated aggregate supply, in turn, reduces the equilibrium price, inducing both, zombie and non-zombie firms, to produce less. Zombie credit thus increases aggregate supply, but with asymmetric effects on the individual production scale of zombie and non-zombie firms. It has a strictly negative effect on the scale of non-zombie firms due to the lower equilibrium price, and two opposing effects on the scale of zombies: positive due to the incentive to overproduce and negative due to the lower equilibrium price.

Insights from the Model. Our empirical analysis is in the spirit of Figure 2 and compares equilibrium product prices in markets that—because of the heterogeneity in the prevalence of zombie firms—have a different supply curve. We present this analysis in Section III.

The inner workings of the zombie credit mechanism generate insights beyond the effect on product prices, which provide the basis for our empirical analysis in Section IV and Section V. First, zombie credit reduces firm default rates, thereby increasing the number of active firms. The resulting elevated aggregate production reduces product prices, making the market less attractive to potential entrant firms. Moreover, while the elevated number of active firms reduces sales for individual non-zombie firms, the depressed output prices slightly increase aggregate demand, which leads to relatively higher aggregate sales. As a result, markets with a higher zombie prevalence experience a relatively lower drop in sales growth in response to a negative demand shock. We test these predictions in Section IV.A.

Second, our numerical exercises in Internet Appendix I suggest that, for markets with a high zombie prevalence, the elevated number of active firms and the resulting lower equilibrium price can lead to a higher average idle capacity for individual firms, outweighing the incentive of zombies to overproduce in anticipation of potentially being supported with zombie credit.

We test the effect of zombie credit on idle capacity in Section IV.B.

Third, the mirror image in our model of product prices and zombie credit is the congestion of input markets due to zombie credit. By sustaining the number of active firms and their production, zombie credit increases the aggregate demand for labor and intermediate inputs, thereby raising input costs. We test these predictions in Section IV.C.[8]

Fourth, zombie credit creates negative spillover effects for non-zombie firms; these firms experience lower markups, sales, and profitability as they are forced to share the market demand with zombie firms. We test these spillover effects in Section IV.D.

Finally, the effect of zombie credit on prices should be more pronounced (i) when the zombie share measure relates to the scope of the respective market (i.e., national for nontradable goods and supranational for tradable goods) and (ii) in industries characterized by high fixed costs. The intuition for the latter effect is that zombie credit lowers firms' expected bankruptcy costs associated with sustaining a high fixed costs base and the resulting high optimal production scale. We test these predictions in Section V.

[8]In our theoretical framework, we develop predictions on how zombie credit affects product prices normalized by costs. Our baseline model assumes a form of rigidity on the cost side but can be adapted to a setting where firms set prices for their inputs (i.e., labor and materials). Our framework implies a positive effect of zombie credit on input prices as "too many" firms demand the same input factors.

II. Data and Empirical Work

In this section, we describe our data and our strategy to identify zombies. We test the zombie credit mechanism in the context of the European economy during the 2009-2016 period, which is well-suited to analyze the effect of zombie credit and the associated supply adjustment frictions following a negative demand shock. First, Europe was hit by the global financial crisis and the subsequent sovereign debt crisis. Second, while the U.S. banking system was recapitalized decisively in the aftermath of the 2007-08 financial crisis, the European banking system remained weakly-capitalized after its crises, which led to zombie lending behavior (see, e.g., Acharya et al. (2019)).

II.A. Data

Our core data set combines detailed firm-level and industry-country-level data, as well as product-level inflation data from 2009 to 2016. The firm-level data are financial information, firm characteristics, firm default information, and information about firms' bank relationships from Bureau van Dijk's (BvD) Amadeus database.[9] BvD obtains the data, which is initially collected by local chambers of commerce, through roughly 40 information providers including business registers. Kalemli-Ozcan et al. (2019) shows for selected European countries that Amadeus covers roughly 75-80% of the eco-

[9]The coverage of the Amadeus 2017 version is incomplete before 2009. Amadeus provides the names of the most important relationship banks. We obtain the time-series of the "banker" variable through historic vintages. For some tests, we also include lending relationship information from Refinitiv's DealScan database.

nomic activity reported in Eurostat. Moreover, we obtain industry-country level data on the number of active firms, firm entry and exit rates, labor costs, labor productivity, as well as value added from Eurostat.

The inflation data are also from Eurostat, which provides information for various consumer price indices for all European countries. This data set is very granular as we observe consumer prices at the five-digit COICOP (product category) level. Since the firm data are at the industry (NACE) level, we use COICOP-NACE linking tables to merge these two data sets. More precisely, we use the linking tables to obtain inflation at the industry-country level, by calculating a weighted CPI growth average of all COICOP categories that are related to a NACE (two digits) industry. Consider, for example, the textiles industry (NACE 13). This industry's CPI is a weighted average of the following COICOP categories: (i) clothing, (ii) furniture and furnishings, carpets and other floor coverings, (iii) household textiles, (iv) goods and services for routine household maintenance, and (v) other major durables for recreation and culture. Following the literature, we exclude utilities and financial and insurance industries from the sample.

Our final sample consists of 1,167,460 firms for 12 European countries and 65 industries. The 12 countries are Austria, Belgium, Denmark, Finland, France, Germany, Italy, Poland, Portugal, Slovakia, Spain, and Sweden.[10]

[10]For the other European countries either the inflation data is not reported at a sufficiently granular level or is incomplete, and/or key financial firm data are missing.

II.B. Identifying Zombie Firms

Since our objective is to analyze the effect of zombie credit on prices, we need to identify (i) whether a firm is distressed and (ii) whether it receives subsidized debt financing. Hence, in the spirit of Caballero, Hoshi, and Kashyap (2008) and Acharya et al. (2019), we classify a firm as zombie if it meets the following two criteria that capture these two elements of zombie credit.[11] First, the firm is of low-quality, which we define as having an IC ratio below the median and a leverage ratio above the median, where the medians are calculated at the industry-country-year level.[12] Note that we use a two-year average for the IC ratio criterion to avoid misclassification. Low-quality firms are thus impaired in the sense that they have both operational problems (captured via the IC ratio criterion) as well as a high debt level (captured via the leverage criterion). Second, the firm obtains credit at very low interest rates, i.e., the ratio of its interest expenses relative to the sum of its outstanding loans, credit, and bonds in a given year is below the interest rate paid by its most creditworthy industry peers, namely AAA-rated firms in the same industry and year in our sample.[13] In Section III, we conduct

[11]Also note that, as argued by Caballero, Hoshi, and Kashyap (2008), defining zombies solely based on their operating characteristics would hard-wire a negative correlation between the zombie prevalence in a particular market and the market's average profitability and growth. Adding the borrowing cost criterion allows us to test for the relationship between the zombie prevalence and market-level outcomes.

[12]The firms' IC ratio is defined as EBIT/interest expense and the firms' leverage ratio is defined as (loans + short-term credit + long-term debt)/total assets.

[13]We infer ratings of firms from their IC ratio as in Acharya et al. (2019).

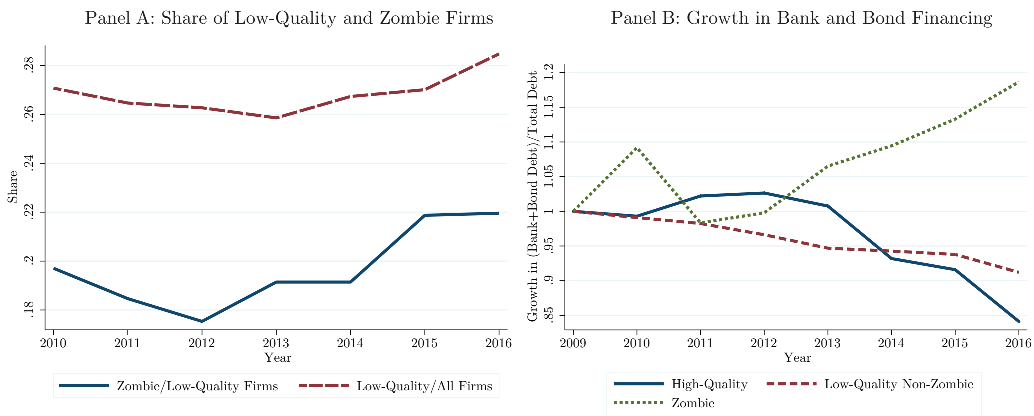

Figure 3. Firm shares and firm financing. Panel A shows the share of zombie firms relative to all low-quality firms (solid line) and the share of low-quality firms relative to all firms (dashed line). Panel B shows the growth rate in bank and bond financing as a fraction of total debt relative to the beginning of our sample period for zombie firms (dotted line), low-quality non-zombie firms (dashed line), and high-quality firms (solid line).

several robustness checks with regard to the zombie firm definition.

Zombie Share. Figure 1 shows that the share of zombie firms in our sample increased from roughly 4.5% to 6.7% between 2012 and 2016 (with a large cross-sectional variation across countries and industries).[14] In Figure 3, we document that this rise of zombie firms is mainly driven by more low-quality firms obtaining credit at very low interest rates and not by firms that already enjoy access to cheap credit deteriorating in quality. Panel A shows that, while the share of low-quality firms remains at roughly 27% during our sample period, the share of zombie firms relative to low-quality firms increased

[14]The standard deviation in the annual growth rate of the zombie share is 7.5%. In Figures IA.7 and IA.8 in the Internet Appendix, we show that alternative zombie definitions yield a similar time-series pattern. Table IA.XII presents summary statistics of the zombie share and the average CPI growth by industry and country.

from 17.5% to 22% between 2012 and 2016. Panel B shows that loans and bonds play an increasingly important role in the funding mix of zombie firms.

Zombie Firm Characteristics. Table I presents descriptive statistics for our sample firms separately for high-quality firms, low-quality non-zombie firms, and zombie firms. Zombie firms are weaker than low-quality non-zombie firms along several observable dimensions. Zombies have on average a lower market-to-book ratio, lower (even negative) IC ratio, lower EBITDA/assets ratio, lower net worth, and higher leverage. The market-to-book ratio of zombie firms is close to one, suggesting that these firms have limited growth prospects. Nevertheless, zombie firms pay extremely low interest rates, even compared with high-quality firms. Given their high leverage and low profitability, zombie firms would have likely had a higher default rate if they had not received subsidized debt.

Importantly, zombie firms are not younger nor more reliant on short-term credit compared with low-quality non-zombie firms, suggesting that our zombie definition does not simply capture early stage companies or companies reliant on short-term debt. The lower debt costs of zombie firms also do not seem to be due to differences in collateral availability as zombies have less tangible assets. Finally, based on syndicated loan data, Acharya et al. (2019) shows that there are also no significant differences between zombie and low-quality non-zombie firms in other loan characteristics like loan size, maturity, or loan type.

Table I. Summary statistics. This table shows descriptive statistics for our sample firms. We split firms into high-quality, low-quality non-zombie, and zombie firms. A firm is classified as low-quality if it has below-median IC ratio and above-median leverage, where medians are calculated at the industry-country-year level. A low-quality firm is classified as zombie if its interest rate paid on its debt financing is lower than the rate paid by AAA-rated industry peers in the same year. The estimation of firm markups is discussed in Internet Appendix II. Material cost is material input cost/turnover. Total assets is measured in thousand euro. Tangibility is fixed assets/total assets. IC Ratio is EBIT/interest expense. Net worth is total shareholders funds and liabilities - current and non current liabilities - cash, divided by assets. Leverage is debt/total assets. Market-to-book is the ratio of a firm's market capitalization to its book value. The last column is a test for the difference between Column (2) and Column (3).

		Low-Quality		
	High-Quality	Non-Zombie	Zombie	
	(1)	(2)	(3)	(2)-(3)
Markup	1.13	1.05	1.01	0.040***
EBITDA/Assets	0.090	0.046	0.014	0.032***
Material Cost	0.424	0.476	0.552	−0.076***
Total Assets (th EUR)	1,617	1,726	1,607	119.0***
Tangibility	0.327	0.312	0.190	0.122***
IC Ratio	4.90	1.01	−0.53	1.540***
Net Worth	0.224	0.107	0.069	0.038***
Leverage	0.161	0.351	0.437	−0.086***
ST Debt/Total Debt	0.337	0.510	0.525	−0.015
Firm Age (years)	17.5	17.3	17.8	−0.500*
Interest Rate	0.028	0.039	0.009	0.030***
Market-to-Book	2.07	1.88	1.03	0.85*

Zombie Firm Performance. Finally, we track the performance of the firms we classify as zombies over time to confirm that these firms are not only temporarily weak, that is, firms that "look weak" based on observable characteristics but that might actually have a promising outlook that allows them to obtain cheap debt financing. In Figure 4, we plot the time-series evolution of leverage and incurred interest rate, where year zero corresponds to the first sample year where the respective firm is classified as zombie.

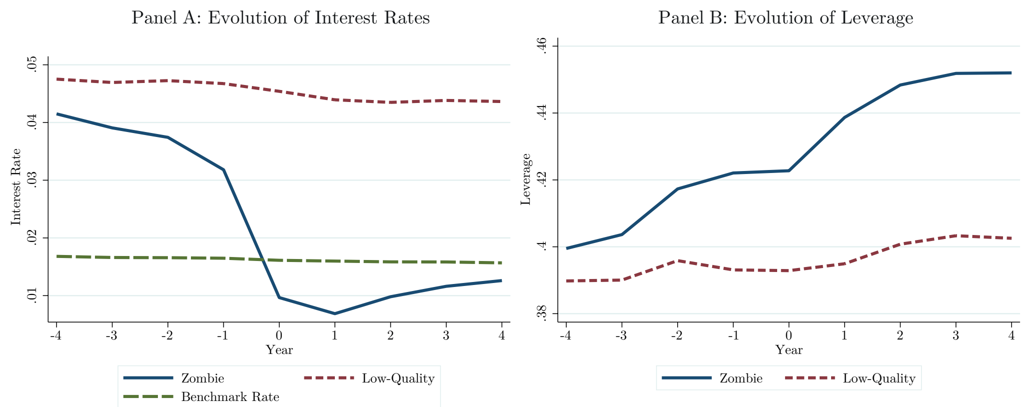

Figure 4. Evolution of leverage and interest rates. This figure shows the evolution of interest rates and leverage for zombie firms. Year 0 corresponds to the first sample year when a firm is classified as zombie. The zombie status can change after year 0, i.e., the zombie condition is not imposed for years 1 to 4. The performance of zombies is compared to a matched sample of low-quality firms. Panel A shows the evolution of asset-weighted interest rates, while Panel B shows the evolution of asset-weighted leverage. The long dashed line in Panel A represents the benchmark interest rate below which debt is classified as subsidized.

Panel A of Figure 4 shows that the average interest rate on outstanding debt paid by zombie firms decreased substantially in the year in which these firms became a zombie, while before their "zombification" these firms had to pay interest rates comparable to the rates incurred by low-quality non-zombie firms. Using syndicated loan data, Acharya et al. (2019) shows that this rate reduction for zombie firms is driven by both, very advantageous interest rates on newly raised debt and renegotiations of the interest rates on pre-existing loans, which then turn the respective low-quality firms into zombies.

Panel B shows that, after becoming zombies, these firms experience a leverage increase. Since zombies have on average a negative IC ratio (even though they benefit from subsidized debt), they are unable to meet their

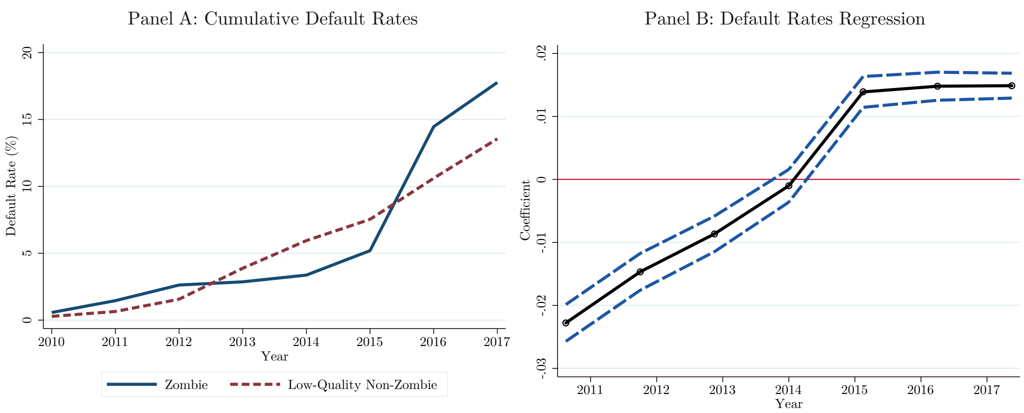

Figure 5. Ex-post firm default rates. Panel A shows the cumulative ex-post default rate of zombie firms (firms that have been zombies continuously since at least 2012) and low-quality non-zombie firms (low-quality non-zombie firms that were never classified as zombies). Panel B shows the coefficients from Specification (1).

current interest payments from their earnings. To avoid default, these firms thus have to raise additional debt (which thanks to zombie credit is cheap) to obtain the liquidity necessary to meet payments on other outstanding loans.

Figure IA.9 shows that zombie firms experience a sharp drop in their sales growth and profitability in the run-up to becoming a zombie firm. While these firms' sales growth temporarily increases after turning into a zombie, their (very low) profitability does not materially improve. The fact that the interest rate paid by zombie firms is not generally lower, but drops exactly at the time when their profitability deteriorates supports the notion that these firms indeed benefit from subsidized interest rates.

In Figure 5, we analyze ex-post defaults, non-parametrically in Panel A and parametrically in Panel B.[15] Panel A shows that the default rate of

[15] For this analysis, we employ the legal status variable from Amadeus (see Acharya et al. (2019)).

zombie firms increased towards the end of the sample period, suggesting that (at least some) zombies were not able to eventually avoid default despite their cheap debt financing. We test this default pattern by estimating, in the subsample of low-quality firms, the following specification separately for every year τ:

$$Default_{ihjt} = \alpha + \beta_\tau \times \mathcal{I}_{t\tau} \times Zombie_{ihjt} + \gamma \times X_{ihjt} + \eta_{hjt} + \epsilon_{ihjt}, \quad (1)$$

where i is a firm, h the country, j the industry, and t the year. $\mathcal{I}_{t\tau}$ is a yearly indicator variable equal to 1 if $t = \tau$ and 0 otherwise and η_{hjt} are industry-country-year fixed effects. The vector X_{ihjt} includes the uninteracted *Zombie* variable as well as other firm characteristics. The coefficient β_τ plotted in Panel B confirms that zombie firms default more often than non-zombie firms towards the end of our sample period.

These figures suggest that zombie firms, even with their subsidized debt financing, still underperformed other firms, including low-quality non-zombie firms. This ex-post evidence validates our zombie measure, suggesting that our measure does not capture only temporarily weak firms that are actually positive NPV projects for the lender. This evidence also rules out that cheap credit is provided due to relationship lending and superior information.

III. Zombie Firms and CPI Growth

In this section, we provide evidence consistent with a negative effect of the presence of zombie firms on inflation. In Section III.A, we presents OLS

Figure 6. Inflation dynamics – Non-parametric evidence. This figure shows inflation (year-over-year CPI growth) at monthly frequency for markets that experienced an above median (High Zombie) and below median (Low Zombie) increase in the asset-weighted share of zombie firms between 2009 and 2014.

estimates documenting a robust negative correlation between the presence of zombie firms and CPI growth. In Section III.B, we conduct an IV estimation to further address potential endogeneity concerns.

We start by providing non-parametric evidence on the correlation, across markets, between the zombie share and CPI growth, our main variable of interest. Figure 6 shows the year-over-year CPI growth for markets with a high (above median) and low (below median) growth of zombie firms. Consistent with the rise of zombies starting in 2012, we see that, beginning in mid-2012, markets with a higher increase in the zombie share experience a stronger decline in CPI growth.[16]

[16] In Figure IA.10, we show that our aggregate CPI growth measure, calculated from our disaggregated market-level CPI data, closely tracks the official CPI growth for our sample countries. The difference becomes even smaller when we exclude "extreme markets," that is, markets that have an absolute value of annual CPI growth of more than 50% (five

III.A. OLS Estimation

We test the effect of zombie credit on CPI growth by estimating the following specification:

$$Y_{hjt} = \beta \times Share\ Zombies_{hjt-1} + \gamma_{ht} + \nu_{jt} + \mu_{jh} + \epsilon_{hjt}, \tag{2}$$

where the unit of observation is country h, industry j, and year t. Y_{hjt} is the annual CPI growth rate. Our key explanatory variable is the lagged (asset-weighted) share of zombie firms in a particular market: $Share\ Zombies_{hjt-1}$. In the most conservative specification, we control for industry-country, country-year, and industry-year fixed effects.

Our fixed effects allow us to isolate the effect of zombie credit on our outcome variables of interest, holding constant the time-varying demand at the industry- and country-level. The country-year fixed effects absorb all shocks at the national level that could affect firms (e.g., country-level demand shocks, changes in tax rates and national regulations). The industry-year fixed effects absorb all shocks at the industry level (e.g., industry-level demand shocks). Industry-country fixed effects control for time-invariant industry-country characteristics.

The estimation results in Panel A of Table II confirm that markets that experience an increase in the share of zombie firms subsequently have lower CPI growth. The estimated coefficient is stable as we add different layers of fixed effects. Based on the estimates in Column (4), a 2.2pp higher *Share*

markets). All regression results are insensitive to whether we include or exclude these five markets, as shown in Table IA.I.

Table II. Prevalence of zombie firms and CPI growth. This table presents estimation results from Specifications (2) and (3). The dependent variable is the annual CPI growth rate (inflation) from $t-1$ to t. *Share Zombies* and *Share Low-Quality* measure the asset-weighted share of zombie firms and low-quality firms in a particular market at $t-1$, respectively. A firm is classified as zombie if it is low-quality and paid advantageous interest rates (see Section II.B for more details). Standard errors are clustered at the industry-country level and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Panel A: Without Quality Control	ΔCPI	ΔCPI	ΔCPI	ΔCPI
Share Zombies	−0.021**	−0.018***	−0.025***	−0.023***
	(0.008)	(0.007)	(0.009)	(0.007)
Observations	3,880	3,880	3,880	3,880
R-squared	0.496	0.732	0.526	0.764
Panel B: Baseline	ΔCPI	ΔCPI	ΔCPI	ΔCPI
Share Zombies	−0.025***	−0.021***	−0.028***	−0.024***
	(0.009)	(0.007)	(0.009)	(0.007)
Share Low-Quality	0.005	0.004	0.004	0.002
	(0.004)	(0.003)	(0.004)	(0.003)
Observations	3,880	3,880	3,880	3,880
R-squared	0.496	0.733	0.526	0.764
Panel C: Placebo	ΔCPI	ΔCPI	ΔCPI	ΔCPI
Share Low-Quality	0.001	0.000	−0.000	−0.002
	(0.004)	(0.003)	(0.004)	(0.003)
Observations	3,880	3,880	3,880	3,880
R-squared	0.495	0.731	0.524	0.763
Country-Industry FE	✓	✓	✓	✓
Year FE	✓			
Industry-Year FE		✓		✓
Country-Year FE			✓	✓

Zombies (i.e., the zombie share increase between 2012 and 2016 shown in Figure 1) is associated with a 5.1bp lower CPI growth.

A potential concern is that the negative correlation between zombie share and CPI growth could be driven by negative demand shocks, which might simultaneously reduce price levels and increase the number of low-quality firms (and, in turn, zombie firms). We address this concern with two sets of tests. First, we additionally control for the average firm quality in each market. Second, we construct more stringent zombie share measures by considering additional criteria that are unrelated to demand effects.

Specifically, for our first test, we add a control for the share of low-quality firms in a particular market to Specification (2):

$$\begin{aligned} Y_{hjt} &= \beta_1 \times \textit{Share Zombies}_{hjt-1} + \beta_2 \times \textit{Share Low-Quality}_{hjt-1} \\ &+ \gamma_{ht} + \nu_{jt} + \mu_{jh} + \epsilon_{hjt}, \end{aligned} \tag{3}$$

where Y_{hjt} is again the annual CPI growth rate. This additional control captures industry-country-year specific factors that affect average firm quality. The results in Panel B of Table II show that the coefficient of *Share Low-Quality* is insignificant and that adding this control has almost no effect on the coefficient of *Share Zombies*.

As a further robustness test, in Table IA.XVI, we employ an alternative low-quality firm measure that includes only firms that are of low-quality but non-zombie (*Share Low-Quality NZ*). While there is a positive correlation between *Share Low-Quality NZ* and CPI growth, including this alternative measure does not materially affect the statistical significance nor the economic magnitude of *Share Zombies*.

Finally, in Panel C of Table II, we conduct a placebo test and substitute *Share Zombies* in Specification (2) with *Share Low-Quality*. Its coefficient remains insignificant.

For our second test, we employ three more stringent zombie classifications where we include additional criteria based on the zombie lending mechanism

Table III. CPI growth – Stringent zombie share measures. This table presents estimation results from Specification (3). The dependent variable is the annual CPI growth rate (inflation) from $t-1$ to t. A firm is classified as zombie if it is low-quality and paid advantageous interest rates (see Section II.B for more details). *Share Zombies (IR)* measures the asset-weighted share of zombie firms in a particular market at $t-1$ where we only consider zombie status changes that occurred due to a switch in the advantageous interest rates criterion. In Columns (2) and (3), we additionally require for the zombie classification that the firm's banks have on average a Tier-1 capital ratio below 9% (Weak Banks). In Column (3), we additionally require for the zombie classification that the firm is only connected to a single bank. All regressions control for the asset-weighted share of low-quality firms. Standard errors are clustered at the industry-country level and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	ΔCPI	ΔCPI	ΔCPI
Share Zombies (IR)	−0.031**		
	(0.014)		
Share Zombies (IR+Weak Banks)		−0.061**	
		(0.027)	
Share Zombies (IR+Weak&Single Banks)			−0.083**
			(0.034)
Observations	3,880	2,080	2,080
R-squared	0.765	0.807	0.805
Country-Industry FE	✓	✓	✓
Industry-Year FE	✓	✓	✓
Country-Year FE	✓	✓	✓

(i.e., subsidized credit from weakly-capitalized banks to non-viable borrowers) that are unlikely affected by demand-side factors. In Table III, Column (1) we only consider changes to the zombie status that occurred due to a *switch* in the advantageous interest rates criterion. Specifically, we do not classify firms as zombies that first received debt at low interest rates (maybe for reasons other than zombie lending), and then turned into a zombie because their quality deteriorated.

In Columns (2) and (3), we further restrict the zombie share measure of

Column (1) to instances where firms are connected to weak banks, that is, banks that have, on average, a Tier-1 ratio below 9% in 2009.[17] In Column (3), we additionally require that the firm is only connected to one bank. Zombie lending incentives should be stronger for these firms as the respective bank does not need to worry that its loan is used to repay another bank.

The magnitudes for these more stringent zombie share measures in Table III are larger than our baseline results in Table II. For the zombie share measure in Column (1), we observe a 1.7pp increase from 2012 to 2016, implying a 5.3bp lower aggregate CPI growth. The measure in Column (2) leads to a 1.25pp zombie share increase from 2012 to 2016, which corresponds to a drop in CPI growth of 7.6bp. For the most stringent zombie share measure in Column (3), we observe a 1.15pp increase from 2012 to 2016, which implies a 9.5bp lower CPI growth.[18]

These results provide further evidence in support of the zombie credit channel and suggest that our estimates are not materially biased by demand-side effects. Moreover, the fact that including more stringent criteria based on the zombie credit mechanism increases the magnitude of the OLS estimate hints towards a reduction in the number of cases where we misclassify

[17] We set the Tier-1 capital ratio threshold to 9% since the European Banking Authority required banks to comply with a minimum 9% ratio by 2012. Measuring capitalization in 2009 rules out that banks are weakly-capitalized because of negative demand shocks during our sample period. Overall, 21% of our banks have a ratio below 9% in 2009.

[18] These magnitudes are consistent with the fact that the majority of zombie firms are linked to banks with a Tier-1 ratio below 9% (56%), only report one banking relationship (72%), and turn into zombies through a switch in the interest rate criterion (70%). These shares are even higher in the 2012-2016 period.

"true" non-zombie firms as zombies relative to our baseline OLS regression. These misclassifications can lead to an underestimation of the true zombie credit effect on CPI growth in our baseline specification since they inflate the zombie share measure, while the misclassified firms do not contribute to the downward pressure on product prices. This evidence thus suggests that our baseline OLS estimate constitutes a lower bound for the effect of zombie credit on CPI growth.

As a further placebo check in the context of Table III, we employ specifications in which we only consider firms that are connected to banks with an average Tier-1 capital ratio of at least 9% and firms that are only connected to multiple banks that have on average a Tier-1 capital ratio above 9%, respectively. We still find a weak effect on CPI growth for the first specification (-0.011^*), but the effect disappears for the latter specification.

Finally, we conduct several robustness checks. First, we show that our results are robust to using alternative zombie classifications (see Table IA.II). In particular, we (i) calculate median values for leverage and IC ratio at the industry-year level instead of the industry-country-year level, (ii) consider solely the IC ratio criterion and solely the leverage criterion instead of both criteria, and (iii) calculate the IC ratio using EBITDA/interest expenses instead of EBIT/interest expenses. Moreover, to mitigate concerns that our zombie classification is influenced by inflation-induced differences in loan rates across countries, we employ an alternative zombie definition that includes a debt cost adjustment for the differential between the inflation of the respective firm's home country and EU-wide inflation.[19]

[19]The cost of providing credit is positively linked to inflation. Hence, when inflation in

Second, our results are robust to employing alternative zombie share measures (see Table IA.III). Specifically, we (i) use a weighting by turnover instead of assets for the zombie share calculation and (ii) account for the potential non-linear effect of zombies on inflation by setting the value of *Share Zombies* to zero if it is below 5% or 2%, respectively.

Third, our results do not materially change if we drop one country or industry at a time (Figure IA.11). Fourth, we show that the zombie credit mechanism can also be observed when we measure price changes with the PPI instead of the CPI (Table IA.XV, Column 1). Fifth, we find that the effect of a higher zombie share on CPI growth is driven by borrowers with a single lender (Table IA.IV), which is consistent with the zombie credit mechanism. Sixth, in Internet Appendix VIII, we show that our results are not explained by alternative supply-side channels.

III.B. IV Estimation

To address potential omitted variable biases and, in particular, to further rule out that the negative correlation between the presence of zombie firms and CPI growth is driven by demand effects, we run an IV regression. To this end, we focus on the zombie lending incentives of weakly-capitalized banks as a predictor for the increase in zombie prevalence. By extending subsidized loans to non-viable borrowers, weakly-capitalized banks can avoid regulatory repercussions and gamble for resurrection (see, e.g., Bruche and

a country decreases, loan rates might follow, which can mechanically increase the zombie share in that country since its firms have a higher likelihood of paying interest rates below the benchmark rate relative to firms in other countries.

Llobet (2014), Homar and van Wijnbergen (2017), Begenau et al. (2023), and Acharya, Lenzu, and Wang (2022)).

Section III.B.1 explains our Bartik-style shift-share instrument. Section III.B.2 presents the estimation results. Section III.B.3 presents validity and diagnostic tests. Section III.B.4 presents a counterfactual exercise to assess the economic magnitude of the zombie credit channel.

III.B.1. Setup

We use a Bartik-style shift-share instrumental variable approach (Bartik, 1991), where we instrument a market's zombie share with the product between the weighted Tier-1 capital ratio in 2009 of banks connected to the firms in this market (weighted by the banks' number of firm relationships) and country-level loan growth (obtained from the ECB data warehouse). Formally, our Bartik instrument is:

$$\tilde{B}_{hjt} = \sum_{b} \left[m_{bhj,2009} \times \text{Tier-1 ratio}_{b,2009} \times \text{Loan Growth}_{ct} \right], \tag{4}$$

where $m_{bhj,2009}$ denotes the number of bank relationships of firms in market hj (industry j in country h) to bank b in 2009 divided by the total number of bank relationships in 2009 of market hj. Tier-1 ratio$_{b,2009}$ is bank b's Tier-1 ratio in 2009, while Loan Growth$_{ct}$ is the aggregate loan growth in bank b's country of incorporation c at time t.

The logic behind our shift-share instrument is that the average health of banks connected to firms in the respective markets differs across markets at the beginning of the sample period, and markets linked to weakly-capitalized banks are more likely to see an increase in zombie lending when the macroeconomic conditions decline.[20]

Our instrument gets all of the cross-sectional variation in the exposure to weak banks from pre-existing lending shares, and all of its time-series variation from country-level bank health shocks. The instrument thus brings additional information even with the inclusion of industry-country, industry-year, and country-year fixed effects because it has both variation across markets and over time. Although the weights could reflect unobserved differences across industry-country pairs, this heterogeneity does not vary with time and is thus controlled for by the industry-country fixed effects.

A key identification assumption is that the variation in initial bank capital is unrelated to variation in the prevalence of zombie firms. We believe this assumption is met in our empirical context for three reasons. First, the share of zombie firms was rather low in 2009 for most European countries (see, e.g., McGowan, Andrews, and Millot (2018), Helmersson et al. (2021), and Banerjee and Hofmann (2022)) and zombie firms were thus not a major factor in 2009. The European economy experienced a significant increase in zombie firms only after 2009 (see Figure 1). Second, the variation in equity capitalization across European banks in 2009 was largely driven by their exposure to the U.S. housing market and the associated losses incurred, for example, on mortgage-backed securities and due to off-balance sheet vehicles. Hence, banks' capitalization in 2009 was mainly determined by factors unrelated to their corporate lending. This observation is also reflected in the relatively

[20] Acharya et al. (2019) shows that banks' Tier-1 capital ratio is a good predictor for zombie lending.

low non-performing loan levels of European banks in 2009 (see, e.g., Huljak et al. (2020)). Third, Table IA.XIV shows that there is no significant relationship between bank composition in 2009 (i.e., bank shares across different markets) and market characteristics.

We use the country-level loan growth as proxy for time-varying shocks to the banking sector health since there is ample evidence that a drop in loan supply is a strong indicator for a stressed banking sector (for the European context see, e.g., Bofondi, Carpinelli, and Sette (2018), Balduzzi, Brancati, and Schiantarelli (2018), Acharya et al. (2018b), De Marco (2019), and Blattner, Farinha, and Rebelo (2023); for the U.S. see, e.g., Ivashina and Scharfstein (2010), Cornett et al. (2011), and Chodorow-Reich (2014)).

III.B.2. Estimation Results

Table IV presents the results for the IV specification. In our preferred specification, we determine bank-firm relationships using both Amadeus and DealScan (Column 1). As a robustness check, we redo our analysis using bank-firm relationships (i) solely from Amadeus (Column 2) and (ii) from DealScan for Italy (Amadeus does not have bank-firm relationships for Italy) and from Amadeus for other countries (Column 3).[21]

The first stage, shown in Panel B, explains the share of zombie firms at

[21] Given that Amadeus does not report the firms' main banks for all countries, our sample size decreases when focusing on Amadeus data only. Whenever available, we can augment firm-bank links using syndicate loan data from DealScan. Still, in some industry-country pairs syndicated lending is quite rare. As a result, our overall sample size is lower for our IV estimation.

Table IV. Instrumental variable estimation. This table presents the estimation results from the IV specification. The first stage results are shown in Panel B and the second stage results in Panel A. The dependent variable in the second stage is the annual CPI growth rate (inflation). *Share Zombies* measures the asset-weighted share of zombie firms at $t-1$. *Tier-1 2009* measures the Tier-1 ratio of the banks linked to the firms in the particular market in 2009. *Loan Growth* measures the annual loan growth rate at the country-level of the bank's country of incorporation. Bank relationships are determined using Amadeus and DealScan in Column (1), solely Amadeus in Column (2), as well as Amadeus plus DealScan for Italian firms in Column (3). Standard errors are clustered at the industry-country level and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Panel A: Second Stage	ΔCPI	ΔCPI	ΔCPI
$\widehat{\textit{Share Zombies}}$	−0.122**	−0.105**	−0.130**
	(0.051)	(0.048)	(0.053)
Observations	2,080	1,839	2,080
Panel B: First Stage	Share Zombies	Share Zombies	Share Zombies
Tier-1 2009 × Loan Growth	−10.05***	−13.85***	−9.97***
	(2.37)	(3.21)	(2.37)
F-Test	30.8	37.4	30.7
Observations	2,080	1,839	2,080
R-squared	0.687	0.691	0.687
Sample	Amadeus + DealScan	Amadeus Only	Amadeus + DealScan Italy
Country-Industry FE	✓	✓	✓
Industry-Year FE	✓	✓	✓
Country-Year FE	✓	✓	✓

time $t-1$ in a particular market (*Share Zombies*) using its weighted *Tier-1 2009* × *Loan Growth* from Eq. (4), where the loan growth is measured from $t-2$ to $t-1$, controlling for a stringent set of fixed effects. The instrument always has a negative and significant effect on *Share Zombies*. The F-statistic ranges between 30.7 and 37.4, while the p-value is always below 0.01, confirming the strength of the instrument.

In the second-stage estimation, shown in Panel A, we replace the *Share*

Zombies with the predicted $\widehat{Share\ Zombies}$ from the first stage. The IV estimated coefficients confirm the negative effect of an increase in the prevalence of zombie firms on CPI growth, alleviating concerns that our effect might be driven by an omitted variable bias. In Table IA.V, we show that our results are robust to using the country-level growth in non-performing loans (NPLs) as a proxy for country-level shocks to the health of the banking sector instead of the aggregate loan growth.[22]

Comparing the magnitudes across our OLS and IV estimations shows that, while the coefficients based on the more stringent zombie classifications are larger than the baseline OLS estimates, they are still smaller than our IV estimates. The remaining differences between the OLS and IV estimates are likely due to a deviation between the average treatment effect (ATE) from our OLS estimation and the local average treatment effect (LATE) from our IV estimation. Specifically, our diagnostic tests (see Section III.B.3) indicate that our IV results are driven by a subset of banks, that is, weakly-capitalized large banks. While collectively these banks are exposed to 90% of all industry-country pairs in our sample, the weighting of their industry-country exposure differs from the exposure of the average bank in our sample. Moreover, the results in Section V show that the effect of zombie credit on CPI growth differs across markets (e.g., high vs. low fixed cost sectors, tradable vs. nontradable goods). Therefore, the LATE estimated with our IV approach does not necessarily coincide exactly with the estimate of the

[22]Specifically, the first stage explains $Share\ Zombies_{t-1}$ in a particular market with the market's weighted *Tier-1 2009* × *(-NPL Growth)*, where the *NPL Growth* is measured from $t-2$ to $t-1$. We obtain data about the NPL growth from the ECB data warehouse.

ATE from our OLS specification.

In sum, our evidence suggests that the coefficient is between -0.024 and -0.13, where our baseline OLS estimates mark the lower end and the IV estimates the upper end of this range.

III.B.3. Validity

In this section, we further assess the validity of our zombie classification, instrument, and the identification assumptions of our Bartik IV approach.

Instrument and Zombie Firm Classification. Building on the theoretical insights from Section I, we first further check the plausibility of our instrument and zombie firm classification by investigating whether the first stage estimates show a more pronounced link between bank health and zombie prevalence in markets that are more prone to zombie lending.

Specifically, when our instrument and zombie classification are well-designed, we should see a stronger effect for markets that, in addition to being connected to weak banks, are depressed and/or more uncertain.[23] Moreover, the effect should be more pronounced when banks face a more lenient supervisor, for example one that does not require them to write-off NPLs. Accordingly, we rerun the first stage of the IV specification (i.e., regressing the zombie share on our Bartik instrument) separately for depressed and non-

[23] A higher market uncertainty lowers the NPV of the firms' operating profits (which increases the number of zombie candidates) as risk-averse investors drive a higher discount rate, while a wider distribution of possible outcomes still allows for high payoff outcomes, increasing the attractiveness of gambling-for-resurrection.

Table V. First stage – Splits. This table presents the estimation results from the first stage of the IV specification. In Panel A, we split markets into non-depressed markets (high health) and depressed markets (low health) as well as into markets with a high and low degree of uncertainty in 2011 (i.e., at the beginning of the zombie share increase). In Panel B, we split markets according to whether the respective supervisory intensity measure, *Supervisory Powers* or *Asset Classification*, is high or low. *Share Zombies* measures the asset-weighted share of zombie firms at $t-1$. *Tier-1 2009* measures the Tier-1 ratio of the banks linked to the firms in the particular market in 2009. *Loan Growth* measures the annual loan growth rate at the country-level of the country where the bank is incorporated. Bank relationships are determined using Amadeus and DealScan. Standard errors clustered at the industry-country level reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	Health		Uncertainty	
	(high)	(low)	(low)	(high)
Panel A: Market Conditions	Share Zombie	Share Zombie	Share Zombie	Share Zombie
Tier-1 2009 × Loan Growth	−4.13**	−12.84**	−5.76**	−11.80***
	(1.95)	(5.32)	(2.64)	(3.51)
Observations	1,019	1,061	1,058	1,022
R-squared	0.739	0.591	0.647	0.714

	Supervisory Powers		Asset Classification	
	(high)	(low)	(high)	(low)
Panel B: Bank Supervision	Share Zombie	Share Zombie	Share Zombie	Share Zombie
Tier-1 2009 × Loan Growth	−4.82**	−15.69***	−5.40**	−14.57***
	(2.01)	(5.02)	(2.57)	(3.59)
Observations	1,216	864	1,061	1,019
R-squared	0.689	0.789	0.569	0.741
Country-Industry FE	✓	✓	✓	✓
Industry-Year FE	✓	✓	✓	✓
Country-Year FE	✓	✓	✓	✓

depressed markets, high and low uncertainty markets, and countries with a high and low intensity of bank supervision.[24]

To rank markets according to their health at the end of 2011 (i.e., at

[24]For this analysis, we employ our preferred instrument specification, in which we determine bank-firm relationships using both Amadeus and DealScan.

the beginning of the zombie share increase), we calculate the change in value added at the industry-country level from 2007 (last pre-crisis year) to 2011. We then split markets at the median of their value added changes into depressed (low health) and non-depressed (high health) markets. Before conducting this split, we account for the fact that the relevant market for nontradable goods is likely national, while it extends beyond national borders for tradable goods. Accordingly, we average the value added change for tradable sectors across all EU countries before conducting the split, where we follow Mian and Sufi (2014) to distinguish between tradable and nontradable sectors.[25] To separate markets into high and low uncertainty markets, we split them at the median of their cross-sectional standard-deviation of sales growth in 2011 (in spirit of Bloom et al. (2018)), again adjusting for the market scope of tradable sectors.

Panel A of Table V confirms that the link between a market's exposure to weak banks and its subsequent change in the zombie prevalence is indeed more pronounced in markets that are depressed and markets that have a higher uncertainty.

To split markets into high and low bank supervisory intensity, we employ data from the World Bank Bank Regulation and Supervision Survey. This database provides information on bank regulation and supervision for 143 jurisdictions, including all our sample countries. We use data from the fol-

[25] Mian and Sufi (2014) defines a four-digit NAICS industry as tradable if its imports plus exports are at least $10,000 per worker, or if total exports plus imports for the NAICS four-digit industry exceed $500M. Nontradable industries are defined as the retail sector and restaurants.

lowing two survey topics: "Asset classification mechanisms" (which includes questions such as "*Do you require banks to write off non-performing loans after a specific time period?*") and (ii) "Supervisory powers in cases of bank losses" (which includes questions such as "*Please indicate whether the supervisory agency can require banks to constitute provisions to cover actual or potential losses*"). For each topic, we code the yes/no responses as 1/0 and compute the mean per category for each country. We explain the variable construction in detail in Internet Appendix VI.

We then conduct two splits in which we separate markets with an above and below median value of our bank supervisory intensity measures: *Supervisory Powers* (proxy for the supervisory powers in cases of bank losses) and *Asset Classification* (proxy for the strictness of the asset classification mechanisms). Table V, Panel B shows that zombie lending is indeed more prevalent in countries with more lenient bank supervision.[26]

Taken together, our evidence confirms that the relation between a market's exposure to weak banks and its zombie prevalence is stronger in markets that are more prone to zombie lending, supporting the plausibility of our instrument and zombie classification.

Bartik IV Approach. To further assess the identification assumptions of our Bartik IV approach, we conduct a set of diagnostic tests outlined in Goldsmith-Pinkham, Sorkin, and Swift (2020). We discuss these tests in

[26]This result is in line with the evidence from existing studies on the relationship between supervisory intensity and zombie lending behavior, such as Kulkarni et al. (2021) for India, Angelini et al. (2021) for Italy, and Bonfim et al. (2023) for Portugal.

detail in Internet Appendix V and summarize the main conclusions in the following.

Goldsmith-Pinkham, Sorkin, and Swift (2020) shows that the Bartik IV approach is equivalent to using a weighted average of a set of instruments based on cross-sectional shares, with weights based on time-varying aggregate shocks. In our setting, the instruments are each market's "exposure" to banks (and their respective capitalization) in 2009 and the weights are the aggregate loan growth shocks in bank b's country of incorporation at time t.

First, we perform a Rotemberg decomposition of our Bartik IV estimator. The Rotemberg weights tell us how sensitive the overall estimator is to a potential misspecification of individual instruments. Panel A of Table IA.XIII shows that the sum of the negative and positive Rotemberg weights are -0.516 and 1.516, respectively.

The existence of negative Rotemberg weights raises the possibility of (but does not necessarily imply) nonconvex weights on market-specific parameters (β_{hj}). In this case the overall Bartik estimate would not have a LATE-like interpretation as a weighted average of treatment effects (note that weights on β_{hj} cannot be directly estimated). A higher variation in the $\hat{\beta}_b$ increases the likelihood of negative weights on β_{hj}. Naturally, in our setting, there is some variation in the $\hat{\beta}_b$ across banks. Banks differ with respect to their exposures to different markets, and, as shown in Section V, the effect of zombie credit on CPI growth depends on market characteristics.

In a second step, we thus probe the patterns of this heterogeneity by visualizing the distribution of the just identified IV estimates (i.e., the $\hat{\beta}_b$). Figure IA.14 shows that there is some dispersion around the Bartik $\hat{\beta}$, but banks with larger Rotemberg weights tend to be close to the overall point estimate. Moreover, none of the high-powered banks have negative Rotemberg weights, mitigating concerns about potentially negative weights on β_{hj}.

Third, we use the Rotemberg decomposition to investigate the drivers of our IV estimates. Panel B of Table IA.XIII shows that the Rotemberg weights ($\hat{\alpha}_b$) are correlated with the variation in the bank shares across markets ($\text{var}(Share_{hjb})$), suggesting that the variation in bank relationships is driving our estimates. Panel D presents summary statistics for the banks with the highest Rotemberg weights, showing that our IV estimates are driven by weakly-capitalized large banks. These findings are consistent with the zombie credit mechanism.

Finally, we check whether there is variation that could be a concern for the exclusion restriction. Table IA.XIV shows that there is no problematic relationship between bank composition in 2009 (i.e., bank shares across different markets) and market characteristics, specifically, output, intermediate consumption, wages, and consumption of fixed capital.

III.B.4. Counterfactual

In Europe, political constraints led to a hesitant introduction of recapitalization measures in the aftermath of the 2008 global financial crisis (see Acharya et al. (2018a)), which led to zombie lending incentives (see Acharya et al. (2019), Schivardi, Sette, and Tabellini (2022), and Blattner, Farinha, and Rebelo (2023)). We can use our IV estimate to determine the evolution of the CPI growth in the hypothetical case where important banks in need of capital entered our sample period with a higher capital buffer.

For this counterfactual exercise, similar in spirit to the approach in Chodorow-Reich (2014), we "recapitalize" banks with a Tier-1 capital ratio below X% in 2009 to:

$$\textit{Tier-1 ratio}^{C}_{b,2009} = X\%,$$

where we employ the thresholds $X = 9\%$ and 10%, respectively. Accordingly, we obtain the counterfactual value of our Bartik instrument as:

$$B^{C}_{hjt} = \sum_{b} \left[m_{bhj,2009} \times \text{Tier-1 ratio}^{C}_{b,2009} \times \text{Loan Growth}_{ct} \right],$$

which allows us to calculate the counterfactual zombie share:

$$\begin{aligned}&\textit{Share Zombies}^{C}_{hjt} = \textit{Share Zombies}^{C}_{hjt-1} + \\ &[\textit{Share Zombies}_{hjt} \textit{Share Zombies}_{hjt-1}] + \left[\widehat{\beta}_B \times \left(B^{C}_{hjt} - B_{hjt} \right) \right].\end{aligned}$$

Specifically, we accumulate the differences for each industry-country pair over time between the actual and the counterfactual zombie share that are induced by the higher counterfactual bank capitalization. We set the counterfactual zombie share to zero for negative values of $\textit{Share Zombies}^{C}_{hjt}$ since in practice the share of zombie firms cannot be negative. We then calculate the counterfactual CPI growth for each market as:

$$\textit{CPI Growth}^{C}_{hjt} = \textit{CPI Growth}_{hjt} + \left[\widehat{\beta}_S \times \left(\textit{Share Zombies}^{C}_{hjt} - \textit{Share Zombies}_{hjt} \right) \right].$$

In a final step, we calculate the weighted sum (using Eurostat CPI weights) of the market-level counterfactual CPI growth to the aggregate counterfactual

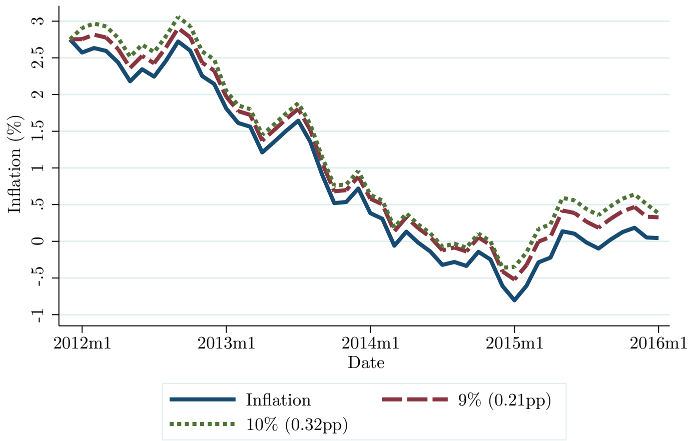

Figure 7. CPI growth counterfactual. This figure shows the actual CPI growth in our sample and two counterfactual CPI growth rates. The counterfactual inflation rates are measured as the CPI growth that would have prevailed from 2012 to 2016 if weakly-capitalized banks entered our sample period with a higher Tier-1 ratio. Specifically, we consider the cases where banks with a Tier-1 ratio below 9% and 10% in 2009, respectively, are recapitalized to the respective threshold value. For each counterfactual, the label includes the respective share of markets that would have become zombie-free, as well as the average spread between the actual CPI growth and the counterfactual CPI growth.

CPI growth.

Figure 7 plots the results for this counterfactual exercise for the period characterized by a significant increase in the zombie share (i.e., 2012 to 2016; see Figure 1). The solid line is the observed CPI growth and the thin dashed lines are counterfactual CPI growth rates for recapitalization thresholds of 9% and 10%, respectively. The figure shows that the annual CPI growth would have been on average 0.21pp higher for the 9% recapitalization threshold and 0.32pp higher for the 10% threshold between 2012 and 2016. Figure IA.12 and Figure IA.13 show the sensitivity of these counterfactuals to more stringent zombie definitions.

There are two caveats to our counterfactual exercise. The first caveat relates to the fact that we use a partial equilibrium analysis with a focus on supply-side factors. However, a higher bank capitalization and, in turn, less zombie lending likely affects CPI growth also through the demand channel. At least in the medium-term, a more efficient capital allocation would likely lead to higher firm investment and household income levels (see, e.g., Jiménez et al. (2017) and Célérier et al. (2018)), which would push the CPI growth further upwards. Hence, in a general equilibrium framework, raising bank capital might induce an even higher counterfactual CPI growth compared to our partial equilibrium counterfactual.

The second caveat relates to how bank capitalization is raised, that is, whether the recapitalization measure requires banks to increase their equity capital, or just their equity to risk-weighted assets ratio. Specifically, recapitalization measures that require banks to increase their risk-weighted capital ratio, like the capital exercise conducted in 2012 by the European Banking Authority, can have unintended consequences. As shown in Gropp et al. (2019), banks tend to respond to higher risk-weighted capital requirements mainly by lowering their risk-weighted assets (i.e., by decreasing their loan supply), as opposed to an increase in their equity capital. This loan volume reduction potentially affects CPI growth also through the demand channel due to the resulting decrease in investment activity and sales growth of affected borrowers. It is also not obvious whether the affected banks would dial back their loan supply more strongly for zombie or non-zombie firms.

Our counterfactual exercise is more applicable to a recapitalization program that requires a capital increase in absolute terms, such that the increase in the capital ratio we consider in the counterfactual exercise is driven by an increase in the numerator of the bank's capital ratio. A good example for such a program is the Supervisory Capital Assessment Program (SCAP) in the U.S., which stated the banks' capital shortages in absolute terms.

IV. Equilibrium Predictions

In this section, we show evidence consistent with the insights of our theoretical framework about the inner workings of the zombie credit channel.

Specifically, employing our baseline Specification (3), we show that a higher zombie prevalence is associated with (i) lower default and entry rates, as well as a higher number of active firms and sales growth (Section IV.A); (ii) a higher average idle productive capacity (Section IV.B); as well as, (iii) lower firm markups and higher average input costs (Section IV.C). Moreover, in Section IV.D, we show that an increase in the share of zombie firms leads to negative spillover effects for non-zombie firms, that is, these firms have lower markups, profitability, and sales growth, as well as higher input costs. In Table IA.VI, we report the mean and standard deviation for our equilibrium prediction outcome variables.

IV.A. Active Firms, Default, Entry, and Sales Growth

In this section, we test the prediction of the zombie credit channel that more zombie credit is associated with lower default and entry rates, as well as a higher number of active firms and higher aggregate sales growth.

Table VI shows the estimation results. Using our most conservative spec-

Table VI. Number of active firms, firm defaults, firm entry, sales growth. This table presents estimation results from Specification (3). The dependent variable is the change in the number of firms (Panel A), the share of firm exits (Panel B), the share of firm entries (Panel C), and aggregate sales growth (Panel D). *Share Zombies* measures the asset-weighted share of zombie firms in a particular market at $t-1$. A firm is classified as zombie if it is low-quality and paid advantageous interest rates (see Section II.B for more details). All regressions control for the asset-weighted share of low-quality firms. Standard errors are clustered at the industry-country level and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Panel A	ΔActive Firms	ΔActive Firms	ΔActive Firms	ΔActive Firms
Share Zombies	0.064***	0.074***	0.065***	0.075***
	(0.023)	(0.025)	(0.019)	(0.020)
Observations	3,844	3,844	3,844	3,844
R-squared	0.475	0.529	0.625	0.675
Panel B	Default	Default	Default	Default
Share Zombies	−0.016**	−0.019**	−0.017**	−0.020**
	(0.007)	(0.009)	(0.007)	(0.008)
Observations	3,626	3,626	3,626	3,626
R-squared	0.828	0.842	0.872	0.885
Panel C	Entry	Entry	Entry	Entry
Share Zombies	−0.024**	−0.026**	−0.021**	−0.021**
	(0.010)	(0.012)	(0.010)	(0.011)
Observations	3,824	3,824	3,824	3,824
R-squared	0.825	0.846	0.874	0.895
Panel D	Sales Growth	Sales Growth	Sales Growth	Sales Growth
Share Zombies	0.144**	0.183***	0.161**	0.193***
	(0.070)	(0.070)	(0.069)	(0.067)
Observations	3,894	3,894	3,894	3,894
R-squared	0.200	0.289	0.410	0.496
Country-Industry FE	✓	✓	✓	✓
Year FE	✓			
Industry-Year FE		✓		✓
Country-Year FE			✓	✓

ification in the last column, the estimate in Panel A suggests that an increase in the share of zombie firms by 2.2pp (i.e., the observed zombie share increase from 2012 to 2016) is associated with a 16.5bp larger change in the number of active firms. Moreover, the results in Panels B and C show that a 2.2pp zombie share increase is associated with a 4.4bp and 4.6bp lower share of firm entries and exits, respectively.[27] These findings are consistent with the evidence in Bertrand, Schoar, and Thesmar (2007), that shows that inducing banks to quit zombie lending leads to an increase in firm entry and exit rates.

Moreover, Panel D shows that a 2.2pp higher zombie share is associated with a 42bp higher aggregate sales growth. This finding provides further evidence that our results are not driven by a drop in demand and a subsequent deterioration in firm quality as this demand channel would predict *lower* sales growth in markets with a high zombie prevalence.

IV.B. Capacity Utilization

In this section, we analyze whether the zombie-induced congestion leads to a higher average idle productive capacity in the affected markets. Zombie credit elevates aggregate supply through both the survival of zombie firms and their overproduction, reducing the equilibrium price and, in turn, inducing zombie and non-zombie firms to reduce their production. Our model in Internet Appendix I shows that this effect can outweigh the higher individual production level of zombie firms (due to the incentive to overproduce induced by zombie lending), leading to a higher aggregate production and a higher

[27]Note that the entry and default variables provided by Eurostat only capture "the creation or dissemination of production factors if no other enterprises/units are involved in the event." Hence, the number of active firms can change for various additional reasons that are not captured by the entry and exit variable. Table IA.VII confirms that our results are robust to calculating firm default rates using Amadeus data.

Table VII. Capacity utilization. This table presents estimation results from Specification (3). The dependent variable is the idle productive capacity as percentage of full capacity. *Share Zombies* measures the asset-weighted share of zombie firms in a particular market at $t-1$. A firm is classified as zombie if it is low-quality and paid advantageous interest rates (see Section II.B for more details). All regressions control for the asset-weighted share of low-quality firms. Standard errors are clustered at the industry-country level and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	Idle Capacity	Idle Capacity	Idle Capacity	Idle Capacity
Share Zombies	5.042**	6.639***	4.924*	6.639***
	(2.469)	(2.392)	(2.536)	(2.478)
Observations	2,409	2,409	2,409	2,409
R-squared	0.781	0.825	0.799	0.843
Country-Industry FE	✓	✓	✓	✓
Year FE	✓			
Industry-Year FE		✓		✓
Country-Year FE			✓	✓

average idle capacity at the same time.

We obtain information about capacity utilization by country and industry (NACE 2-digits) from the EU's "Business and consumer surveys." These harmonized EU-wide surveys are conducted using a representative firm sample at the industry-country level and published on a monthly/quarterly basis by the "Directorate General for Economic and Financial Affairs" (DG ECFIN). These surveys provide data on capacity utilization (as percentage of full capacity) of European firms on a quarterly basis. We build our idle capacity variable using the following survey question: *"At what capacity is your company currently operating (as a percentage of full capacity)?"*

Table VII shows the estimation results, where the dependent variable, *Idle Capacity*, is calculated as 100%-(capacity utilization as % of full capacity). Across all fixed effects specifications, we find that the prevalence of zombie firms in a particular market is positively correlated with the average idle productive capacity of the firms in the same market. The estimates in Column (4) imply that a 2.2pp increase in the share of zombie firms is associated with a 14.6bp increase in the idle capacity. Recall that a zombie share increase of 2.2pp is associated with a 5.3bp lower CPI growth (see Table II, Panel B). Putting these two magnitudes into perspective shows that, per 1pp increase in idle capacity, we observe a change in CPI growth of -0.36pp (-5.3bp/14.6bp), which lines up well with the recent evidence on the Phillips curve. For example, using cross-sectional data, Hazell et al. (2022) and Hooper, Mishkin, and Sufi (2020) estimate for the U.S. price-Phillips curve a negative slope with a point estimate of -0.34 and between -0.301 and -0.441, respectively.

IV.C. Markup and Input Costs

In this section, we analyze whether the zombie congestion results in lower markups and higher input costs. Lower markups are the equilibrium outcome of the higher supply of products in markets with a high zombie share. Higher input costs are the equilibrium outcome of the higher demand for labor and intermediate inputs in these markets.

Table VIII shows the estimation results. In Panel A, the dependent variable is the change in markups (price over marginal costs). We measure markups following De Loecker and Warzynski (2012) and De Loecker, Eeckhout, and Unger (2019), that is, we rely on optimal input demand conditions obtained from standard cost minimization to determine markups for each firm (we explain this approach in detail in Internet Appendix II).[28] In Panels B and C, the dependent variables are material costs and labor costs, measured as material cost/turnover and with the Eurostat's labor cost index, respectively.[29]

The estimation results confirm that a higher zombie prevalence is associated with lower markups and higher material costs. Interestingly, the positive correlation between the presence of zombie firms and labor costs only exists for markets with a high job vacancy rate, where *High Vacancy* is a dummy equal to one for industries with an above median job vacancy rate.[30] The insignificant coefficient for *Share Zombies* suggests that the relatively higher average labor cost for (some) zombie markets is indeed induced by a larger number of active firms and the resulting higher labor scarcity.

The estimates in the last column of Table VIII imply that a 2.2pp zombie share increase is associated with a 16bp decrease in markups, a 10bp increase in material costs, and a 30bp increase in the labor cost index for markets with

[28]This approach has the advantage that it only requires firms' financial statements information and no assumptions on demand and on how firms compete. Following De Loecker, Eeckhout, and Unger (2019), we aggregate firm markups in the respective market using firms' turnover as weight.

[29]The Eurostat's labor cost index is designed to capture the labor cost pressure. It is calculated dividing the labor cost by the number of hours worked. Importantly, the labor cost index is provided at less granular industry classifications, which leads to a significant reduction in the number of observations.

[30]The job vacancy rate is calculated from Eurostat's job vacancy statistics and is defined as the number of job vacancies as a percentage of the sum of the number of occupied posts and job vacancies.

Table VIII. Markups and input costs. This table presents estimation results from Specification (3). The dependent variables are the turnover-weighted change in markups from $t-1$ to t (Panel A), the industry material cost (material input cost/turnover, Panel B), and the industry labor cost (Eurostat's labor cost index, Panel C), respectively. *High Vacancy* is a dummy equal to one for industries with above median job vacancy rate. *Share Zombies* measures the asset-weighted share of zombie firms in a particular market at $t-1$. A firm is classified as zombie if it is low-quality and paid advantageous interest rates (see Section II.B for more details). All regressions control for the asset-weighted share of low-quality firms. Standard errors are clustered at the industry-country level and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Panel A	ΔMarkup	ΔMarkup	ΔMarkup	ΔMarkup
Share Zombies	−0.077***	−0.071***	−0.076***	−0.073***
	(0.023)	(0.025)	(0.023)	(0.026)
Observations	3,261	3,261	3,261	3,261
R-squared	0.133	0.272	0.157	0.296
Panel B	**Material Cost**	**Material Cost**	**Material Cost**	**Material Cost**
Share Zombies	0.053**	0.051**	0.048**	0.046**
	(0.022)	(0.023)	(0.023)	(0.023)
Observations	3,701	3,701	3,701	3,701
R-squared	0.943	0.951	0.945	0.953
Panel C	**Labor Cost**	**Labor Cost**	**Labor Cost**	**Labor Cost**
Share Zombies	0.015	0.006	0.004	−0.008
	(0.022)	(0.024)	(0.024)	(0.027)
High Vacancy	−0.002	0.003	−0.007*	−0.003
	(0.004)	(0.004)	(0.004)	(0.004)
Share Zombies	0.095***	0.124***	0.110**	0.138***
× High Vacancy	(0.036)	(0.043)	(0.043)	(0.052)
Observations	922	922	922	922
R-squared	0.259	0.360	0.397	0.500
Country-Industry FE	✓	✓	✓	✓
Year FE	✓			
Industry-Year FE		✓		✓
Country-Year FE			✓	✓

a high job vacancy rate. Our results on the effect of an increase in the zombie share on CPI and PPI growth (Table II and Table IA.XV) suggest that the negative effect of the zombie credit mechanism on markups dominates its positive effect on input costs, pushing product prices downwards.

Consistent with these findings, we confirm in Internet Appendix VII, using PPI data from Eurostat and input-output tables from the World Input-Output Database (WIOD), that the zombie credit mechanism affects prices along the supply chain. First, we show that a zombie share increase in supplier industries decreases prices for goods that these industries sell to customer industries. Second, we show that a higher zombie prevalence in a particular customer industry leads to higher prices for goods sold to this industry by supplier industries.

Given its positive effect on input costs and its negative effect on markups, the zombie credit channel thus might help to explain the recent weakening of the relationship between cost and product price inflation documented in the macro literature (see, e.g., Taylor (2000), Bobeica, Ciccarelli, and Vansteenkiste (2019), Del Negro et al. (2020)).

IV.D. Spillovers

In this section, we present evidence consistent with negative spillover effects from zombie to non-zombie firms, another prediction of the zombie credit channel. In our model, a rise of zombie credit leads to more active firms and an elevated aggregate production, resulting in a negative price pressure for *all* firms, zombie and non-zombie. Our empirical analysis confirms that non-zombie firms in markets with a high zombie prevalence face lower markups, profitability, and sales growth, and higher input costs.

Taking advantage of our firm-level data, we follow Caballero, Hoshi, and Kashyap (2008) and test for these spillover effects by estimating the following

Table IX. Markups, EBIT/sales, material costs, and sales growth – Firm-level evidence. This table presents estimation results from Specification (5). The dependent variables are a firm's markup, EBIT/sales, material cost (material input cost/turnover), or sales growth. *Non-Zombie* is an indicator variable equal to one if a firm is classified as non-zombie in year t. *Share Zombies* measures the asset-weighted share of zombie firms in a particular market at $t-1$. Firm-level controls include net worth, leverage, ln(total assets), and the IC ratio. A firm is classified as zombie if it is low-quality and paid advantageous interest rates (see Section II.B for more details). Standard errors are clustered at the industry-country level and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	Markup	EBIT/Sales	Material Cost	Sales Growth
Non-Zombie	0.063***	0.086***	−0.023***	0.060***
	(0.007)	(0.008)	(0.002)	(0.007)
Non-Zombie	−0.235***	−0.198***	0.074***	−0.153***
× Share Zombies	(0.044)	(0.033)	(0.019)	(0.032)
Observations	4,211,633	5,910,165	4,653,410	5,922,959
R-squared	0.565	0.157	0.517	0.033
Industry-Country-Year FE	✓	✓	✓	✓
Firm-Level Controls	✓	✓	✓	✓

regression at the firm-year level:

$$\begin{aligned} Y_{ihjt} = {} & \beta_1 \times \text{Non-Zombie}_{ihjt} \\ & + \beta_2 \times \text{Non-Zombie}_{ihjt} \times \text{Share Zombies}_{hjt-1} + \eta_{hjt} + \epsilon_{ihjt}, \end{aligned} \quad (5)$$

where i is a firm, h a country, j an industry, and t a year. Our dependent variables are firm markup, EBIT/sales, material cost, and sales growth. We include industry-country-year fixed effects to absorb industry-country specific shocks. Our coefficient of interest is β_2, that is, whether non-zombie firms that operate in markets with a high share of zombie firms perform differently than non-zombie firms in markets with a lower share of zombie firms.

The first column of Table IX shows that non-zombie firms in markets with a low zombie prevalence have higher markups than zombie firms in the same market. However, consistent with our results at the industry-country level, markups of non-zombie firms tend to be lower when the share of zombie firms active in the same market is high. Results are very similar for the EBIT margin (Column 2). The results in Column (3) confirm that non-zombie firms that face an increase in the zombie share in their respective markets have to pay higher material costs relative to non-zombie firms in non-zombie markets (we only observe a very noisy measure of labor costs at the firm-level). Finally, Column (4) confirms that a rise of zombie credit is associated with lower sales growth for individual non-zombie firms as more firms have to share a given demand level.

These results confirm that there is a zombie contagion from zombie to non-zombie firms in markets with a strong rise in zombie credit. That is, healthy firms in zombie markets suffer a decrease in their profitability due to higher price pressures and higher input costs. As a result, initially healthy non-zombie firms might turn into zombies over time due to a high prevalence of other zombies in their markets.

Moreover, this evidence suggests that the observed aggregate effects at the market-level associated with an increase in the zombie share can at least partly be explained by negative spillover effects to non-zombie firms (as predicted by the zombie credit channel), and are not solely caused by compositional effects (i.e., due to more zombies relative to non-zombies in markets that experience an increase in the zombie prevalence).

As a placebo test for the firm-level results presented in Table IX, we employ the share of low-quality firms as independent variable (instead of the share of zombie firms); thus, muting the advantageous interest rate criterion. The results presented in Table IA.VIII show that the spillover effects on non-zombie firms do not occur *per se* when the share of low-quality firms increases in a market. This evidence suggests that the contagion to non-zombie firms is indeed caused by an increase in the share of actual zombie firms, that is, low-quality firms receiving subsidized credit. Moreover, these results provide further evidence that the negative correlation between the rise of zombie credit and CPI growth is not linked *per se* to a deteriorating average firm performance in a specific market (e.g., due to a drop in demand).

V. Testing the Mechanism

In this section, we provide further evidence in support of the zombie credit channel. Section V.A shows that its effects are more pronounced in high compared to low fixed cost industries. Section V.B shows that the effect of zombie credit on prices is driven by national markets for nontradable goods and by supranational markets for tradable goods. Section V.C analyzes the time dynamics of the zombie credit mechanism.

V.A. High vs. Low Fixed Cost Industries

Our model suggests that the effect of zombie credit on CPI growth is more pronounced in markets characterized by high fixed costs. The idea is that zombie credit lowers firms' expected bankruptcy costs associated with sustaining high fixed costs and the resulting high optimal production scale.

For this analysis, we use the ratio of the firms' labor expenses to total

Table X. CPI growth – Cost structure split. This table presents estimation results from Specification (3). The dependent variable is the annual CPI growth rate (inflation) from $t-1$ to t. *Share Zombies* measures the asset-weighted share of zombie firms in a particular market at $t-1$. A firm is classified as zombie if it is low-quality and paid advantageous interest rates (see Section II.B for more details). We use the ratio of labor expenses to total costs to proxy for their degree of fixed costs exposure. The first two columns report the results for firms in markets that have an above median average fixed costs ratio, while the last two columns report the results for the markets below the median. All regressions control for the asset-weighted share of low-quality firms. Standard errors are clustered at the industry-country level and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	High Fixed Costs		Low Fixed Costs	
	ΔCPI	Idle Capacity	ΔCPI	Idle Capacity
Share Zombies	−0.026***	6.629**	−0.007	2.989
	(0.008)	(3.111)	(0.008)	(3.748)
Observations	1,855	875	2,025	1,534
R-squared	0.768	0.797	0.838	0.802
Country-Industry FE	✓	✓	✓	✓
Industry-Year FE	✓	✓	✓	✓
Country-Year FE	✓	✓	✓	✓

costs to proxy for the industries' fixed costs exposure. The idea is that it is more difficult to reduce labor costs than to adjust material costs and other operating costs, which is especially true in Europe given the relatively high firing costs (see, e.g., Holden (2004)).

Table X confirms this model prediction. Specifically, the results show that the effects of an increase in the zombie prevalence on idle capacity and CPI growth are only significant for industries with an above median average ratio of fixed costs to total costs.

V.B. Tradable vs. Nontradable Goods

In this section, we exploit differences in the markets' geographic scope to further pin down the zombie credit mechanism. Specifically, the effect of zombie credit on CPI growth should be more pronounced when the zombie share measure comprises the precise scope of the respective market. To this end, we take advantage of the fact that, while the relevant market for nontradable goods is likely national, it goes beyond national borders for tradable goods.

To test this prediction, we again follow Mian and Sufi (2014) to distinguish between tradable and nontradable sectors. Table XI shows the estimation results of our baseline specification. Column (1) shows the results for industries producing nontradable goods, Column (2) for sectors producing tradable goods, and Column (3) covers the full sample. Moreover, in Panel A, we employ our standard *Share Zombies* measure that captures the zombie prevalence at the industry-country level, while in Panel B we employ *Industry Share Zombies*, which measures the zombie share at the industry-level (i.e., all firms in the same industry are considered to be in the same market, without a further country breakdown).

The results in Panel A show that the negative correlation between the zombie prevalence and the CPI growth is significant for both tradable and nontradable sectors when we measure the zombie share at the industry-country level. The effect, however, is stronger for nontradable than for tradable sectors. Panel B shows that, when measured at the industry-level, an increase in the zombie share only significantly affects the CPI growth in

Table XI. CPI growth – Tradable and nontradable goods. This table presents estimation results from Specification (3). The dependent variable is the annual CPI growth rate (inflation) from $t-1$ to t. *Share Zombies* and *Industry Share Zombies* measure the asset-weighted share of zombie firms in a particular industry-country pair and industry at $t-1$, respectively. A firm is classified as zombie if it is low-quality and paid advantageous interest rates (see Section II.B for more details). Column (1) reports the results for nontradable sectors, Column (2) for tradable sectors, and Column (3) for the full sample. We follow Mian and Sufi (2014) to identify tradable and nontradable sectors. All regressions control for the asset-weighted share of low-quality firms. Standard errors are clustered at the industry-country level in Panel A and at the industry level in Panel B. We report the standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	Nontradable	Tradable	Full Sample
Panel A: Industry-Country Measure	ΔCPI	ΔCPI	ΔCPI
Share Zombies	−0.035***	−0.018**	−0.024***
	(0.009)	(0.008)	(0.007)
Observations	1,454	2,181	3,880
R-squared	0.747	0.807	0.764
Country-Industry FE	✓	✓	✓
Industry-Year FE	✓	✓	✓
Country-Year FE	✓	✓	✓
Panel B: Industry Measure	ΔCPI	ΔCPI	ΔCPI
Industry Share Zombies	0.036	−0.161***	0.028
	(0.030)	(0.052)	(0.061)
Observations	1,454	2,181	3,880
R-squared	0.502	0.558	0.532
Country-Industry FE	✓	✓	✓
Country-Year FE	✓	✓	✓

tradable sectors.

This evidence confirms the zombie credit mechanism and reinforces the notion that our baseline OLS results, where we measure the zombie share at the industry-country level for all sectors, constitute a lower bound for the effect size of zombie credit on CPI growth.

V.C. Time Dynamics

To analyze the dynamics of the zombie credit mechanism, we add additional lags of *Share Zombies* relative to the respective dependent variable (i.e., CPI growth and idle capacity) to our baseline specification. The results in Table IA.IX indicate that the zombie credit channel appears to be a short- to medium-term phenomenon, which partially reverses after four years. This timing lines up with our evidence on default rates of zombie firms, which pick up four years after the initial zombie share increase (see Figure 5).

There are two potential reasons for the effects of the zombie credit mechanism taking some time to reverse, one at the extensive and one at the intensive margin. First, a downward adjustment of the zombie-credit-induced elevated aggregate supply through firm exits (i.e., at the extensive margin) can be a long drawn-out process when policies that enable zombie lending become entrenched (see, e.g., McGowan, Andrews, and Millot (2017), Banerjee and Hofmann (2018), Andrews (2019), Gropp, Guettler, and Saadi (2020), Acharya, Lenzu, and Wang (2022), and Becker and Ivashina (2022)). A high zombie prevalence creates negative spillover effects on healthy firms (see Table IX and Table IA.X), causing an economic slowdown. In response, policy makers have an incentive to stabilize the economy by loosening policies, e.g., by practicing regulatory forbearance towards banks. This can create a doom-loop, making it increasingly difficult to push the resulting large number of zombies through bankruptcy.

Second, when facing zombies in their industry, firms need to trade off the costs associated with maintaining their current production during the time their industry is congested, against the adjustment costs associated with down-scaling during the congestion phase and up-scaling again afterwards. Given the high likelihood that non-viable firms eventually have to exit, viable firms might thus decide against immediately down-scaling. This conjecture is supported by the literature that studies firms' labor adjustments in response to negative shocks, which shows that (i) given adjustment costs, firms respond sluggishly to shocks due to the option value of waiting and gathering more information on the shock (see, e.g., van Wijnbergen and Willems (2013)), and (ii) firms are less likely to adjust if the shock is perceived as temporary rather than permanent (see, e.g., Guiso, Pistaferri, and Schivardi (2005)).

VI. Real Effects

In this section, we discuss the real effects of the zombie credit channel. While formalizing these predictions requires a general equilibrium model (beyond this paper's scope), we provide empirical evidence suggesting that zombie credit increases capital and labor misallocation, and reduces investment, value added, and productivity.

First, we analyze investment and capital misallocation using, again, Specification (3). In Panel A in Table XII, we find that an increase in the zombie share is associated with lower average net investment (Column 1).[31] In par-

[31]We measure net investment using Amadeus firm-level data and aggregate firms' non-negative change in fixed assets (i.e., the change is set to zero if negative) to the market-level with the firms' assets as weights.

Table XII. Investment, employment, and factor misallocation. This table presents estimation results from Specification (3). In Panel A, the dependent variables are net investment (measured as the growth in fixed assets and set to zero if negative), capital misallocation (measured as the standard deviation of log(MRPK)), and the value added growth. The dependent variables in Panel B are employment growth, labor misallocation (measured as the standard deviation of log(MRPL)), and labor productivity (valued added/number of employees). *Share Zombies* measures the asset-weighted share of zombie firms in a particular market at $t-1$. A firm is classified as zombie if it is low-quality and paid advantageous interest rates (see Section II.B for more details). All regressions control for the asset-weighted share of low-quality firms. Standard errors are clustered at the industry-country level and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Panel A	Net Investment	Capital Misallocation	ΔValue Added
Share Zombies	−0.068**	0.142**	−0.109***
	(0.028)	(0.063)	(0.040)
Observations	3,464	2,976	4,020
R-squared	0.397	0.920	0.488

Panel B	Employment Growth	Labor Misallocation	Labor Productivity
Share Zombies	0.002	0.113**	−0.019**
	(0.018)	(0.056)	(0.009)
Observations	3,896	2,976	3,892
R-squared	0.497	0.905	0.948
Country-Industry FE	✓	✓	✓
Industry-Year FE	✓	✓	✓
Country-Year FE	✓	✓	✓

ticular, a 2.2pp increase in the share of zombie firms in a given market implies a 15bp lower net investment ratio.[32] This reduction of investments in zombie markets can be a result of (i) the excess aggregate supply in these markets and thus a lack of profitable investment opportunities, which prevents both, zombie as well as non-zombie firms, to increase their capital expenditures, and (ii) a lower allocative efficiency of capital hampering investment activity.

Employing the firm-level test from Specification (5), we confirm that a

[32]The net investment ratio ranged between 0% and 2% in the last decade in Europe.

high zombie prevalence lowers the investment activity of non-zombie firms (Panel A of Table IA.X, Column 1). Similarly, Column (1) of Table IA.X, Panel B shows that more productive firms in zombie markets invest less compared with productive firms in non-zombie markets.

We also find evidence supporting a lower allocative efficiency of capital. For this test, we follow Hsieh and Klenow (2009) and Gopinath et al. (2017) and track the dispersion of the marginal revenue product of capital (MRPK) across markets. The underlying idea is that, given the MRPK is diminishing (i.e., decreasing returns to scale with respect to capital), firms should optimally equate it with their borrowing rate. In the absence of any borrowing distortions, the MRPK should thus be equated across otherwise equal firms. Hence, the dispersion of the MRPK across firms in a particular market is a measure of the degree of capital misallocation—since aggregate output could be increased by reallocating capital from firms with a low MRPK to firms with a higher MRPK.[33]

To calculate firms' MRPK, we decompose MPRK into the value of the marginal product ($VMPK_{ijt}$) and the inverse-markup (μ_{ijt}^{-1}):

$$MRPK_{ijt} \equiv \frac{\partial(P_{ijt}(Q_{ijt})Q_{ijt})}{\partial K_{ijt}} = \underbrace{P_{ijt}\frac{\partial Q_{ijt}}{\partial K_{ijt}}}_{VMPK_{ijt}} \underbrace{\left(1 + \frac{Q_{ijt}}{P_{ijt}}\frac{\partial P_{ijt}}{\partial Q_{ijt}}\right)}_{\mu_{ijt}^{-1}} = \theta_{ijt}^{K}\frac{P_{ijt}Q_{ijt}}{K_{ijt}}\frac{1}{\mu_{ijt}},$$

where $P_{ijt}Q_{ijt}$ is sales (price times quantity), K_{ijt} is capital, and θ_{ijt}^{K} is the output elasticity of capital. To estimate firms' markup and output elasticity

[33] An example for a distortion due to zombie lending is that zombies benefit from subsidized loans, while non-zombies can only borrow at regular rates. As a result, the MRPK of zombies is lower than that of non-zombies and reallocating capital from zombies to non-zombies would thus increase the allocative efficiency.

of capital, we rely on the procedure outlined in Internet Appendix II.

The results in Column (2) of Table XII, Panel A show that, across markets, a rise in the zombie share is associated with an increase in the MRPK dispersion, measured as the standard deviation of log(MRPK). This evidence suggests that the weak investment dynamic in markets affected by zombie credit is caused by a combination of excess aggregate supply and misallocation of capital. Column (3) in Panel A further shows that a higher zombie prevalence is associated with a lower growth in value added (obtained from Eurostat).[34] Hence, while zombie credit attenuates the aggregate sales reduction that usually follows a negative demand shock, the concurrent reduction in prices and increase in input costs associated with a higher zombie prevalence reduces the GDP contribution of these markets. Hence, our results suggest that the global rise in zombie firms (see Banerjee and Hofmann (2018)) might contribute to the observed secular slowdown in GDP growth.

Second, we analyze the impact of zombie credit on employment. Column (1) of Table XII, Panel B shows that an increase in a market's zombie prevalence does not affect its aggregate employment growth. There are two opposing effects of zombie credit on employment growth. One the one hand, by its very nature, zombie credit prevents layoffs at zombie firms by keeping

[34] Table IA.XI, Panel A provides a robustness check for this test where we use *ln(Value Added)* instead of the value added growth. The results are qualitatively similar. Panel B of Table IA.XI shows a similar negative effect of a rise in zombie credit on productivity, where we follow Caballero, Hoshi, and Kashyap (2008) and measure productivity as *log(sales)–2/3*log(employment)–1/3*log(fixed assets)*.

these firms afloat.[35] On the other hand, zombie credit hampers an efficient reallocation of labor from zombie to non-zombie firms and reduces the available labor supply for non-zombie firms, potentially lowering the allocative efficiency of labor across firms. Through these spillovers, zombie credit negatively affects the employment growth of non-zombie firms active in markets with a high zombie prevalence. Employing Specification (5), we confirm these negative spillovers in Panels A and B of Table IA.X, Column (2).[36]

The insignificant result of an increase in the zombie share on aggregate employment can thus be explained by these two opposing effects on employment growth in markets affected by zombie credit, which seem to offset each other. While zombie credit prevents restructuring in zombie firms, thereby keeping employment up in these firms, it impedes employment growth in non-zombie firms by hampering the labor reallocation from zombie to non-zombie firms. In this way, zombie credit can potentially lower the allocative efficiency of labor across firms.

We formally analyze to what extent a zombie share increase is associated with a larger labor misallocation by determining the markets' dispersion of the marginal revenue product of labor (MRPL), measured as the standard

[35]Descriptively, our data confirms that indeed employment growth is slightly less negative for zombie firms compared to low-quality non-zombie firms.

[36]This result is consistent with the results of Caballero, Hoshi, and Kashyap (2008) that finds negative spillover effects of zombie lending on employment at non-zombie firms in the context of the Japanese crisis in the 1990s.

deviation of log(MRPL), where

$$MRPL_{ijt} \equiv \frac{\partial(P_{ijt}(Q_{ijt})Q_{ijt})}{\partial L_{ijt}} = \underbrace{P_{ijt}\frac{\partial Q_{ijt}}{\partial L_{ijt}}}_{VMPL_{ijt}} \underbrace{\left(1 + \frac{Q_{ijt}}{P_{ijt}}\frac{\partial P_{ijt}}{\partial Q_{ijt}}\right)}_{\mu_{ijt}^{-1}} = \theta_{ijt}^{L}\frac{P_{ijt}Q_{ijt}}{L_{ijt}}\frac{1}{\mu_{ijt}}.$$

Following Gopinath et al. (2017), we measure the labor input, L_{ijt}, with the firm's deflated wage bill.[37] Column (2) of Table XII, Panel B confirms that a higher zombie prevalence is associated with a higher MRPL dispersion, that is, a lower labor allocative efficiency.

Finally, the results in Column (3) of Table XII, Panel B highlight that the factor misallocation due to zombie credit drags down labor productivity, calculated by dividing value added by the number of employees (see Andrews, Criscuolo, and Gal (2016)). In particular, zombie credit and the resulting factor misallocation simultaneously lead to lower value added and labor allocative efficiency. Both effects reduce labor productivity.

Overall, the evidence in this section suggests that, while zombie credit likely has a stabilizing effect in the short-term, it has an adverse impact on the factor allocation and thus economic growth in the medium- to long-term. The resulting sluggish economic growth, in turn, feeds back into lasting disinflation. Hence, scaling down the provision of zombie credit can raise productivity and labor productivity by improving the allocative efficiency across firms and thereby spur economic growth and inflation.[38]

[37] Using the wage bill instead of employment accounts for differences in the workforce quality across firms.

[38] Relatedly, Bertrand, Schoar, and Thesmar (2007) shows that net employment and value added per worker increased in bank-dependent sectors following a French deregulation that reduced subsidized zombie lending.

VII. Conclusion

The low-growth low-inflation environment that prevailed in Europe between its sovereign debt crisis and the Covid-19 pandemic bears a striking resemblance to Japan's "lost decade" in the aftermath of its crisis in the early 1990s. Similar to the Bank of Japan's crisis response, in an environment characterized by weakly-capitalized banks, the European central banks followed canonical demand-side theory and lowered interest rates, as well as, implemented massive quantitative easing programs to encourage more investment and consumption, hoping that this would lead to a surge in inflation. However, despite a significant drop in firm funding costs, inflation did not pick up as expected, which became known as Europe's "missing inflation puzzle" (see, e.g., Constâncio (2015)).

In this paper, we propose and test a novel supply-side channel that shows that zombie lending—subsidized credit to non-viable firms—has a disinflationary effect, thereby providing an explanation for the persistent low inflation rates in Europe. In Europe, political constraints led to a hesitant introduction of recapitalization measures in the aftermath of the 2008 global financial crisis, which led to zombie lending incentives. We show that, by fueling the survival of non-viable firms, zombie lending creates excess supply, which puts downward pressure on prices and inflation.

We test this zombie credit channel using a new inflation and firm-level data set that covers 1.1 million firms in 12 European countries across 65 industries. We show that markets that experienced a rise in zombie firms subsequently have lower firm defaults and entries, capacity utilization, markups, and inflation, higher input costs as well as a misallocation of capital and labor, which results in lower productivity, investment, and value added.

Our findings show that a central bank that implements policy measures that contribute to a persistent zombification of the economy with the objective of restoring inflation and growth might end up working against its own objectives. Conversely, accommodative monetary policy might be more effective in times of a weakening financial sector, if accompanied by a targeted bank recapitalization program.

Finally, our results draw attention to the often-neglected effect of supply-side financial frictions on inflation. The inclusion of these frictions in general equilibrium models is, in our view, an important area of future research.

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