

# Low for Long: Could Extended Periods of Ultra-low Monetary Policy Rates Have Harmful Effects?\*

Etibar Jafarov<sup>a</sup> and Enrico Minnella<sup>b</sup>

<sup>a</sup>International Monetary Fund

<sup>b</sup>Bank of England

Extended periods of ultra-low monetary policy rates in advanced economies have rekindled debates about the zombification of weak companies and its impact on resource allocation, economic growth, inflation, and financial stability. Using both firm-level and macroeconomic data, we find that recessions are a critical factor in the increase in the number of zombie firms and that extended periods of low interest rates are associated with a higher probability of zombification. Our findings imply a trade-off between conducting a countercyclical monetary policy and using expansionary tools for long periods, which may lead to a combination of low interest rates, low growth, and high financial vulnerability. We also find that strong banking supervision reduces the probability of zombification.

JEL Codes: E44, E52, E58, G20.

## 1. Introduction

During the Global Financial Crisis (GFC) in 2008 and the COVID-19 pandemic in early 2020, central banks in advanced economies

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lowered policy rates effectively to the zero lower bound (ZLB) and implemented ultra-low interest rate policies alongside unconventional monetary policy (UMP) operations.<sup>1</sup> These policies are widely considered successful in preventing financial meltdowns and closing output gaps, as highlighted by Vayanos and Vila (2009), Krishnamurthy and Vissing-Jorgensen (2011), Harrison (2012, 2017), and Corrado, Grassi, and Minnella (2021), among others. However, in some jurisdictions, they were subsequently continued to boost aggregate demand amid subdued inflationary pressure. Critics suggest that such prolonged ultra-low monetary policy rates could lead to unsustainable capital flows and booms in housing and financial asset prices, raising the odds of a future financial crisis (Turner et al. 2019), supporting weak companies at the cost of healthy ones, and leading to financial fragility and resource misallocation, as discussed in frameworks such as the Austrian business cycle theory and Minsky's financial instability hypothesis (Minsky 1977). Japan's experience with the short-term policy rate at the ZLB over many years illustrates the risks associated with such policies. Attempts to combat deflation and low growth with various economic stimuli, running large fiscal deficits and ultra-loose monetary policy, led to the so-called zombie lending, as coined by Caballero, Hoshi, and Kashyap (2008). This phenomenon laid the foundation for a rich stream of literature on the causes and effects of corporate zombification. Their seminal paper estimates that around 30 percent of Japanese firms were recipients of zombie lending in the late 1990s.<sup>2</sup> Other examples in this wide literature include Acharya et al. (2019), who found that the Outright Monetary Transactions programs (OMT) in the euro zone during the Sovereign Debt Crisis benefited low-quality borrowers, contributing to the zombification of weak firms and negative spillovers to more productive firms; Banerjee and Hofmann (2018), who suggested that the increase in zombie firms may be linked to reduced financial pressure; and Bonfim et al. (2023), who found that

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<sup>1</sup>See Joyce et al. (2012) for a detailed review of the theoretical transmission channels of UMPs.

<sup>2</sup>Peek and Rosengren (2005) argue that zombie lending was not only a by-product of economic conditions but also contributed to Japan's low output growth during its "lost decade."

inspected banks are less likely to refinance zombie firms after the inspection.<sup>3</sup>

In this paper, we analyze whether extended periods of low monetary policy interest rates in advanced economies have contributed to the zombification of weak firms and low economic growth. Using both firm-level and macroeconomic data, we find that recessions are a critical factor in the increase in the number of zombie firms and that extended periods of low interest rates are associated with a higher probability of zombification. We also find that, in such environments, small and medium enterprises are more likely to become zombie firms since they are less dynamic than other firms and are usually in sectors least exposed to foreign competition. Moreover, we find that Japan experienced a larger economic slowdown than other countries during our sample period of 1996–2021, partly due to the increase in the number of zombie firms. This raises concerns about the sustainability of prolonged periods of ultra-low monetary policy rates, especially in countries with low growth rates. Additionally, we find evidence of negative spillovers to more productive companies operating in sectors with higher shares of zombie firms. Lastly, we find that higher supervisory power can play a role in reducing zombie lending, highlighting the importance of the post-GFC prudential regulations.

This paper makes at least two contributions to the literature. First, it uses both macroeconomic and large microeconomic data to study zombification trends and their impact on resource allocation and growth. Second, it analyzes the impact of the “low for long” policies on zombification. The paper is organized as follows: Section 2 describes the data and methods used and presents the results of various empirical analyses of factors of zombification, including extended periods of low monetary policy rates. Section 3 discusses the impact of zombification on economic growth. Section 4 discusses the impact of supervisory power on zombification and reflects on financial stability aspects. Section 5 concludes.

## 2. Empirical Analysis of Zombification

Answering questions related to zombie firms has one initial challenge related to defining such firms. Although zombies can certainly be

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<sup>3</sup>See Acharya et al. (2022) for a more detailed literature review on the topic.

considered unprofitable corporates, Caballero, Hoshi, and Kashyap (2008) depart from this assumption and classify firms as zombies based on whether they have received subsidized credit. They do so by calculating a hypothetical lower bound on interest payments that they expect from high-quality borrowers and comparing it with the actual interest payment. Giannetti and Simonov (2013) and Acharya et al. (2019) use a similar definition. On the other hand, Banerjee and Hofmann (2018) focus on the profitability of firms by considering two different definitions. A broader measure, following Adalet McGowan, Andrews, and Millot (2018), considers firms as zombies if their interest coverage ratio (ICR)—defined as the ratio between earnings before interest and taxes (EBIT) and interest payments—is less than unity for at least 3 consecutive years and if they are at least 10 years old, and a narrower measure if the firm's Tobin's  $q$  is lower than its sector median. While the former focuses on the firm's current profitability (more precisely, on the firm's ability to pay its interest expenses), the latter focuses on future profitability. For our analysis, we follow the second strand of literature and inspect firms' profitability. We use firm-level annual data for publicly traded companies and small firms from the Orbis database, provided by Bureau Van Dijk, with around half a million firm-year observations.<sup>4</sup> The data set spans 1996 to 2021 and contains balance sheet data and ratios for around 60,000 companies from 21 countries, including the United States, Japan, and all 19 euro-zone countries.<sup>5</sup> According to our definition, a firm is classified as a zombie if it is at least 10 years old and its ICR is lower than one for at least two consecutive periods. The first requirement allows us to exclude relatively young, healthy corporates which might suffer initial losses due to their high investments—some of which through high loan volumes—in their first years of activity. In addition, we allow firms to fluctuate between the zombie and non-zombie states whenever the conditions above are not met. By doing so, we can detect the year-specific characteristics

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<sup>4</sup>We merge firm-level data and information coming from different Orbis sub-databases and clean the data set following the steps outlined in Diez, Fan, and Villegas-Sánchez (2019).

<sup>5</sup>Data availability is very limited for Slovenian firms compared to the rest of the sample.

of a firm and link them to the current monetary policy implementations to inspect their correlation in recession and ZLB periods. To check the robustness of our results, we also repeat the analyses using an alternative definition of zombie firms, under which a company's ICR is below one in three successive years, which produces similar results (see the appendix for details).

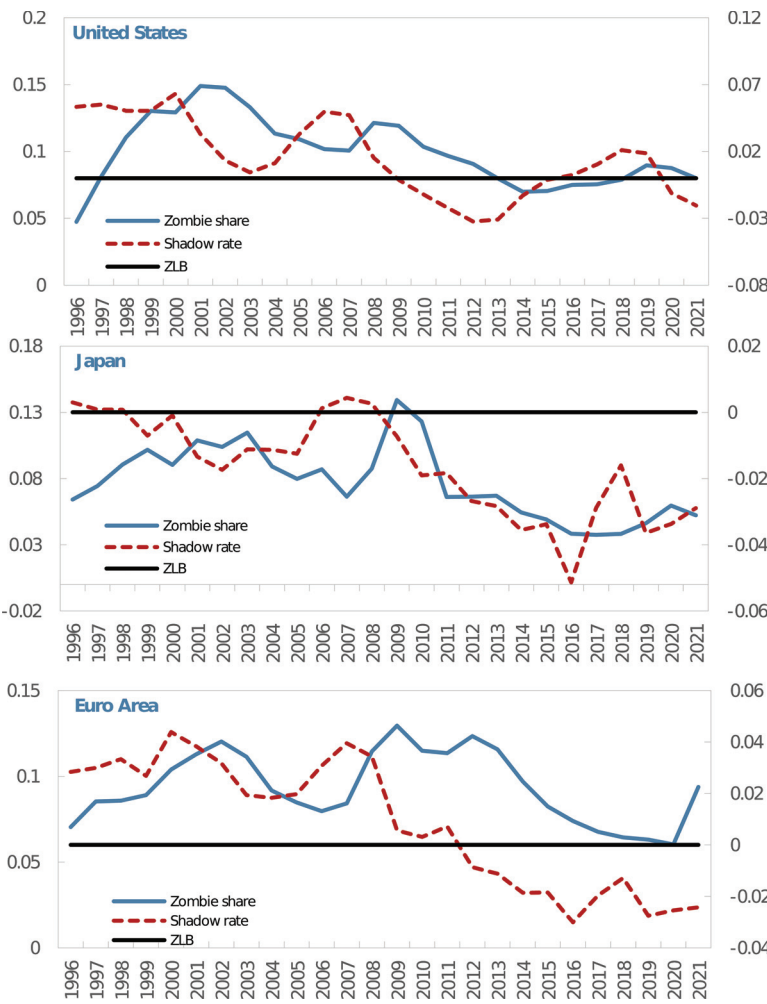
## 2.1 *Stylized Facts*

As shown in Figure 1, the number of zombie firms and their share in the total number of firms increased after recessions and broadly declined at other times. In the U.S., the share of zombie firms increased during the recessions in the early 2000s (after the collapse of the speculative dot-com bubble and the September 11 terrorist attacks), during the GFC, and during the COVID-19 pandemic, when the output gap turned negative. The share gradually declined in most other periods. In Japan, the share of zombie firms had a similar pattern, but Japan had high levels of zombie share also before our sample period, as documented by Caballero, Hoshi, and Kashyap (2008). In Europe, the zombie share increased to the highest level during the GFC and increased the most (among the three regions) during the pandemic. On the other hand, monetary policy rates, here proxied by the shadow rates,<sup>6</sup> were reduced following the recessions and were tightened as the economies recovered. These episodes imply negative correlations between the shadow rate and zombie share, but there were also periods, such as 2011–13 in the

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<sup>6</sup>The shadow rate, first suggested in Black (1995)'s seminal work, corresponds to the shortest-maturity interest rate that the yield curve would have generated had the ZLB not been binding. The literature offers many alternatives to estimating this measure. For example, Krippner (2013), Wu and Xia (2016), and Lemke and Vladu (2017) employ term structure models, while Lombardi and Zhu (2018) use factor analysis, and Mavroeidis (2021) and Ikeda, Mavroeidis, and Zanetti (2024) develop a new vector autoregression (VAR) estimation technique which nests the estimation of a shadow rate. Many theoretical and empirical papers have employed such instruments in the recent past. Among others, Mouabbi and Sahuc (2019) and Hohberger, Priftis, and Vogel (2019) estimate dynamic stochastic general equilibrium (DSGE) models, with the first using a shadow EONIA (euro overnight index average) rate and the second with an occasionally binding constraint on the ZLB by employing a shadow interest rate. They both build macroeconomic scenarios with low nominal interest rates and assess the effect of UMPs.

Figure 1. Share of Zombie Firms and the Shadow Rate

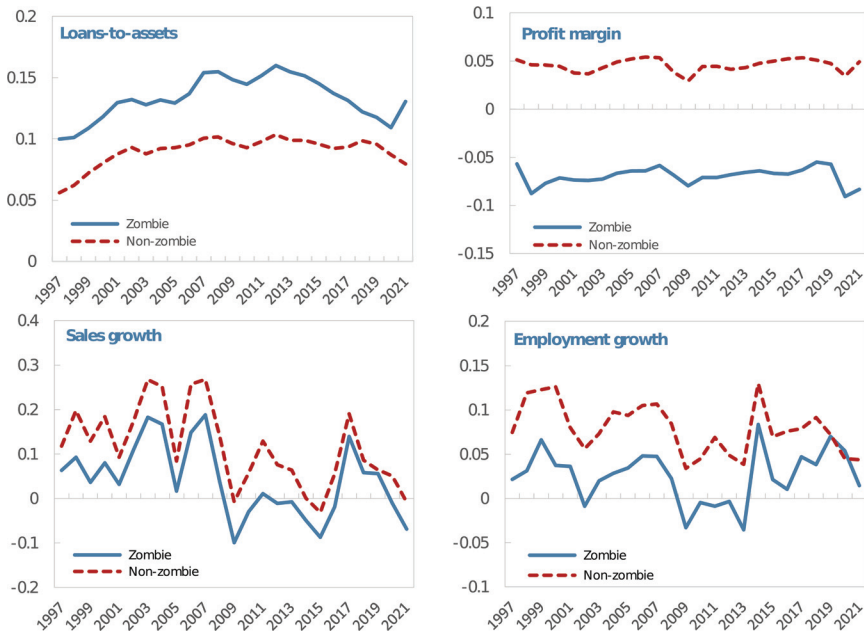


**Note:** The zombie shares (left-hand-side axis) are computed as the fraction of zombie firms over the total number of firms at time  $t$ . The shadow rates (right-hand-side axis) are Krippner (2013)’s estimates.

**Sources:** Orbis database and the authors’ calculations.

U.S., 2011–15 in Japan, and 2012–15 in the euro area, when both variables moved in the same direction. Note that in Japan, the shadow rate has been in the negative area since the early 2000s,

**Figure 2. Zombie vs. Non-zombie Firms Performance**

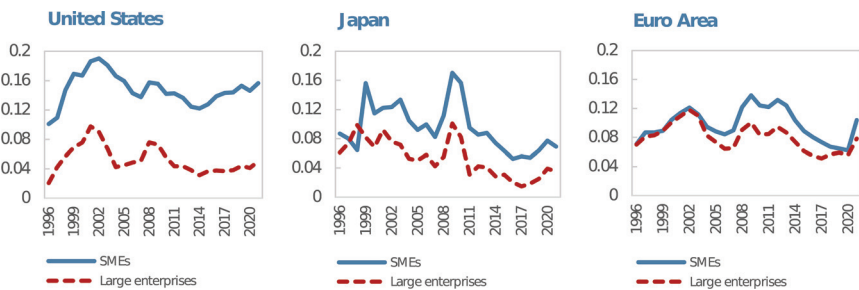


**Note:** The solid blue line is the mean value of the corresponding performance indicator for the firms classified as zombies, whereas the dashed red line is the mean value of the firms not classified as zombies in our data set.

**Sources:** Orbis database and the authors' calculations.

except for a brief period in 2007–08. In the euro zone, the shadow rate turned negative during the GFC and stayed at negative levels for most years after that, when the share of zombie firms also declined. These point to the importance of controlling for the business cycle, which we do by including the recession variable, GDP growth rate, and output gap in various specifications. As expected, the data set reveals that zombie firms' financial performance is worse than that of non-zombie firms. Almost by definition, zombie firms are more indebted, and most make losses. They also record lower sales and employment growth (Figure 2). But it is worth noting that most of them were still increasing their sales, employment, and borrowing except for the aftermath of the GFC, suggesting that they might have taken market shares from their healthier competitors.

Figure 3. Zombie Shares in Small-Medium and Large Enterprises

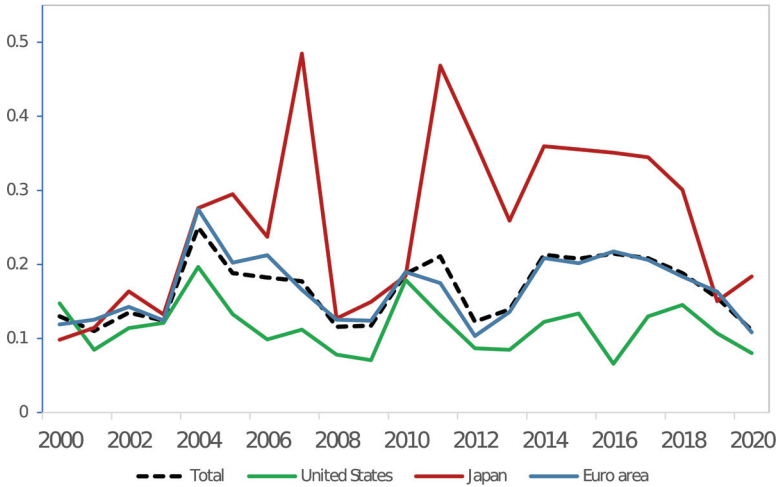


**Note:** The solid blue line and the dashed red line correspond to the zombie shares of SMEs and LEs, respectively.  
**Sources:** Orbis database, and authors’ calculations.

Descriptive statistics from our data set also reveal an interesting pattern for smaller companies compared to larger enterprises. We identify the former as firms with 1,000 or fewer employees. Figure 3 shows the ratios of identified zombie firms over the total number of firms for both small and medium enterprises (SMEs) and large enterprises (LEs). In all regions, both series closely follow the path of the economic cycle, increasing during recessions and decreasing during expansions, and depict a clear outperformance of the LEs, having lower zombie shares throughout the sample period. However, there are some notable differences across regions. First, the U.S. experiences a larger gap between SMEs and LEs, with the latter being on average 10 percentage points (pp) less than the former. Second, the gap spikes in Japan around 2000, coinciding with the beginning of the Zero Interest Rate Policy (ZIRP) implemented by the Bank of Japan, and persists until the end of the sample period, although somewhat narrowing. Third, a similar gap emerges in the euro area in the early 2000s, increasing even further during the GFC. The gap narrows around 2020 but then increases again during the COVID-19 pandemic. On average, SMEs have a higher share of zombie firms.

Lastly, we are interested in the degree of persistence that the firms have in remaining zombie firms, once classified as such. Figure 4 illustrates the share of firms that exited the zombie state over the

Figure 4. Exiting Rate from the Zombie State



**Note:** The solid lines are the exiting rate for the three distinctive regions of the sample, and the dashed line is the full-sample exiting rate.  
**Sources:** Orbis database, and authors’ calculations.

total number of zombie firms in each year and regional unit of our sample, as well as the share for the full sample. We compute it as the ratio of the firms not classified as zombies in  $t$ , while being classified as such in  $t - 1$ , over the total number of zombie firms in  $t - 1$ . To a certain extent, it can be observed how the capacity of a firm to exit the zombie state has some degree of correlation with the state of the economy. All regions experienced a massive drop between 2008 and 2010, as well as around 2013. This means that during crisis periods the number of firms already classified as zombies that are able to escape that state is significantly lower than average. Despite a similar pattern with the business cycle, Japan’s values are more volatile, with a higher average exit rate but a similar trough during the GFC.

2.2 Monetary Policy and Zombification

In our first regression analysis, we investigate the effect of monetary policy implementations on the probability of a firm becoming

a zombie. Our baseline specification for firm  $i$  in country  $j$  at time  $t$  reads as

$$\begin{aligned} \text{Zombie}_{i,j,t} = & \beta_1 \cdot \text{Shadow}_{j,t} + \beta_2 \cdot \text{Rec}_{j,t} + \beta_3 \cdot \text{ZLB}_{j,t} \\ & + \beta_4 \cdot \text{Shadow}_{j,t} \cdot \text{Rec}_{j,t} + \beta_5 \cdot \text{Shadow}_{j,t} \cdot \text{ZLB}_{j,t} \quad (1) \\ & + \beta_6 \cdot \text{SME}_{i,j,t} + \gamma \cdot X_{i,j,t} + u_{i,j,t}, \end{aligned}$$

where  $\text{Zombie}_{i,j,t}$  is a dummy variable equal to one if a firm is classified as a zombie according to our definition,  $\text{Shadow}_{j,t}$  is the shadow interest rate estimated using term structure models as estimated by Krippner (2013),<sup>7</sup> and  $\text{Rec}_{j,t}$  and  $\text{ZLB}_{j,t}$  are dummy variables that are equal to one in recession periods and when the interest rate is lower than 25 basis points (bps), respectively. We also include their respective interaction terms with the shadow rate. We include an  $\text{SME}_{i,j,t}$  dummy variable for small and medium enterprises, and a set of country-level and firm-level control variables  $X_{i,j,t}$ , including real GDP growth, the one-year lag of the shadow rate, return on firms' assets, and their profit margin (for each firm). Table 1 shows the results of our first estimation exercise. The first four columns illustrate panel fixed-effect (FE) estimates according to four different specifications. The first regression includes the recession and its interaction term with the shadow rate, while the second regression includes the ZLB dummy variable and its interaction term with the shadow rate. The third column includes both dummies and their interaction terms, and the fourth column augments this last specification with a lag of the shadow rate. In all settings, we control for firm size, profitability, balance sheet characteristics, and economic growth measured by GDP.

The estimation highlights a positive relationship between our dependent variable and recessions, and a negative relationship with the shadow rate when the policy rate is above the ZLB. This means that being in a recession increases the probability of a firm being a zombie firm. Being a small or medium enterprise also increases this probability.<sup>8</sup> On the contrary, increases in aggregate output as

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<sup>7</sup>We use the shadow rates as estimated by Krippner (2013) since they are the most comprehensive coverage of the countries/regions studied here.

<sup>8</sup>This outcome might be because smaller firms often belong to the sectors least exposed to foreign competition and thus may be less productive and more

**Table 1. Effect on the Probability of Being a Zombie Firm during Recessions and at the ZLB**

| Dependent Variable:<br>Zombie | Linear Probability Model |                    |                    |                    | Probit Model ( <i>mfx</i> ) |                    |
|-------------------------------|--------------------------|--------------------|--------------------|--------------------|-----------------------------|--------------------|
|                               | (1)                      | (2)                | (3)                | (4)                | (5)                         | (6)                |
| Shadow Rate                   | -0.25***<br>(0.03)       | -0.47***<br>(0.05) | -0.52***<br>(0.04) | -0.51***<br>(0.05) | -0.25***<br>(0.02)          | -0.25***<br>(0.03) |
| Recession                     | 1.19***<br>(0.10)        |                    | 0.83***<br>(0.09)  | 0.54***<br>(0.12)  | 0.41***<br>(0.06)           | 0.08<br>(0.07)     |
| Shadow Rate × Recession       | 0.24***<br>(0.04)        |                    | 0.30***<br>(0.04)  | 0.23***<br>(0.04)  | 0.13***<br>(0.02)           | 0.07***<br>(0.03)  |
| ZLB                           |                          | 1.06***<br>(0.16)  | 0.95***<br>(0.17)  | 1.10***<br>(0.19)  | 0.45***<br>(0.09)           | 0.74***<br>(0.11)  |
| Shadow Rate × ZLB             |                          | 1.17***<br>(0.82)  | 1.07***<br>(0.08)  | 1.17***<br>(0.08)  | 0.69***<br>(0.04)           | 0.75***<br>(0.05)  |
| SME                           | 0.59**<br>(0.28)         | 0.53*<br>(0.28)    | 0.55*<br>(0.28)    | 0.51<br>(0.31)     | 0.31***<br>(0.09)           | 0.65***<br>(0.10)  |
| GDP Growth                    | -2.40**<br>(1.18)        | -5.90***<br>(1.00) | -3.49***<br>(1.16) | -2.88**<br>(1.23)  | -1.44**<br>(0.60)           | -1.85***<br>(0.66) |
| ROA                           | -0.47***<br>(0.04)       | -0.47***<br>(0.01) | -0.47***<br>(0.01) | -0.52***<br>(0.01) | -0.43***<br>(0.01)          | -0.50***<br>(0.01) |
| Profit Margin                 | -0.22***<br>(0.01)       | -0.22***<br>(0.01) | -0.21***<br>(0.01) | -0.21***<br>(0.01) | -0.06***<br>(0.01)          | -0.05***<br>(0.01) |
| Shadow Rate (-1)              |                          |                    |                    | 0.10***<br>(0.04)  |                             | 0.14***<br>(0.03)  |
| Firm FE                       | Yes                      | Yes                | Yes                | Yes                | No                          | No                 |
| Observations                  | 433,151                  | 433,151            | 433,151            | 371,626            | 433,151                     | 371,626            |
| Individual Firms              | 63,488                   | 63,488             | 63,488             | 54,813             | 63,488                      | 54,813             |
| $R^2$                         | 0.09                     | 0.09               | 0.09               | 0.10               |                             |                    |

**Note:** Coefficients expressed in percentage points. Standard errors in parentheses. \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

well as the ROA (return on assets) and the profit margin of a firm, which control for firm-level health, reduce the probability of being a zombie firm. The impact of monetary policy decisions, represented by the shadow rate, on zombification depends on the economic cycle when these decisions are made. In particular, while the shadow rate is negatively correlated with the probability of a firm being a zombie under the first specification, this correlation turns positive when we control for ZLB environments under the second specification. Specifically, the interaction of the shadow rate with the ZLB variable (in the second specification) has a positive coefficient, which exceeds the negative coefficient for the shadow rate. Hence the relationship between the shadow rate and the dependent variable is positive. In particular, in this specification, a 1 pp decrease in the shadow rate seems to increase by roughly 0.5 pp the probability of a firm becoming a zombie, but at the ZLB, *ceteris paribus*, this probability decreases by around 0.6 pp. In other words, an expansionary monetary policy implementation at the ZLB reduces the probability of a firm being a zombie, but such a policy would lead to more zombification in the other (non-ZLB) periods. The third and fourth specifications, which include all the variables and the lag of the shadow rate variable, yield similar results. Columns 5 and 6 show the results with the same set of variables using a panel probit model. These results are consistent with the linear probability model (LPM) estimates (in the previous columns) both in terms of the sign and magnitude.

To check the robustness of our results, we also analyze the relationship between monetary policy implementation and the rise of zombie firms in a macroeconomic setting. First, we build the zombie share variable, a country-level measure of the number of zombies in country  $j$  at time  $t$  over the total number of firms. Then, we regress it against a set of relevant macroeconomic variables while allowing for country-specific fixed effects. Table 2 shows that, on average, being in a recession or at the ZLB increases the zombie share. However, when expansionary measures are implemented when the economy reaches the ZLB, the effects are beneficial to those firms, confirming the results of our previous estimation exercise.

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exposed to domestic economic cycles. The reasons for this finding are not pursued further here.

Table 2. Effect of Macroeconomic Variables on the Country-Specific Zombie Shares

| Dependent Variable:<br>Zombie Share                                                                                                          | (1)               | (2)                | (3)                |
|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------|--------------------|
| Shadow Rate                                                                                                                                  | 0.25***<br>(0.04) | −0.33***<br>(0.08) | −0.36***<br>(0.07) |
| Rec                                                                                                                                          | 1.97***<br>(0.21) |                    | 1.65***<br>(0.20)  |
| Shadow Rate × Rec                                                                                                                            | 0.34***<br>(0.09) |                    | 0.34***<br>(0.08)  |
| ZLB                                                                                                                                          |                   | 1.05***<br>(0.36)  | 0.40<br>(0.30)     |
| Shadow Rate × ZLB                                                                                                                            |                   | 2.00***<br>(0.16)  | 1.73***<br>(0.15)  |
| GDP Growth                                                                                                                                   | −3.99**<br>(1.70) | −6.85***<br>(1.50) | −1.21<br>(1.58)    |
| Inflation                                                                                                                                    | 0.24**<br>(0.11)  | 0.33***<br>(0.26)  | 0.17*<br>(0.09)    |
| Country FE                                                                                                                                   | Yes               | Yes                | Yes                |
| Observations                                                                                                                                 | 546               | 546                | 546                |
| Year-Observations                                                                                                                            | 21                | 21                 | 21                 |
| $R^2$                                                                                                                                        | 0.32              | 0.37               | 0.46               |
| <b>Note:</b> Coefficients expressed in percentage points. Standard errors in parentheses.<br>* $p < 0.10$ , ** $p < 0.05$ , *** $p < 0.01$ . |                   |                    |                    |

2.3 Monetary Policy: Low for Long

While the previous subsection found that expansionary policy is generally associated with higher zombification but can help reduce zombification at the ZLB, this section aims to assess the impact of prolonged periods of low interest rates. We do so by introducing a variable named  $Long_{j,t}$ , a dummy variable for country  $j$  at time  $t$ , capturing periods when the short-term policy rate was kept low for an extended period. We set it equal to one if two conditions apply. Firstly, if the policy rate was lower than 25 bps for at least two consecutive years. Secondly, since unconventional monetary policies can on their own exert some effect on the probability of a firm becoming

a zombie, we decide to set the dummy equal to one at time  $t$  if also quantitative easing (QE) was not implemented. This second requirement ensures that we can capture the implementation of persistently low interest rate policies<sup>9</sup> without mistakenly including the effects of QE on firms' borrowing costs and other financial indicators.<sup>10</sup> For this analysis, we estimate the following regression:

$$\begin{aligned} \text{Zombie}_{i,j,t} = & \beta_1 \cdot \text{Shadow}_{j,t} + \beta_2 \cdot \text{Long}_{j,t} + \beta_3 \cdot \text{Shadow}_{j,t} \cdot \text{Long}_{j,t} \\ & + \beta_4 \cdot \text{Rec}_{j,t} + \beta_5 \cdot \text{SME}_{i,j,t} + \gamma \cdot X_{i,j,t} + u_{i,j,t}, \end{aligned} \quad (2)$$

where  $X_{i,j,t}$  includes the same set of control variables as in our baseline specification. Table 3 reports the results of panel ordinary least squares (OLS) and probit model estimations. Both estimations confirm the negative relationship between the shadow rate and the probability of being a zombie firm. Long periods of low interest rates seem to be correlated with higher probabilities of having zombie firms, given that the interaction term of the monetary policy rate during prolonged periods of low interest rates is highly negative and significant.

These results highlight the negative impact that prolonged periods of very low interest rates can have on the rise of zombie firms. As discussed by Caballero, Hoshi, and Kashyap (2008), when interest rates are very low and banks are subject to strict capital requirements, their willingness to keep lending to unprofitable firms can generally increase, as they may hope for government support to the borrowers. Furthermore, expectations play an important role. The longer interest rates are kept low, the more likely the agents will believe that the central bank will stick to a low interest rate policy,

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<sup>9</sup>Note that the purpose here is not to identify monetary policy shocks. Instead, we focus on the correlation between extended periods of low interest rates and zombification.

<sup>10</sup>In addition, asset purchases of central banks normally focus on buying financial instruments of healthier large firms experiencing some liquidity issues. Accordingly, QE might not be detrimental to productivity, while lower interest rates for extended periods would facilitate the survival of zombie firms, increasing the probability of a weak firm becoming a zombie. There are also alternative views. For example, Krishnamurthy and Vissing-Jorgensen (2011) highlight that the default risk channel of QE could benefit riskier firms more than healthier firms, increasing the probability of their survival and thus the probability of becoming zombie firms.

**Table 3. Effect on the Probability of Being a Zombie Firm during Long Periods of Low Interest Rates**

| Dependent Variable:<br>Zombie                                                                                                                            | Linear Probability<br>Model |                    | Probit Model<br>( <i>mfx</i> ) |                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------------------|--------------------------------|--------------------|
|                                                                                                                                                          | (1)                         | (2)                | (3)                            | (4)                |
| Shadow Rate                                                                                                                                              | −0.21***<br>(0.03)          | −0.22***<br>(0.03) | −0.03***<br>(0.01)             | −0.04***<br>(0.01) |
| Long                                                                                                                                                     | 2.49***<br>(0.32)           | 1.97***<br>(0.32)  | 1.24***<br>(0.14)              | 0.94***<br>(0.14)  |
| Shadow Rate × Long                                                                                                                                       | −3.55***<br>(0.45)          | −3.04***<br>(0.44) | −1.70***<br>(0.24)             | −1.43***<br>(0.24) |
| Recession                                                                                                                                                |                             | 1.02***<br>(0.10)  |                                | 0.55***<br>(0.06)  |
| SME                                                                                                                                                      | 0.57**<br>(0.28)            | 0.58**<br>(0.28)   | 0.34***<br>(0.09)              | 0.34***<br>(0.09)  |
| GDP Growth                                                                                                                                               | −8.78**<br>(0.98)           | −3.75**<br>(1.10)  | −4.48***<br>(0.54)             | −1.68***<br>(0.61) |
| ROA                                                                                                                                                      | −0.47***<br>(0.01)          | −0.47***<br>(0.01) | −0.43***<br>(0.01)             | −0.43***<br>(0.01) |
| Profit Margin                                                                                                                                            | −0.22***<br>(0.01)          | −0.22***<br>(0.01) | −0.06***<br>(0.01)             | −0.06***<br>(0.01) |
| Firm FE                                                                                                                                                  | Yes                         | Yes                | No                             | No                 |
| Observations                                                                                                                                             | 433,151                     | 433,151            | 433,151                        | 433,151            |
| Individual Firms                                                                                                                                         | 63,488                      | 63,488             | 63,488                         | 63,488             |
| <i>R</i> <sup>2</sup>                                                                                                                                    | 0.09                        | 0.09               |                                |                    |
| <b>Note:</b> Coefficients expressed in percentage points. Standard errors in parentheses.<br>* <i>p</i> < 0.10, ** <i>p</i> < 0.05, *** <i>p</i> < 0.01. |                             |                    |                                |                    |

even exacerbating this mechanism. This is mainly captured by the Japanese experience; Japan was the first country to adopt ultra-low monetary policy rates for extended periods, with the implementation of the ZIRP before extensively using QE—the first such case in an advanced economy.

To show the robustness of our results, we saturate our previous specification by controlling for all cross-sectional and time variations within firm, sector, and country. Table 4 shows that the coefficient for the interaction term between the monetary policy instrument

Table 4. Too Low for Too Long—Saturated Specification

| Dependent Variable: Zombie                                                                                                                | (1)                | (2)                | (3)                | (4)                | (5)                |
|-------------------------------------------------------------------------------------------------------------------------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Shadow Rate $\times$ Long                                                                                                                 | -3.78***<br>(0.51) | -2.58***<br>(0.56) | -3.12***<br>(0.43) | -3.55***<br>(0.39) | -1.64***<br>(0.57) |
| Controls                                                                                                                                  | Yes                | Yes                | Yes                | Yes                | Yes                |
| Time                                                                                                                                      | No                 | Yes                | Yes                | No                 | No                 |
| Firm                                                                                                                                      | No                 | No                 | Yes                | Yes                | No                 |
| Sector                                                                                                                                    | No                 | No                 | No                 | Yes                | No                 |
| Sector $\times$ Time                                                                                                                      | No                 | No                 | No                 | No                 | Yes                |
| Country                                                                                                                                   | No                 | No                 | No                 | Yes                | No                 |
| Observations                                                                                                                              | 433,151            | 433,151            | 433,151            | 423,851            | 433,151            |
| $R^2$                                                                                                                                     | 0.095              | 0.097              | 0.56               | 0.56               | 0.10               |
| $R^2_{adj}$                                                                                                                               | 0.095              | 0.097              | 0.49               | 0.49               | 0.10               |
| <b>Note:</b> Coefficients expressed in percentage points. Standard errors in parentheses. * $p < 0.10$ , ** $p < 0.05$ , *** $p < 0.01$ . |                    |                    |                    |                    |                    |

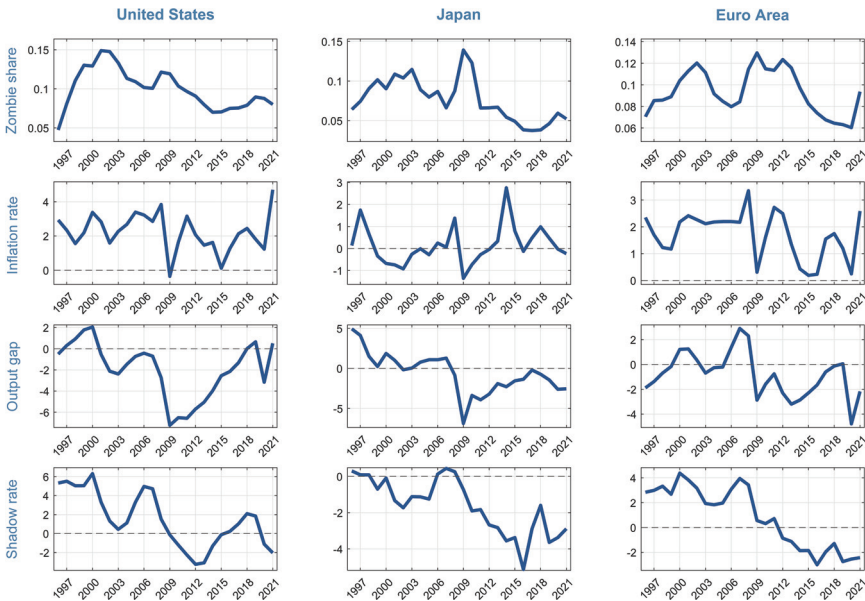
and our “Long” measure is negative and significant in all settings. This supports the claim that keeping interest rates too low for an extended period increases the probability of a firm turning into a zombie firm.

### 3. Zombification and Economic Growth

#### 3.1 *Impact on Growth*

The previous micro and macro analyses suggest that extended periods of low interest rates can indeed facilitate zombification, but it needs to be clarified if and how the rise of zombie firms would reduce economic growth. On the one hand, at the firm level, there is a negative correlation between GDP growth and the probability of being a zombie firm. On the other hand, this relationship is not always significant on the macroeconomic side, as seen in Table 2. To shed light on this matter, we estimate a Bayesian panel VAR on the three regional units of our sample corresponding to monetary unions, namely the United States, Japan, and the euro zone. We identify the structural shocks using a Cholesky ordering. The variables of the system are the region-specific zombie share, the CPI inflation rate, the output gap, and the shadow rate in that order, based on the idea that monetary policy shocks do not have contemporaneous effects on the other variables of the system, which is consistent with the existing literature on structural VAR (SVAR) models, including Bernanke and Mihov (1998), Christiano, Eichenbaum, and Evans (1999), and Primiceri (2005). It is worth noting that the results are robust to different Cholesky ordering. Figure 5 shows the endogenous variables of the panel VAR system for each country of our sample. Given the time coverage of the firm-level data set, we estimate the model for the period 1996–2021.

As outlined by Canova and Ciccarelli (2013), there exist many alternatives to the estimation of panel VAR models in a Bayesian setting with different degrees of complexity. As we are interested in capturing the cross-sectional differences in the impact of the increase in the share of zombies on economic activity, we use the algorithm of Jarociński (2010). His Gibbs sampler employs hierarchical priors and treats the common mean and covariances of the VAR coefficients as random parameters. We estimate 50,000 Markov-chain Monte

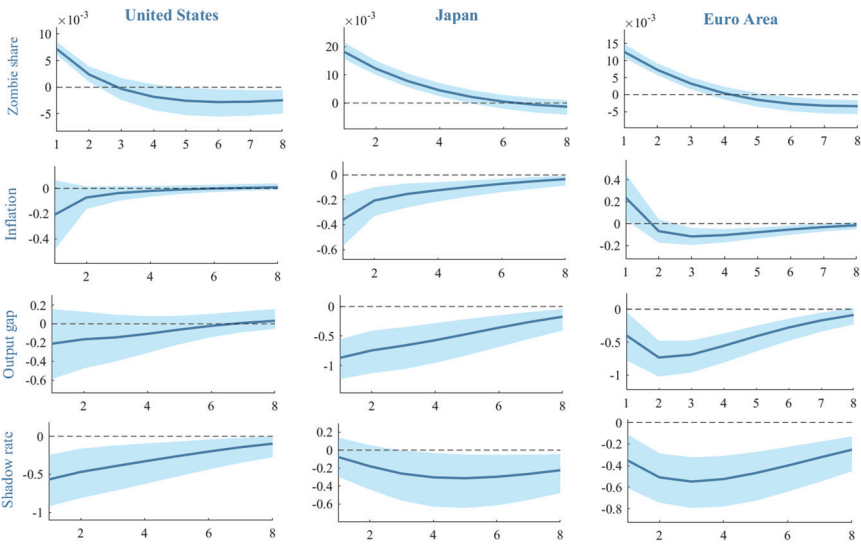
**Figure 5. Endogenous Variables of the Panel VAR**

**Note:** Each column of the figure corresponds to a cross-sectional regional unit of the panel VAR, while each row shows the variables of the system. The zombie share is the fraction of zombie firms over the total number of firms for each regional unit; the inflation rate comes from the FRED (Federal Reserve Economic Data) database of the Federal Reserve Bank of St. Louis for the U.S., from the Bank of Japan's website for Japan, and from Eurostat for the euro area; the output gap is obtained from the IMF database; and the monetary policy rates are the shadow rates as estimated by Krippner (2013).

Carlo (MCMC) simulations and discard the first 20,000 as burn-in. Figure 6 shows the impulse response functions (IRFs) following a one-standard-deviation shock increase in the region-specific zombie share on itself, CPI inflation rate, output gap, and the shadow rate. We can gauge different responses among the panel units.

In particular, the effect of the increased zombification on the output gap is negative in all the regions, peaking at negative 0.9 pp in Japan, followed by 0.75 pp in the euro area, although it is statistically insignificant in the case of the U.S. This might be evidence that the Japanese and European experiences in keeping interest rates very low for an extended period resulted in the zombification of their

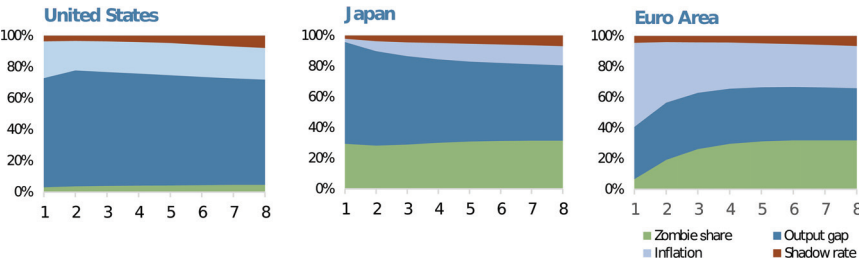
**Figure 6. Impulse Response Functions—Zombie Share Shock**



**Note:** Each column of the figure corresponds to a cross-sectional regional unit of the panel VAR, while each row shows the variables of the system. The solid blue line is the posterior median response of each variable to a one-standard-deviation shock increase to the zombie share, with the corresponding 90 percent confidence bands in shaded blue.

weak firms, which was more detrimental to growth than in the U.S. Note that the shadow rates significantly decrease in response to the shock, which implies the monetary policy authorities responded to the increase in the share of zombie firms with expansionary policies. It is also worth noting that the lower shadow rates in response to the shock are more persistent in Japan, while they recover to the pre-shock level relatively quickly in the U.S., potentially explaining the differences in the adverse effects of zombification in the three regions. Figure 7 further supports the evidence that Japan and the euro zone suffered the most from the rise of zombie firms. Each chart corresponds to the region-specific forecast error variance decomposition of the output gap resulting from the panel VAR estimation. The output gap explains most of its variance throughout the response horizon period in all three regions. However, while the zombie share explains

Figure 7. Forecast Error Variance Decomposition—Output Gap



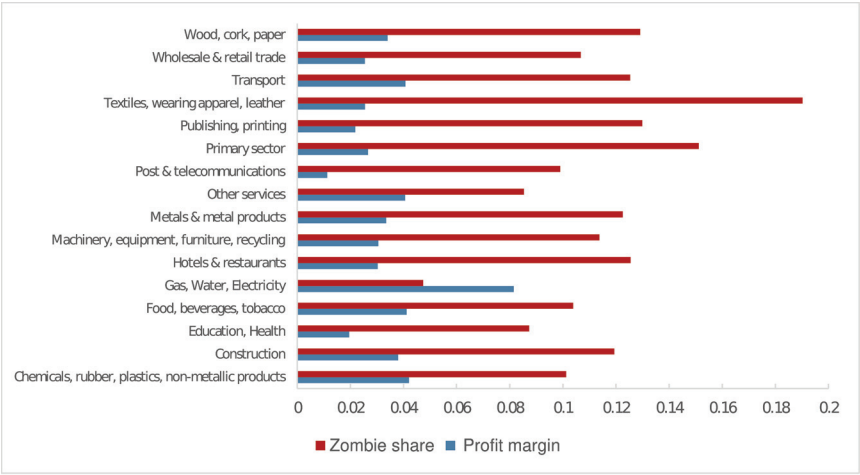
**Note:** Each chart shows the region-specific share of the variance of the output gap, respectively, explained by shocks in the zombie share in green, the output gap itself in dark blue, the inflation rate in light blue, and the shadow rate in red.

respectively around 6 percent of the variability of the output gap in the U.S., this contribution accounts for up to 30 percent in Japan and the euro zone. As noted earlier on the higher persistency of the IRFs, the contribution of the zombie share is, on average, higher for the Japanese economy in the selected horizon, followed by the euro zone. This finding suggests that Japan, followed by the euro zone, experiences the sharpest economic slowdown explained by the zombification of its corporate sector.

3.2 Spillover Effects

The above adverse effects of zombification on economic growth might come from both direct effects of the presence of zombie firms with worse performance and indirect effects through impact on the more profitable and healthy firms. We employ descriptive statistics computed from our firm-level data set and compute zombie shares and profit margin growth for each sector. Figure 8 compares the full-sample averages of the two variables, from which we can notice some degree of negative correlation between sector performance and the zombie share. The sectors with lower profit margin growth, like textiles, wearing apparel, leather, and the primary sector, seem to have a relatively higher number of zombies. At the same time, gas,

**Figure 8. Sectoral Zombie Shares and Economic Performance**



**Note:** For each sector, the red and the blue bars correspond to the average zombie share and the average profit margin, respectively.

**Sources:** Orbis database, and the authors' calculations.

water, and electricity, experiencing the lowest sectoral zombie share, also have the highest average profit margin growth.

In order to ascertain this hypothesis, we test whether high shares of zombie firms had a negative impact on the healthier firms of the same sector. We consider a similar specification as in Acharya et al. (2019) and estimate the following panel fixed-effects regression:

$$y_{i,j,h,t} = \beta_1 \cdot Nonzombie_{i,j,h,t} + \beta_2 \cdot Nonzombie_{i,j,h,t} \cdot Sector\ Frac\ Zombie_{j,h,t} + \gamma \cdot X_{i,j,h,t} + u_{i,j,h,t}, \quad (3)$$

where dependent variables are the employment growth and the profit margin of firms;  $Nonzombie_{i,j,h,t}$  is a dummy variable equal to one if a firm  $i$ , in country  $j$ , sector  $h$ , and time  $t$  is not a zombie according to our specification;  $Sector\ Frac\ Zombie_{j,h,t}$  measures the sector-specific zombie share; and  $X_{i,j,h,t}$  is a set of firm-level control variables including the ICR, loan growth, and the ratio of EBIT over total assets. In this specification, the coefficient  $\beta_2$  estimates the impact that an increase in the sector-specific zombie share has on

the respective dependent variable of non-zombie firms belonging to the same sector, hence, if zombie firms produce negative spillovers to healthy firms. Table 5 shows that an increase in the sector-specific zombie share exerts a sizable reduction on both the employment growth and the profit margin of non-zombie firms operating in the same sector. By saturating our fixed-effects specification, we obtain an average 12 pp decrease on the employment growth and a 12.2 pp decrease on the profit margin of healthy firms. Our results are consistent with Banerjee and Hofmann (2018), who employ a similar measure of zombie firms. What might be in place is a potential transmission channel that leads to a more general resource misallocation problem. If prolonged periods of low interest rates increase the probability that unprofitable firms keep on “floating,” the market will indirectly deprive the healthier firms of investment possibilities, in turn leading to lower employment and profits. In this sense, monetary policy at very low level of interest rates could be considered a form of financial repression.

#### **4. Financial Stability and Banking Supervision**

Some existing literature points to a weak banking sector as a key factor facilitating zombie firms’ emergence and survival. Caballero, Hoshi, and Kashyap (2008) document that zombie lending in Japan in the 1990s was mainly driven by undercapitalized banks “ever-greening” to loss-making companies to avoid additional provisioning, which would reduce these banks’ capital adequacy ratios, and Blattner, Farinha, and Rebelo (2023) show that weak European banks directed cheap credit to nonviable firms in the aftermath of the GFC. At the same time, supervisory powers seem to play an important role in taming zombie lending, as documented by Bonfim et al. (2023), who find that supervisors’ inspections reduce the likelihood of banks to refinance zombie firms after the inspection.

##### *4.1 Supervisory Power*

In the absence of specific bank-level data, we leverage our extensive firm-level data set in conjunction with the World Bank’s Bank Regulation and Supervisory Survey (BRSS) to assess whether country-level supervisory power affects the probability of a firm becoming

Table 5. Spillovers to Non-zombie Firms

| Dependent Variable:<br>Employment Growth                                                                                                  | (1)                 | (2)                 | (3)                 | (4)                 | (5)                 |
|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Sector Frac Zombie $\times$ Nonzombie                                                                                                     | -0.18***<br>(0.03)  | -0.15***<br>(0.03)  | -0.11**<br>(0.05)   | -0.06*<br>(0.03)    | -0.10*<br>(0.05)    |
| Observations                                                                                                                              | 312,045             | 312,045             | 303,447             | 303,447             | 303,447             |
| $R^2$                                                                                                                                     | 0.03                | 0.06                | 0.16                | 0.16                | 0.17                |
| $R^2_{adj}$                                                                                                                               | 0.03                | 0.06                | 0.03                | 0.03                | 0.04                |
| Dependent Variable:<br>Profit Margin                                                                                                      |                     |                     |                     |                     |                     |
| Sector Frac Zombie $\times$ Nonzombie                                                                                                     | -0.12***<br>(0.004) | -0.15***<br>(0.006) | -0.11***<br>(0.007) | -0.12***<br>(0.005) | -0.11***<br>(0.007) |
| Observations                                                                                                                              | 300,812             | 300,812             | 292,659             | 292,659             | 292,618             |
| $R^2$                                                                                                                                     | 0.29                | 0.30                | 0.64                | 0.64                | 0.65                |
| $R^2_{adj}$                                                                                                                               | 0.29                | 0.30                | 0.59                | 0.59                | 0.60                |
| Controls                                                                                                                                  | Yes                 | Yes                 | Yes                 | Yes                 | Yes                 |
| Time                                                                                                                                      | No                  | Yes                 | Yes                 | No                  | No                  |
| Firm                                                                                                                                      | No                  | No                  | Yes                 | Yes                 | Yes                 |
| Time $\times$ Country                                                                                                                     | No                  | No                  | No                  | No                  | Yes                 |
| Sector                                                                                                                                    | No                  | No                  | No                  | Yes                 | Yes                 |
| Country                                                                                                                                   | No                  | No                  | No                  | Yes                 | No                  |
| <b>Note:</b> Coefficients expressed in percentage points. Standard errors in parentheses. * $p < 0.10$ , ** $p < 0.05$ , *** $p < 0.01$ . |                     |                     |                     |                     |                     |

a zombie, and how this varies alongside a loosening monetary policy. Following Barth, Caprio, and Levine (2001), we construct an updated version of the Official Supervisory Power (OSP) index. This variable is determined by yes or no responses to 16 questions asked to the countries' central banks and prudential authorities and captures the extent to which supervisory authorities can intervene and take corrective actions. Our index, spanning the period 1999–2016, has annual frequency and compiles information from all surveys released to date.<sup>11</sup> For this analysis, we estimate the following regression specification:

$$\begin{aligned} \text{Zombie}_{i,j,t} = & \beta_1 \cdot \text{Shadow}_{j,t} + \beta_2 \cdot \text{OSP}_{j,t} \\ & + \beta_3 \cdot \text{Shadow}_{j,t} \cdot \text{OSP}_{j,t} + \gamma \cdot X_{i,j,t} + u_{i,j,t}, \end{aligned} \quad (4)$$

where  $\text{OSP}_{j,t}$  is the logarithm of the supervisory power index in country  $j$  at time  $t$ , and  $X_{i,j,t}$  includes the same set of control variables as in our baseline specification. The coefficient  $\beta_2$  estimates the impact of an increase in country-level supervisory power on the probability of a firm becoming a zombie, while  $\beta_3$  estimates how the interaction between supervisory power and monetary policy rates affects this probability. Table 6 presents the results of this analysis with a comprehensive set of fixed effects. The first row aligns with our previous analyses, indicating a negative relationship between interest rates and the probability of firms becoming zombies. The second row presents the estimated coefficients of our OSP series, which are negative and significant, highlighting a negative correlation between supervisory power and the likelihood of a firm becoming a zombie. This finding confirms that increased supervisory stringency, through more frequent inspections and enhanced control powers, can mitigate the “evergreening” of loans to unprofitable companies. The third and final row illustrates that higher supervisory powers can partially counteract the adverse effects of expansionary monetary policy. However, since the coefficient for the interaction term is positive but lower than the main coefficient for

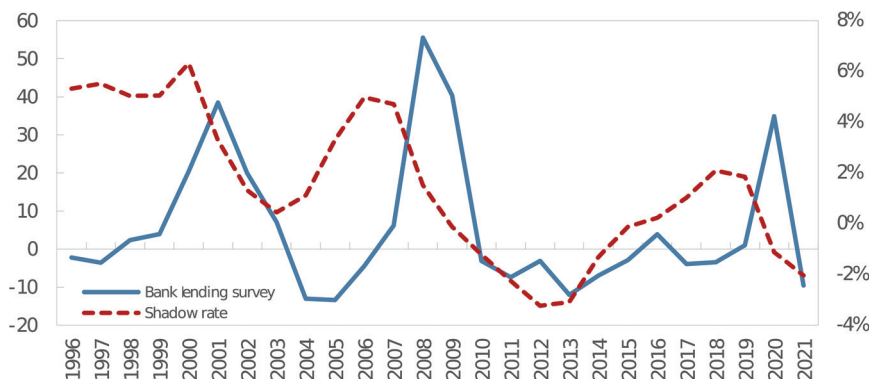
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<sup>11</sup>Note that, since the surveys are not released annually, we build the index based on the release dates and assume that supervisory power remains constant until a new survey is released. This approach aligns with the fact that prudential regulations change with low frequency, allowing us to avoid distorting the data by interpolating between two adjacent values.

Table 6. Official Supervisory Power

| Dependent Variable: Zombie                                                                                                                | (1)                  | (2)                  | (3)                  | (4)                 | (5)                  |
|-------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|----------------------|---------------------|----------------------|
| Shadow Rate                                                                                                                               | -0.66***<br>(0.21)   | -0.55***<br>(0.24)   | -0.19***<br>(0.025)  | -0.24***<br>(0.023) | -0.08<br>(0.24)      |
| OSP                                                                                                                                       | -0.039***<br>(0.001) | -0.039***<br>(0.001) | -0.021***<br>(0.001) | -0.011*<br>(0.003)  | -0.038***<br>(0.001) |
| Shadow Rate × OSP                                                                                                                         | 0.003***<br>(0.001)  | 0.003***<br>(0.001)  | 0.008***<br>(0.001)  | 0.008***<br>(0.001) | 0.002***<br>(0.001)  |
| Controls                                                                                                                                  | Yes                  | Yes                  | Yes                  | Yes                 | Yes                  |
| Time                                                                                                                                      | No                   | Yes                  | Yes                  | No                  | No                   |
| Firm                                                                                                                                      | No                   | No                   | Yes                  | Yes                 | No                   |
| Sector                                                                                                                                    | No                   | No                   | No                   | Yes                 | No                   |
| Sector × Time                                                                                                                             | No                   | No                   | No                   | No                  | Yes                  |
| Country                                                                                                                                   | No                   | No                   | No                   | Yes                 | No                   |
| Observations                                                                                                                              | 330,884              | 330,884              | 321,540              | 321,540             | 330,884              |
| $R^2$                                                                                                                                     | 0.10                 | 0.10                 | 0.58                 | 0.58                | 0.11                 |
| $R^2_{adj}$                                                                                                                               | 0.10                 | 0.10                 | 0.52                 | 0.52                | 0.10                 |
| <b>Note:</b> Coefficients expressed in percentage points. Standard errors in parentheses. * $p < 0.10$ , ** $p < 0.05$ , *** $p < 0.01$ . |                      |                      |                      |                     |                      |

**Figure 9. Monetary Policy (right-hand side) and Bank Lending Standards (left-hand side) in the U.S.**



**Sources:** Orbis database, IMF World Economic Outlook database, and the authors' calculations.

the shadow rate, decreasing interest rates remain the primary driver of company zombification, even with higher supervisory power.

#### 4.2 Lending Standards

Lastly, we try to gauge if banks had leniency toward weak companies by analyzing trends in net changes in the standards and terms on bank loans to SMEs in the U.S. using the Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS). As can be seen from Figure 9, there is a strong correlation between the shadow rate (with a two-year delay) and the loan standards in the U.S. in the periods when the shadow rate was reduced to low levels. Although low interest rates and government incentives would normally be expected to support credit growth, the persistent easing of loan standards during 2004–06, when financial imbalances were building ahead of the GFC, and during 2010–18, when the economy was recovering from the GFC, can arguably be interpreted as a sign of greater leniency toward weaker firms.

However, Favara, Minoiu, and Perez-Orive (2021) find that U.S. banks do not seem to offer credit on favorable terms to zombie firms. On average, they charge zombie firms higher loan spreads, require

more collateral, and offer shorter-maturity loans than to non-zombie firms. Moreover, banks appear to assess zombie firms as having a higher probability of default and systematically rate their credit ratings lower than those of other firms.

Overall, related financial-sector risks in the 21 countries studied appear manageable in the short-to-medium term. Banks have significantly improved their lending and loan classification practices, capital and liquidity adequacy ratios, and stress-testing capacity in the aftermath of the GFC, especially in the context of Basel III reforms. Recent stress tests conducted by banks, regulatory authorities, and the International Monetary Fund (IMF), as part of their respective Financial Sector Assessment Programs (FSAP), indicate that the financial systems in these countries are capable of withstanding significant but plausible shocks. Moreover, these countries have significantly improved their financial-sector supervision and crisis management and resolution frameworks, notably with respect to early warning systems and pre-insolvency frameworks, enabling them to identify adverse trends and manage crises if they occur. Indeed, the financial systems performed well during the COVID-19 pandemic, a once-in-a-century shock. However, the prolonged period of low interest rates poses challenges for financial markets in the medium-to-long term, especially in Japan, as noted in IMF (2017). Profitability pressures are even more intense for smaller institutions outside urban regions in Japan due to declining populations in these areas. Furthermore, the prolonged low domestic interest rate environment is pushing life insurers to turn to foreign investments to provide the yield needed to meet interest guarantees on old policies. These developments imply risks that need to be continuously monitored.

## 5. Conclusions

While expansionary policies that boost economic activity and financial indicators of firms are necessary to smooth economic cycles, extended periods of low monetary policy rates may have undesirable adverse effects. Our empirical analyses confirm that recessions and slow growth are critical factors in the increase in the number of zombie firms. Accordingly, expansionary policies may be used in such cases if the central bank is credible and there are no inflationary

pressures. However, we also find that an extended low interest rate environment facilitates the survival of zombie firms, adversely affecting non-zombie firms through resource misallocation. This implies a trade-off between conducting countercyclical monetary policy and using expansionary tools for long periods, which may lead to a combination of low interest rates, low growth, and higher financial vulnerability. Such a trade-off is not a concern when most countries are tightening their monetary policy stance, but policymakers should be mindful of it during future recessions. Our findings suggest that Japan and, to a lesser extent, the euro area experienced a more significant economic slowdown partly due to the increase in the number of zombie firms. This raises concerns about the sustainability of keeping monetary policy rates low for extended periods, especially in countries with lackluster growth. We also find that stronger supervisory power is associated with a lower likelihood of firms becoming zombies. However, when combined with a low interest rate environment, this mitigation effect diminishes slightly. Despite the important reforms since the GFC, there remain risks to financial stability from extended periods of low monetary policy rates, especially if these need to be followed by policy tightening later, which must be closely monitored.

## **Appendix. Robustness Exercises**

This appendix includes a set of robustness exercises to strengthen the paper's main results. First, we check the robustness of our main findings by departing from our preferred identification scheme of a zombie firm in our data set. Table A.1 shows the results of different specifications of Equation (3), where a firm is classified as a zombie if it is at least 10 years old and its ICR is lower than one for at least three consecutive periods, compared with the two periods in our baseline approach.

The results are similar both from a qualitative and quantitative perspective, and the economic intuitions drawn in Section 3 remain valid. The correlation between the shadow rate and the probability of becoming a zombie firm depends on the economic environment, with expansionary policies being associated with lower probabilities of a firm being a zombie under the ZLB and being associated with



**Table A.2. Effect on the Probability of Being a Zombie Firm during Long Periods of Low Interest Rates (robustness exercise)**

| Dependent Variable:<br>Zombie Share | Linear Probability Model |                    | Probit Model ( <i>mfx</i> ) |                    |
|-------------------------------------|--------------------------|--------------------|-----------------------------|--------------------|
|                                     | (1)                      | (2)                | (3)                         | (4)                |
| Shadow Rate                         | −0.22***<br>(0.03)       | −0.22***<br>(0.03) | −0.04***<br>(0.01)          | −0.04***<br>(0.01) |
| Long                                | 1.71***<br>(0.27)        | 1.43***<br>(0.27)  | 0.81***<br>(0.11)           | 0.68***<br>(0.11)  |
| Shadow Rate × Long                  | −0.55*<br>(0.30)         | −0.28<br>(0.30)    | −0.41**<br>(0.19)           | −0.29*<br>(0.19)   |
| Recession                           |                          | 0.55***<br>(0.08)  |                             | 0.24***<br>(0.04)  |
| SME                                 | 0.62**<br>(0.26)         | 0.62***<br>(0.26)  | 0.20***<br>(0.07)           | 0.20***<br>(0.06)  |
| GDP Growth                          | −5.69**<br>(0.84)        | −2.96**<br>(0.95)  | −2.68***<br>(0.41)          | −1.40***<br>(0.46) |
| ROA                                 | −0.29***<br>(0.01)       | −0.29***<br>(0.01) | −0.21***<br>(0.01)          | −0.21***<br>(0.01) |
| Profit Margin                       | −0.18***<br>(0.01)       | −0.18***<br>(0.01) | −0.04***<br>(0.01)          | −0.04***<br>(0.01) |
| Firm FE                             | Yes                      | Yes                | No                          | No                 |
| Observations                        | 433,151                  | 433,151            | 433,151                     | 433,151            |
| Individual Firms                    | 63,488                   | 63,488             | 63,488                      | 63,488             |
| <i>R</i> <sup>2</sup>               | 0.07                     | 0.07               |                             |                    |

**Note:** Coefficients expressed in percentage points. Standard errors in parentheses. \**p* < 0.10, \*\**p* < 0.05, \*\*\**p* < 0.01.

a higher probability of being a zombie in the other periods. A difference is that the coefficient for the lagged shadow rate in column 4 here is very low and statistically insignificant. Second, in Table A.2, we replicate the estimation of Equation (2) with the zombie firm identification used in Table 5. As in the previous exercise, we can draw conclusions similar to our baseline estimation. Keeping the interest rates low for an extended period is correlated with a higher probability of a firm being a zombie.

## References

- Acharya, V. V., M. Crosignani, T. Eisert, and S. Steffen. 2022. "Zombie Lending: Theoretical, International, and Historical Perspectives." *Annual Review of Financial Economics* 14: 21–38.
- Acharya, V. V., T. Eisert, C. Eufinger, and C. Hirsch. 2019. "Whatever It Takes: The Real Effects of Unconventional Monetary Policy." *Review of Financial Studies* 32 (9): 3366–3411.
- Adalet McGowan, M., D. Andrews, and V. Millot. 2018. "The Walking Dead? Zombie Firms and Productivity Performance in OECD Countries." *Economic Policy* 33 (96): 685–736.
- Banerjee, R., and B. Hofmann. 2018. "The Rise of Zombie Firms: Causes and Consequences." *BIS Quarterly Review* (September): 67–78.
- Barth, J. R., G. Caprio, and R. Levine. 2001. *The Regulation and Supervision of Banks Around the World: A New Database*, Vol. 2588. World Bank Publications.
- Bernanke, B. S., and I. Mihov. 1998. "Measuring Monetary Policy." *Quarterly Journal of Economics* 113 (3): 869–902.
- Black, F. 1995. "Interest Rates as Options." *Journal of Finance* 50 (5): 1371–76.
- Blattner, L., L. Farinha, and F. Rebelo. 2023. "When Losses Turn into Loans: The Cost of Weak Banks." *American Economic Review* 113 (6): 1600–1641.
- Bonfim, D., G. Cerqueiro, H. Degryse, and S. Ongena. 2023. "On-site Inspecting Zombie Lending." *Management Science* 69 (5): 2547–67.
- Caballero, R. J., T. Hoshi, and A. K. Kashyap. 2008. "Zombie Lending and Depressed Restructuring in Japan." *American Economic Review* 98 (5): 1943–77.
- Canova, F., and M. Ciccarelli. 2013. "Panel Vector Autoregressive Models: A Survey." In *VAR Models in Macroeconomics—New Developments and Applications: Essays in Honor of Christopher A. Sims*, ed. T. B. Fomby, A. Murphy, and L. Kilian. Emerald Group Publishing Limited.
- Christiano, L. J., M. Eichenbaum, and C. L. Evans. 1999. "Monetary Policy Shocks: What Have We Learned and to What End?" In *Handbook of Macroeconomics*, Vol. 1, Part A, ed. J. B. Taylor and M. Woodford, 65–148. North-Holland.

- Corrado, L., S. Grassi, and E. Minnella. 2021. "The Transmission Mechanism of Quantitative Easing: A Markov-Switching FAVAR Approach." CEIS Research Paper No. 520.
- Diez, F. J., J. Fan, and C. Villegas-Sánchez. 2019. "Global Declining Competition." IMF Working Paper No. 19/82.
- Favara, G., C. Minoiu, and A. Perez-Orive. 2021. "US Zombie Firms: How Many and How Consequential?" Technical Report, Board of Governors of the Federal Reserve System.
- Giannetti, M., and A. Simonov. 2013. "On the Real Effects of Bank Bailouts: Micro Evidence from Japan." *American Economic Journal: Macroeconomics* 5 (1): 135–67.
- Harrison, R. 2012. "Asset Purchase Policy at the Effective Lower Bound for Interest Rates." Working Paper No. 444, Bank of England.
- . 2017. "Optimal Quantitative Easing." Working Paper No. 678, Bank of England.
- Hohberger, S., R. Priftis, and L. Vogel. 2019. "The Macroeconomic Effects of Quantitative Easing in the Euro Area: Evidence from an Estimated DSGE Model." *Journal of Economic Dynamics and Control* 108 (November): 1–25.
- Ikedá, D., S. Li, S. Mavroidis, and F. Zanetti. 2024. "Testing the Effectiveness of Unconventional Monetary Policy in Japan and the United States." *American Economic Journal: Macroeconomics* 16 (2): 250–86.
- International Monetary Fund. 2017. "Japan: Financial System Stability Assessment." IMF Country Report No. 17/244.
- Jarociński, M. 2010. "Responses to Monetary Policy Shocks in the East and the West of Europe: A Comparison." *Journal of Applied Econometrics* 25 (5): 833–68.
- Joyce, M., D. Miles, A. Scott, and D. Vayanos. 2012. "Quantitative Easing and Unconventional Monetary Policy—An Introduction." *Economic Journal* 122 (564): F271–F288.
- Krippner, L. 2013. "Measuring the Stance of Monetary Policy in Zero Lower Bound Environments." *Economics Letters* 118 (1): 135–38.
- Krishnamurthy, A., and A. Vissing-Jorgensen. 2011. "The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy." Technical Report, National Bureau of Economic Research.

- Lemke, W., and A. Vladu. 2017. "Below the Zero Lower Bound: A Shadow-Rate Term Structure Model for the Euro Area." ECB Working Paper No. 1991.
- Lombardi, M. J., and F. Zhu. 2018. "A Shadow Policy Rate to Calibrate US Monetary Policy at the Zero Lower Bound." *International Journal of Central Banking* 14 (5): 305–46.
- Mavroeidis, S. 2021. "Identification at the Zero Lower Bound." *Econometrica* 89 (6): 2855–85.
- Minsky, H. P. 1977. "The Financial Instability Hypothesis: An Interpretation of Keynes and an Alternative to 'Standard' Theory." *Challenge* 20 (1): 20–27.
- Mouabbi, S., and J.-G. Sahuc. 2019. "Evaluating the Macroeconomic Effects of the ECB's Unconventional Monetary Policies." *Journal of Money, Credit and Banking* 51 (4): 831–58.
- Peek, J., and E. S. Rosengren. 2005. "Unnatural Selection: Perverse Incentives and the Misallocation of Credit in Japan." *American Economic Review* 95 (4): 1144–66.
- Primiceri, G. E. 2005. "Time Varying Structural Vector Autoregressions and Monetary Policy." *Review of Economic Studies* 72 (3): 821–52.
- Turner, P., A. Rebucci, J. Zhou, and P. Monnin. 2019. "The Risks and Side Effects of UMP: An Assessment of IMF Views and Analysis." Background Paper No. 19-01/05, Independent Evaluation Office, International Monetary Fund.
- Vayanos, D., and J.-L. Vila. 2009. "A Preferred-Habitat Model of the Term Structure of Interest Rates." Technical Report, National Bureau of Economic Research.
- Wu, J. C., and F. D. Xia. 2016. "Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound." *Journal of Money, Credit and Banking* 48 (2–3): 253–91.