Firm Productivity and Bank Lending*

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Abstract

Using matched credit-registry and firm-financial data spanning the universe of loans in Turkish manufacturing, this paper studies how firm-specific productivity changes map to bank lending. Firms experiencing negative productivity innovations subsequently see faster loan growth. Notably, they do not face worsening terms—higher interest rates and shorter maturities. This contrasts with the positive response of credit growth to balance-sheet improvements such as higher profitability and liquidity, and lower leverage. The evidence supports a lender-driven channel, which becomes stronger along the intensive margin of lending relationships. Both private and state banks increase credit in response to negative productivity innovations, but through different channels over the credit cycle. The response of private banks is elevated and concentrated in a small number of large firms, whereas state banks tend to reallocate toward low-productivity SMEs. During periods of credit tightening, state banks strongly join private banks in shifting lending toward low-productivity large firms.

Keywords: Bank credit, Bank ownership structure, Credit allocation, Credit cycles, Productivity, Relationship lending

JEL Classification: D24; E51; G21; G32

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1 Introduction

How does a bank adjust its credit to a firm following an idiosyncratic productivity change? Theory implies competing mechanisms. Balance-sheet channel models predict that productivity-driven increases in pledgeable income—via profits, net worth, and collateral values—relax borrowing constraints and increase bank credit.[1] Adverse-selection models imply an attenuated credit response to idiosyncratic productivity when borrower quality is not observable to lenders.[2] Relationship lending models predict that banks continue lending and even increase loan quantities when the borrower's state deteriorates.[3] The last channel may also lead to 'zombie lending' as an extreme case and increase resource misallocation (see, e.g., Albuquerque and Iyer, 2024; Caballero et al., 2008; Banerjee and Hofmann, 2018; Adalet McGowan et al., 2018), which is a significant driver of cross-country income differences (Hsieh and Klenow, 2009). While much is known about how credit supply shocks affect productivity, far less is known about how idiosyncratic productivity changes feed back into credit allocation, especially within bank–firm relationships.[4] In this paper, we fill this gap by presenting, to our knowledge, the first systematic treatment of how bank lending responds to changes in firm productivity at the level of bank–firm relationships. Our contribution is to document a novel and robust fact: bank credit within relationships expands when firms experience productivity declines, even though loan terms do not tighten.

We use matched administrative data covering the full universe of bank–firm credit relationships in Turkish manufacturing over the 2013–2023 period. Türkiye offers a suitable setting. It has a mature banking system with both private and state-owned banks under a unified regulatory framework, alongside relatively underdeveloped capital markets. This structure gives rise to a bank-credit dominated financial system and an outsized role for banks in firm growth, similar to most emerging and developing economies and even the bank-based architecture of continental Europe.[5] The richness of this dataset enables us to condition on better-understood channels—such as transaction-based (arm's-length) lending, time-invariant relationship traits, and bank-level supply shocks—and thereby isolate the granular borrower-specific dimension of credit allocation.

We implement a saturated fixed effects strategy to isolate the link between firm-specific

[1] See Cooley and Quadrini (2001) on firm-level productivity as a stochastic process under borrowing constraints, Carlstrom and Fuerst (1997) and Bernanke et al. (1999) on idiosyncratic return shocks under costly-state-verification and agency frictions, and Kiyotaki and Moore (1997) on aggregate productivity shocks under collateral constraints.

[2] See Jaffee and Russell (1976); Stiglitz and Weiss (1981) on credit rationing models.

[3] Channels include incentives to recover past investments (Faria-e Castro et al., 2024), soft budgets (Dewatripont and Maskin, 1995), loss-recognition avoidance due to limited liability (Bruche and Llobet, 2014), and the valuation of potential future market financing (Hu and Varas, 2021).

[4] There exists a rich literature on how credit affects productivity. Adverse credit supply shocks reduce firm-level TFP growth (Doerr et al., 2018), while expansions have limited effects (Manaresi and Pierri, 2024). Credit also affects aggregate productivity through reallocation (Bai et al., 2018; Gopinath et al., 2017), innovation and R&D investment (Aghion et al., 2012; Amore et al., 2013; Chava et al., 2013), and zombie lending (Caballero et al., 2008; Adalet McGowan et al., 2018).

[5] Bank credit is the dominant source of external finance for firms globally, particularly in emerging markets where capital markets remain shallow and SMEs which face barriers to access alternative sources (Rajan and Zingales, 1998; Beck et al., 2008). For Europe, see European Central Bank (2024).

productivity innovations and bank credit. Differences across banks' balance sheets generate heterogeneous credit supply responses to common monetary or financial shocks (Jiménez et al., 2012; Kashyap and Stein, 2000; Kishan and Opiela, 2000; Khwaja and Mian, 2008). Bank–time fixed effects are often used to mute the credit supply channel (e.g., Jiménez et al., 2014; Amiti and Weinstein, 2018; Alfaro et al., 2021). Motivated by sectoral specialization of bank branches in different locations (Duquerroy et al., 2022), we introduce very granular saturation at the bank–industry–province–year level.[6] In addition, banks may differ in their treatment of observationally similar firms due to existing relations. Relationship lending suggests that banks adjust both the volume and other terms of lending according to their connections with firms.[7] Consequently, we let bank–firm fixed effects absorb time-invariant relationship characteristics such as the average strength of the relationship. We further condition on time-varying firm-level indicators including leverage, liquidity, profitability, tangibility, short-term debt ratio, asset size and age in order to account for firm-specific characteristics. Our productivity indicators span the widely used measures in the literature, including four firm-level TFP measures estimated using the control-function approach (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Wooldridge, 2009; Ackerberg et al., 2015), and for comparison, real value added per worker as a simple labor productivity measure.[8]

This yields a *within-relationship* estimate of how lending volume responds to firm-specific productivity changes, conditional on the financial state of the firm, separated from time-invariant matching traits and common credit conditions. The within-relationship estimate gives a direct reduced form response but does not isolate firm demand from bank supply. Following Khwaja and Mian (2008), we address this by introducing firm–time fixed effects and interacting productivity with relationship strength, measured by a bank's share in firm's total debt. This alternative setting exploits the variation across multiple banks lending to the same firm in a given year, thereby holding firm demand fixed. We also explore how the productivity-credit link varies in the intensity of relationship. We summarize our key findings as follows.

First, negative firm-specific productivity changes are followed by faster loan growth within lending relationships on average. The result is robust across productivity measures, levels of aggregation, loan and firm types.[9] On the other hand, bank lending responds to changes in profitability, liquidity and collateral capacity positively while to changes in leverage and short-term debt negatively. While financial variables relate to bank credit in line with the predictions of balance-sheet and risk channels, the result on productivity is surprisingly in contrast. Investigating the terms of lending, we observe the negative productivity response only on the lending

[6]To our knowledge, this is the first paper using such granular saturation to isolate credit supply shocks. See Er et al. (2025) and the references therein for studies using bank–industry–time fixed effects. We show robustness of our results to a more relaxed set of fixed effects in Section 7.

[7]See e.g., Boot (2000), Ongena and Smith (2000), Degryse et al. (2009).

[8]We adopt a neutral stance regarding methodological differences and present the results from a suite of widely used productivity measures. A burgeoning literature on estimation of firm-level productivity has developed several approaches, each requiring specific assumptions on the data generating process. See the reviews in Van Beveren (2012) and De Loecker and Syverson (2021).

[9]While our baseline analysis focuses on manufacturing due to superior capital measurement, the main patterns persist across the broader economy.

volume as interest rates and maturities do not change with productivity innovations.

Second, we investigate the heterogeneity of our finding with respect to the type of bank ownership, firm size, and credit cycles. We show that declining firm productivity is associated with higher credit growth both in private and state-owned banks, but the patterns substantially differ by firm size. In private banks, the response is elevated and concentrated in a small number of large borrowers who account for most of the loan stock, employment, and net sales in our sample. For these firms, the negative TFP–credit link is several times larger. State banks direct credit toward a large number of SMEs experiencing negative productivity innovations. Moreover, we show how these patterns change over the credit cycle, especially for state banks. During periods of credit tightening, while private banks show no significant change in their behavior, state banks shift lending heavily toward large, low-productivity firms, significantly amplifying the credit response in tight financial conditions.

Third, we present evidence for a supply-driven interpretation. While our finding that lending terms do not worsen for low-productivity firms is suggestive of a supply effect, it is not conclusive. Controlling for firm–time fixed effects, estimations show that banks having a higher debt share of the firm provide more credit to lower productivity firms. This also implies that the negative response of credit growth to productivity disproportionately comes from stronger relationships. Not only do primary relationship banks increase loan quantities to low-productivity borrowers, they do so on easier terms, i.e., lower interest rates and longer maturities, compared to other banks. This behavior is hard to reconcile with borrower-driven demand, which would normally come at a cost of tighter terms.

Lastly, we present evidence that the negative productivity-credit link is not an artifact of evergreening the loans of a subset of firms that cannot survive without continuing support from banks (Caballero et al., 2008). We employ two definitions of zombie firms from the literature (Albuquerque and Iyer, 2024; Adalet McGowan et al., 2018) and show that our results are not driven by borrowers at the tail of financial distress, i.e., mature firms with particularly low interest coverage and/or high leverage. Our key finding extends beyond the relatively small subset of canonical zombies and is pervasively experienced throughout the credit market.

Our main contribution to the literature is to present the first extensive empirical study of the response of lending to firm productivity in the context of lending relationships. There are few empirical papers motivated by the lending outcomes of firm-level productivity. Chen and Matousek (2020) report that firm productivity is positively associated with external financing of Chinese listed firms. George et al. (2023) find evidence that Indian banks overall provide more credit to higher productivity firms, which weakens with state-owned bank exposure. These prior studies at the firm-level do not separate credit supply from the demand and covered limited samples, whereas this paper uses the universe of loans with rich fixed effects to isolate supply-driven effects. Nevertheless, our firm-level estimates confirm the negative productivity response of bank credit observed at the bank–firm level, contrasting with the results of these papers.

Our findings add to the long tradition on relationship lending (Petersen and Rajan, 1994, 1995; Berger and Udell, 1995, 2006). Our results clearly contrast with the strand of this literature

that predicts that relationship lenders offer worse terms to borrowers experiencing negative shocks (Rajan, 1992; Sharpe, 1990; Von Thadden, 1995). Instead, they broadly support those predicting that bank–firm relationships are associated with continued lending after adverse firm-specific shocks, motivated by intertemporal smoothing to extract rents in better times (Bolton et al., 2016), reputation concerns (Dinç, 2000), or avoiding potential losses and benefiting from future financing prospects (Bruche and Llobet, 2014; Dewatripont and Maskin, 1995; Hu and Varas, 2021). However, this literature typically does not model productivity shocks explicitly, focusing simply on the overall state of the borrower. An exception is Faria-e Castro et al. (2024), who provide a direct theoretical benchmark to compare our results. Our evidence is in line with the bank behavior in their model's 'evergreening zone' of a lending relationship, where banks optimally choose to increase credit and lower interest rates to firms with lower productivity. While they empirically show that healthy banks provide more loans to distressed firms, i.e., those with higher default probability, our results suggest that even non-distressed, ordinary firms experiencing lower productivity innovations receive more credit.[10] Hence, we show that firm productivity is a separate, pervasive and relevant facet of relationship lending.[11]

Our results also speak to the literature on the cyclicality of lending by bank ownership. A large literature on bank ownership and credit cyclicality finds that state-owned banks tend to be less procyclical or even countercyclical (Behr et al., 2017; Bertay et al., 2015; Brei and Schclarek, 2015; Coleman and Feler, 2015; Cull and Martínez Pería, 2013; Er et al., 2025; Fungáčová et al., 2013; Gong et al., 2023; Micco and Panizza, 2006), although some studies find no difference relative to private banks (Dekle and Lee, 2015; Zins and Weill, 2018). However, these studies generally rely on bank-level data, with a few exceptions such as Gong et al. (2023) and Er et al. (2025). In addition to utilizing a granular dataset allowing us to control for the potential impact of supply-side heterogeneity, our contribution to this literature is to show a new dimension of divergence: private and state banks differ in how they adjust credit in response to firm productivity shocks, and this divergence varies by firm size.

The remainder of the paper proceeds as follows: Section 2 describes the data and variables. Section 3 introduces the empirical strategy. Section 4 presents the within-relationship results and explores the heterogeneous responses with respect to bank ownership, firm size, and credit cycle. Section 5 presents the results on the intensity of lending relationship and discusses the results in the face of existing theories. Section 6 presents evidence that the results are not driven by a specific subset of zombie firms. Section 7 discusses extensions and robustness of the main results and Section 8 concludes.

[10] In particular, our control set conditions on potential financial distress reflected in balance-sheet variables such leverage, liquidity, size and age. Furthermore, our results hold in the non-zombie subsamples. See Álvarez et al. (2023) for a taxonomy relating probability of default, distress, and zombie lending. See Elsas and Krahnen (1998), Hoshi et al. (1990), Li et al. (2019), Peek and Rosengren (2005), Schäfer (2019), for the separate strand of literature on the consequences of firm distress on credit outcomes in lending relationships.

[11] While the evidence in this paper supports a widespread evergreening interpretation, exploring its consequences on the economy and welfare is beyond its scope.

2 Data

2.1 Data Sources

The data source on bank lending is the Credit Registry provided by the Central Bank of the Republic of Türkiye (CBRT), which contains records of all loan agreements between banks and firms. Key variables include the principal amount, interest rate, issuance date and maturity—all of which we use in our analysis. Missing observations, non-cash loans, credit cards, and non-performing loans are excluded.

For firm-specific characteristics, we employ financial statements compiled by the Revenue Administration of Türkiye, which includes all balance-sheets and income statements of firms at an annual frequency.[12] Social Security Registry data on the number of employees for each firm is merged to this data. We exclude firms with incomplete or incoherent information from the dataset such as firms with negative total assets or negative total sales.

In addition to financial statements, we use information on firm-level value added and material costs from Annual Industry and Service Statistics of the Turkish Statistical Institute for the measurement of productivity, which excludes firms with less than 10 employees.

We collapse the Credit Registry data at the bank–firm–year level and merge with financial statements and firm-level productivity by the unique tax identifiers. We remove outliers by winsorizing all continuous variables, which we introduce below, at the 1% level. Our matched dataset covers 77% of corporate loans granted in Türkiye over the period 2013–2023. We restrict the sample to manufacturing, which covers 27% of the credit stock.[13]

2.2 Variables and summary statistics

We summarize the construction of the variables here and present the summary statistics in Table 1.

Loan variables Our key dependent variable is credit growth, which we measure as the annual log change in a firm's total loan stock from a given bank. The other lending terms we use as dependent variables are the interest rate and maturity. We aggregate at the bank–firm–year level as the average of the interest rate and maturity, weighted by the principal amount of each loan. We use the annual change of the interest rates and the annual log change in maturities. While studying the intensive margin of lending relationships we use the debt share, which is measured as a bank's credit to a firm divided by the firm's total credit in a given year.

[12] Unincorporated businesses such as sole-proprietorship and partnership businesses are not recorded in the data sources. These excluded firms are mostly micro firms that are not obliged to report regular balance sheets and likely play a minor role in credit. Our dataset including incorporated firms, on average, accounts for 90% of the total sales of all firms over the sample period in Türkiye.

[13] Baseline estimates use manufacturing firms, where TFP identification is more reliable; measurement in services is complicated by deflation, output, and capital measurement issues (Syverson, 2011). We later confirm that our results hold economy-wide; see Section 7.3.

Table 1: *Summary statistics*

	Observations	Mean	STD	P25	Median	P75
Loan variables						
Credit (log change)	604,757	0.017	1.575	-0.592	0.000	0.636
Interest rate (%, change)	321,829	2.93	9.12	-0.87	0.71	4.24
Maturity (log change)	319,133	-0.134	1.073	-0.615	-0.216	0.268
Debt share (lagged)	604,757	0.328	0.333	0.059	0.191	0.523
Productivity (lagged, logs)						
ACF	604,757	8.008	0.773	7.515	7.995	8.491
LP	604,757	9.638	0.830	9.097	9.553	10.124
OP	604,203	8.691	0.787	8.199	8.694	9.180
W	604,757	9.749	0.910	9.150	9.648	10.273
RLP	604,757	12.514	0.687	12.022	12.444	12.929
Firm-level balance-sheet controls (lagged)						
Tangibility	604,757	0.437	0.678	0.127	0.262	0.489
Profitability	604,757	0.103	0.131	0.042	0.081	0.140
Liquidity	604,757	0.077	0.109	0.010	0.033	0.097
Leverage	604,757	0.705	0.237	0.577	0.738	0.849
Short-term debt ratio	604,757	0.552	0.329	0.313	0.522	0.740
Total assets (log)	604,757	16.601	1.515	15.525	16.463	17.536
Age (log)	604,757	2.726	0.667	2.303	2.833	3.219

Note: The table reports the summary statistics of the variables. All variables are at the annual frequency. See Section 2.2 for variable definitions.

Productivity We capture firm-level productivity with five alternative measures. Four of them, OP (Olley and Pakes, 1996), LP (Levinsohn and Petrin, 2003), W (Wooldridge, 2009), ACF (Ackerberg et al., 2015), estimate total factor productivity (TFP) and rely on methods of Cobb-Douglas production function estimation, which take into account the potential correlation between firm-specific unobserved productivity shocks and the input choices through control function approaches. Our labor variable is number of employees from Social Security Registry and capital variable is the deflated book value of net tangible assets from the financial statements. OP use investment as a proxy variable in estimation, which we measure as the change in capital stock. LP, W, and ACF use intermediate inputs as the proxy variable. The output measure is real value added, calculated as net sales minus intermediate input expenditure and deflated by the producer price index of the corresponding 4-digit industry. All TFP measures are estimated separately within 4-digit industries and include time-fixed effects removing any common annual shock at the industry level. Finally, as a non-parametric benchmark, we use real labor productivity (RLP) as real value added per employee.[14]

Balance-sheet variables We use a set of firm-level control variables that are used by prior studies as proxies for firms' riskiness and balance-sheet strength (e.g., Er et al., 2025; Gong et al., 2023; Graham et al., 2015; He and Xiong, 2012; Santos and Winton, 2019; Vander Bauwhede et al., 2015; Wang et al., 2020; Yarba and Deniz, 2024, among others). Tangibility, a proxy for collateral capacity, is defined as net property, plant, and equipment divided by total assets. We calculate firm profitability as the ratio of earnings before interest, taxes, depreciation, and

[14]Given that the data do not provide firm-specific prices our productivity measures deflated at the industry level fall within the class of revenue-productivity (Hsieh and Klenow, 2009).

amortization (EBITDA) to total assets. Liquidity is calculated as the sum of cash and cash equivalents divided by total assets. Leverage is measured by the total financial debt of a firm divided by its assets. Short-term indebtedness is calculated as the ratio of short-term debt to total debt. We also use firm size, measured as the log of total assets, and firm age, defined as the log of the number of years since the firm's foundation.

3 Empirical Strategy

3.1 The within-relationship estimate

Our approach is to estimate the response of bank lending through a single equation with fixed-effects saturation and relevant controls. In particular, we estimate the following linear panel regression model with high dimensional fixed effects:

$$\Delta credit_{b,f,t} = \beta \; productivity_{f,t-1} + \Gamma X_{f,t-1} + \alpha_{b,s,l,t} + \alpha_{b,f} + \varepsilon_{b,f,t} \tag{1}$$

where the dependent variable, $\Delta credit_{b,f,t}$, is the log change in the credit provided by bank b to firm f in year t. β is the key parameter in this study measuring the response of credit growth to changes in log productivity of firm f at $t-1$, $productivity_{f,t-1}$. Specifically, credit growth (log difference in credit) changes by β percentage points due to a 1% increase in productivity, holding control variables constant.

We use lagged values of our regressors to avoid simultaneity and because it suits our data generating process. For credit growth, we have continuous measurement throughout the year while productivity can only be measured with our data at the annual frequency. As a result, our dataset has to be constructed at the year level and we use the log change in credit stock from the beginning to the end of the year. Using lagged productivity ensures that the innovation is realized before the credit decision and further avoids overlap where credit decisions could affect measured productivity.

Our balance-sheet variables cover the time-varying financial characteristics of the firm described in Section 2.2. The sensitivity of lending to these variables is measured by the coefficient vector Γ.

Key to our identification strategy is using a rich set of fixed effects. Common shocks can confound the analysis if they differently affect banks and industries in different locations. We introduce saturation through $\alpha_{b,s,l,t}$, capturing any time-varying shocks impacting a bank's lending to a given sector s and location l. This corresponds to very stringent fixed effects: we interact each bank with 4-digit industries (NACE Rev. 2) and 81 provinces (NUTS-3) for each year.[15]

Banks potentially treat observationally similar firms differently, as studied by the extensive literature on relationship lending. In our baseline results, using bank–firm fixed effects $\alpha_{b,f}$, we focus on the response of lending in an average relationship where a bank–firm pair exists for at least two consecutive periods. Bank–firm fixed effects separate any time-invariant characteristic

[15] We show robustness of the results under more relaxed fixed effects in Section 7.

of bank–firm relationships and thus β compares credit responses of the same firm with the same bank as firm productivity changes over time, conditional on the set of controls. This setup allows β to be interpreted as a within-relationship estimate, which we present in Section 4.1.

In addition to loan amount, interest rate and maturity are jointly determined in a credit decision. In order to explore other important dimensions of bank lending we use the annual change in the interest rate and the log change in maturity as dependent variables in equations (1), for which we do not introduce additional equations for brevity.

Since we investigate the consequences of productivity at the firm level, β identifies the observed equilibrium response of credit growth to productivity. Hence, it potentially reflects both the borrower demand and lender supply motives. Studying the response of these alternative lending terms can be instrumental in arguing whether results on credit tilt toward a demand- or supply-side interpretation. If the result is clearly demand (supply) driven, following an adverse productivity innovation, we expect to see worsening (improving) terms of credit—higher (lower) interest rates and shorter (longer) maturities. Section 4.2 presents the results on these other terms of lending.

3.2 Firm productivity and bank lending over the credit cycle

We explore heterogeneity in β in Section 4.3, which replicates estimation of equation (1) in different splits of firms (SME and large) and banks (private or state-owned). A complementary analysis focuses on the potential state-dependent differences in responses. In particular, we ask how the response of credit growth to firm-specific productivity changes with respect to aggregate credit conditions. We employ the following empirical model to answer:

$$\begin{aligned}\Delta credit_{b,f,t} = \phi\, productivity_{f,t-1} + \lambda\, productivity_{f,t-1} \times tight_t \\ + \Gamma X_{f,t-1} + \Omega X_{f,t-1} \times tight_t + \alpha_{b,s,l,t} + \alpha_{b,f} + \varepsilon_{b,f,t}\end{aligned} \tag{2}$$

where $tight_t$ is an indicator of tight credit conditions, taking value 1 in tight credit conditions and 0 otherwise. We characterize periods of tight credit using the ratio of real credit change to real GDP following Er et al. (2025). When the ratio is below its mean for the period that year is indicated as a tight year, i.e., the dummy variable is set to 1. We interact the tightness indicator with both productivity and all firm-level control variables, allowing for a differential effect as a function of the binary state of the credit market. The dummy alone is absorbed by $\alpha_{b,s,l,t}$.

In equation (2), ϕ measures the response of lending to productivity in times of abundant credit, i.e., credit-to-GDP ratio is above average. Our focus of interest is λ, which measures the additional response imposed in years of tight credit. $\lambda > 0$ implies that under tight credit conditions, productivity has a positive impact on credit growth relative to loose credit conditions, and vice versa. As with equation (1), we estimate equation (2) under different sample restrictions based on ownership and size, reported in Section 4.4.

3.3 Estimations based on relationship strength

Our primary interest is the within-relationship productivity response of credit growth, as captured by equation (1). However, much of the relationship lending literature examines how outcomes vary with relationship strength, given the large variation on the intensive margin (Boot, 2000). We therefore extend our analysis to incorporate relationship intensity as follows.

$$\Delta credit_{b,f,t} = \mu\, debt\, share_{b,f,t-1} + \rho\, debt\, share_{b,f,t-1} \times productivity_{f,t-1} + \alpha_{b,s,l,t} + \alpha_{f,t} + \varepsilon_{b,f,t} \quad (3)$$

where, in addition to equation (1), $debtshare_{b,f,t-1}$ denotes $t-1$ period share of bank b in the total debt of firm f and $\alpha_{f,t}$ denotes firm–time fixed effects.

Following Khwaja and Mian (2008), equation (3) introduces two useful dimensions. First, the debt share, a widely used measure of the strength of the relationship, allows us to measure how the credit response to relationship intensity changes according to firm level productivity innovations. μ estimates how credit varies with the banks' importance in a firm's overall debt. Second, $\alpha_{f,t}$ allows comparing the credit outcome of the same firm in a given year across banks. β of equation (1) estimates the typical within-relationship response without separating demand and supply. By comparing, at a given firm–year, how different banks expand credit, we effectively hold the firm's credit demand constant. If the main bank, measured by the higher debt share, lends disproportionately more when productivity is low, that suggests a supply-side motive. Consequently, the interaction term, $\rho < 0$ ($\rho > 0$) indicates that a bank with a higher debt share lends more (less) to a firm with lower productivity compared to other lenders of the same firm.

One remaining concern is that even with firm–year fixed effects, low-productivity firms might behave differently, e.g., they might avoid borrowing from their main bank or conversely borrow only from that bank. If so, borrower demand might not be symmetric across lenders. We use interest and maturity responses to check this. If credit increases are driven by firm demand, we would expect worse terms, i.e., higher interest rates and shorter maturities, even in the firm–year fixed effects setting of equation (3). If it is driven by bank willingness, we expect improved terms for low-productivity borrowers at their main bank. Related results are discussed in Section 5.1.

4 Within-Relationship Results

4.1 Firm-specific productivity and credit

Table 2 shows the estimation result of equation (1). It reports in each column 100 times the coefficient estimate of the corresponding productivity measure. Results for all manufacturing firms point to similar and statistically significant estimates across the five alternative productivity measures, all falling within the -3 – -4 basis points range in credit growth associated with a 1% increase in productivity.[16] The estimated response averaged over columns (1)–(5) of Table 2

[16]Robustness to different productivity metrics reduces the concern about measurement error as a driver of findings.

Table 2: *The within-relationship response of credit growth to firm productivity*

	(1)	(2)	(3)	(4)	(5)
	ACF	*LP*	*OP*	*W*	*RLP*
Productivity	-3.82***	-3.11***	-3.58***	-3.38***	-3.82***
	(0.95)	(1.00)	(0.96)	(0.98)	(1.02)
Tangibility	1.36*	1.41*	1.41*	1.41*	1.39*
	(0.73)	(0.73)	(0.73)	(0.73)	(0.72)
Profitability	6.65**	5.65*	6.65**	6.06*	6.41*
	(3.37)	(3.40)	(3.37)	(3.39)	(3.39)
Liquidity	15.73***	15.67***	15.66***	15.65***	15.86***
	(4.03)	(4.03)	(4.04)	(4.03)	(4.02)
Leverage	-43.68***	-43.72***	-43.74***	-43.72***	-43.83***
	(2.59)	(2.59)	(2.59)	(2.59)	(2.57)
Short-term debt ratio	-13.81***	-13.75***	-13.85***	-13.73***	-13.74***
	(1.32)	(1.32)	(1.32)	(1.32)	(1.31)
Total assets	-11.39***	-11.12***	-11.19***	-11.07***	-11.04***
	(0.94)	(0.96)	(0.95)	(0.96)	(0.95)
Age	-24.03***	-23.84***	-23.71***	-23.84***	-24.09***
	(2.56)	(2.56)	(2.56)	(2.56)	(2.55)
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓
Observations	604,757	604,757	603,943	604,757	612,687
R-squared	0.305	0.305	0.305	0.305	0.307

Note: Table reports the estimated coefficients (multiplied by 100) of the lagged value of the corresponding variable in each row, resulting from the estimation of equation (1), where the dependent variable is credit growth. In columns (1)–(4), productivity refers to a different TFP measure as indicated and column (5) refers to real labor productivity. See Section 2.2 for the construction of variables. All specifications include bank×firm and bank×industry×province×year fixed effects. Standard errors in parentheses are clustered at bank level. Industries are based on 4-digit economic activity codes of NACE Rev. 2. Provinces include all 81 of the official divisions (*il*) corresponding to EUROSTAT's NUTS-3 classification. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

(3.5 basis points following 1% decrease in productivity) corresponds to 2.1% of the mean credit growth (1.7%, Table 1). Considering that moving from 25$^{\text{th}}$ to 75$^{\text{th}}$ percentile in the distribution requires a 1-log-point (172%) increase in productivity, the response indicates an economically meaningful change in credit growth.

This result is in contrast with balance-sheet variables. Table 2 consistently shows across different productivity measures that banks increase credit to firms with rising tangibility, profitability, liquidity while reducing credit growth of firms with increasing short-term debt and leverage. Stronger balance sheets lead to more credit, while riskier financial positions lead to less. The table also reports negative coefficients on total asset size and age of the firm.

In terms of the relative size, the standardized coefficients, calculated using standard deviations in Table 1, suggest that the response of productivity in absolute terms is stronger than that of tangibility, profitability, and liquidity. For leverage, short-term debt ratio, total assets, and age the standardized responses are capable of explaining a larger variation in credit growth.[17]

These establish the core result of this paper that rising credit growth is associated with

[17]In particular, given the very close estimates across the columns, we calculate the mean response for each regressor over columns (1)–(5) of Table 2. Standardized coefficients are given by the mean response times the regressor's standard deviation divided by the standard deviation of the log change in credit. These are not separately reported for brevity.

Table 3: *The within-relationship response of interest rates and maturities*

	(1)	(2)	(3)	(4)	(5)
A. Interest rate	*ACF*	*LP*	*OP*	*W*	*RLP*
Productivity	-0.03	0.00	-0.02	0.01	-0.02
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Observations	321,829	321,829	321,375	321,829	324,967
R-squared	0.758	0.758	0.758	0.758	0.759
B. Maturity					
Productivity	1.21	1.35	1.31	1.06	0.20
	(0.91)	(0.96)	(0.92)	(0.95)	(0.97)
Observations	319,133	319,133	318,680	319,133	322,257
R-squared	0.400	0.400	0.400	0.400	0.402
Control set in all panels					
Balance-sheet variables	✓	✓	✓	✓	✓
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table reports the estimated coefficients (multiplied by 100) of the lagged value of the corresponding variable in each row, resulting from the estimation of equation (1), where the dependent variables are interest rate (annual change) and maturity (annual log change) in panels A and B, respectively. In columns (1)–(4), productivity refers to a different TFP measure as indicated and column (5) refers to real labor productivity. See Section 2.2 for the construction of variables. All specifications include firm-level controls, bank×firm and bank×industry×province×year fixed effects. Standard errors in parentheses are clustered at bank level. Industries are based on 4-digit economic activity codes of NACE Rev. 2. Provinces include all 81 of the official divisions (*il*) corresponding to EUROSTAT's NUTS-3 classification. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

declining firm productivity while balance-sheet improvements are reflected in more credit growth. This is a novel empirical contrast between the *real* versus *financial* performance of the firm with respect to allocation of bank credit.

4.2 Insensitivity of interest rates and maturities

We complement the estimation of equation (1) with other aspects of a lending agreement in order to get a full overview of the response of lending to productivity.

Equation (1) does not allow separating firm demand from bank supply yet the direction of the responses of interest rates and maturities helps indicate because the two channels have different predictions on these terms. In particular, if the negative credit response is due to demand side, negative firm productivity innovations are expected to increase interest rate (negative sign) and lower maturity (positive sign).

Table 3 reports the coefficients on log productivity in the same setting as equation (1), where the dependent variables are the change in interest rate and log change in maturity in panels A and B, respectively. For both aspects of a lending agreement, we find no evidence that lower productivity leads to worse terms; point estimates are near zero. These provide suggestive evidence that the negative productivity-credit link we observe is not purely demand-driven. Next, we explore whether this average response is pervasive across different segments of the loan market.

Table 4: *Firm-level productivity and credit growth in private banks*

	(1)	(2)	(3)	(4)	(5)
A. All firms	*ACF*	*LP*	*OP*	*W*	*RLP*
Productivity	-4.71*	-4.63*	-4.27*	-4.78*	-6.00**
	(2.44)	(2.57)	(2.48)	(2.54)	(2.68)
Observations	102,143	102,143	101,900	102,143	102,945
R-squared	0.351	0.351	0.351	0.351	0.353
B. SMEs					
Productivity	-3.79	-4.02	-3.61	-4.40*	-5.04*
	(2.51)	(2.64)	(2.54)	(2.61)	(2.75)
Observations	95,488	95,488	95,255	95,488	96,116
R-squared	0.357	0.357	0.357	0.357	0.359
C. Large firms					
Productivity	-82.26***	-57.93*	-72.19**	-59.73**	-87.34***
	(30.15)	(31.91)	(29.98)	(27.72)	(31.25)
Observations	2,407	2,407	2,395	2,407	2,439
R-squared	0.514	0.512	0.514	0.513	0.515
Control set in all panels					
Balance-sheet variables	✓	✓	✓	✓	✓
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table reports the estimated coefficients (multiplied by 100) of the lagged value of the corresponding variable in each row, resulting from the estimation of equation (1), where the dependent variable is credit growth. Sample is restricted to private bank loans. In columns (1)–(4), productivity refers to a different TFP measure as indicated and column (5) refers to real labor productivity. See Section 2.2 for the construction of variables. Panels A, B, C show the results for all firms, SMEs (firms with 10–249 employees), and large firms (with employment ≥250), respectively. All specifications include balance-sheet variables, bank×firm and bank×industry×province×year fixed effects. Standard errors in parentheses are clustered at bank level. Industries are based on 4-digit economic activity codes of NACE Rev. 2. Provinces include all 81 of the official divisions (*il*) corresponding to EUROSTAT's NUTS-3 classification. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

4.3 Heterogeneity by bank ownership and firm size

In this subsection, we explore the heterogeneity of the estimated manufacturing-level response of credit growth to productivity in Table 2. The literature suggests two dimensions of heterogeneity in bank behavior. Private banks are usually seen as profit-driven and state banks may be affected by political connections or non-profit mandates (Bertay et al., 2015; Dinç, 2000; Khwaja and Mian, 2005; La Porta et al., 2002). Also, firm size matters in credit allocation (Beck et al., 2008). Here we estimate equation (1) in different splits of the manufacturing sample.

Table 4 focuses on loans of firms that are in a lending relationship exclusively with private banks. The estimated productivity coefficient for all firms in panel A is in the range of -4 and -6 basis points depending on the productivity measure, which is slightly above the benchmark result including all firms. For SMEs, firms with 10–249 employees, reported in panel B, the results are similar though estimated with lower precision. Panel C, which focuses on large borrowers (with at least 250 employees) of private banks, uncovers an interesting result. A 1% point drop

Table 5: *Firm-level productivity and credit growth in state banks*

	(1)	(2)	(3)	(4)	(5)
A. All firms	*ACF*	*LP*	*OP*	*W*	*RLP*
Productivity	-3.54***	-2.45**	-3.13***	-2.79**	-3.00**
	(1.13)	(1.19)	(1.14)	(1.15)	(1.21)
Observations	454,128	454,128	453,636	454,128	459,893
R-squared	0.344	0.344	0.344	0.344	0.347
B. SMEs					
Productivity	-3.47***	-2.46**	-3.25***	-2.76**	-3.00**
	(1.19)	(1.24)	(1.19)	(1.21)	(1.26)
Observations	405,893	405,893	405,438	405,893	410,318
R-squared	0.357	0.357	0.357	0.357	0.359
C. Large firms					
Productivity	-8.04	-9.55	-8.39	-7.62	-8.37
	(7.01)	(8.63)	(7.93)	(8.16)	(7.97)
Observations	26,306	26,306	26,283	26,306	26,781
R-squared	0.430	0.431	0.431	0.430	0.433
Control set in all panels					
Balance-sheet variables	✓	✓	✓	✓	✓
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table reports the estimated coefficients (multiplied by 100) of the lagged value of the corresponding variable in each row, resulting from the estimation of equation (1), where the dependent variable is credit growth. Sample is restricted to state bank loans. In columns (1)–(4), productivity refers to a different TFP measure as indicated and column (5) refers to real labor productivity. See Section 2.2 for the construction of variables. Panels A, B, C show the results for all firms, SMEs (firms with 10–249 employees), and large firms (with employment ≥250), respectively. All specifications include balance-sheet variables, bank×firm and bank×industry×province×year fixed effects. Standard errors in parentheses are clustered at bank level. Industries are based on 4-digit economic activity codes of NACE Rev. 2. Provinces include all 81 of the official divisions (*il*) corresponding to EUROSTAT's NUTS-3 classification. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

in productivity is associated with 58–87 basis points higher credit growth—corresponding to 7.1%–10.7% increase in the mean credit growth. This dramatic rise in the response suggests that shielding lower firm productivity by private banks is concentrated on large borrowers.

Table 5 reports the results for firms borrowing from state banks. For all firms (panel A) and SMEs (panel B) the estimated coefficient is very close to the full sample benchmark and statistically significant. For large firms (panel C) the coefficient is again estimated considerably higher in absolute terms (around -8 basis points) yet imprecisely and much smaller compared to the response estimated in private bank sample.

The subsample results overall confirm that the full manufacturing sample result is prevalent throughout different loan types. They also suggest an interesting interplay between bank ownership and firm size. State banks increase credit to firms with declining productivity, SMEs in particular, with a relatively lower response. By contrast, private banks concentrate on a relatively small group of large borrowers and increase credit to lower productivity firms at a considerably higher rate.

Table 6: *Private banks over the credit cycle*

	(1)	(2)	(3)	(4)	(5)
A. All firms	*ACF*	*LP*	*OP*	*W*	*RLP*
Productivity	-7.25**	-7.51**	-6.57**	-7.33**	-7.32**
	(3.04)	(3.25)	(3.14)	(3.22)	(3.30)
Productivity × (*tight* = 1)	4.87	5.58	4.46	4.91	2.76
	(3.24)	(3.61)	(3.42)	(3.58)	(3.55)
Observations	102,143	102,143	101,900	102,143	102,945
R-squared	0.352	0.352	0.352	0.352	0.353
B. SMEs					
Productivity	-6.04*	-6.74**	-5.57*	-6.60**	-5.92*
	(3.16)	(3.36)	(3.24)	(3.33)	(3.41)
Productivity × (*tight* = 1)	4.25	5.18	3.74	4.20	1.86
	(3.35)	(3.71)	(3.52)	(3.69)	(3.65)
Observations	95,488	95,488	95,255	95,488	96,116
R-squared	0.357	0.357	0.357	0.357	0.359
C. Large firms					
Productivity	-72.65**	-40.65	-64.09*	-42.55	-79.51**
	(35.31)	(35.88)	(34.97)	(35.12)	(36.19)
Productivity × (*tight* = 1)	-9.76	-21.93	-8.62	-4.60	-7.88
	(37.97)	(41.00)	(40.05)	(40.66)	(39.84)
Observations	2,407	2,407	2,395	2,407	2,439
R-squared	0.516	0.515	0.516	0.514	0.517
Control set in all panels					
Balance-sheet variables	✓	✓	✓	✓	✓
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table reports the estimated coefficients (multiplied by 100) of the lagged value of the log of productivity and its interaction with the tightness indicator, resulting from the estimation of equation (2) where the dependent variable is credit growth. Sample is restricted to private bank loans. Tightness is a binary indicator which takes the value 1 when credit is tight and 0 otherwise. In columns (1)–(4), productivity refers to a different TFP measure as indicated and column (5) refers to real labor productivity. See Section 2.2 for the construction of variables. Panels A, B, C show the results for all firms, SMEs (firms with 10–249 employees), and large firms (with employment ≥250), respectively. All specifications include balance-sheet variables, bank×firm and bank×industry×province×year fixed effects. Standard errors in parentheses are clustered at bank level. Industries are based on 4-digit economic activity codes of NACE Rev. 2. Provinces include all 81 of the official divisions (*il*) corresponding to EUROSTAT's NUTS-3 classification. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

4.4 Changing responses over the credit cycle

Previous subsection shows pervasiveness of the negative credit response to firm productivity innovations with some nuances depending on bank and firm type. We now examine whether these relationships change in periods of tight aggregate credit. Table 6 and Table 7 show the results of the estimation of equation (2) for private and state banks, respectively.

For private banks (Table 6), the baseline productivity effect in loose periods is even more negative than before (about -7 basis points following a 1% higher productivity, first line of panel A). During tight periods, the effect becomes less negative as the interaction term at second row is around 5 basis points, but this change lacks statistical significance. Panel B documents the

Table 7: *State banks over the credit cycle*

	(1)	(2)	(3)	(4)	(5)
A. All firms	*ACF*	*LP*	*OP*	*W*	*RLP*
Productivity	-2.85**	-1.27	-2.04	-1.42	-1.79
	(1.33)	(1.44)	(1.37)	(1.40)	(1.41)
Productivity × (*tight* = 1)	-1.20	-2.22	-1.99	-2.60*	-2.38
	(1.40)	(1.62)	(1.48)	(1.57)	(1.54)
Observations	454,128	454,128	453,636	454,128	459,893
R-squared	0.344	0.344	0.344	0.344	0.347
B. SMEs					
Productivity	-2.98**	-1.31	-2.25	-1.20	-1.97
	(1.42)	(1.53)	(1.45)	(1.49)	(1.49)
Productivity × (*tight* = 1)	-0.77	-2.10	-1.74	-2.93*	-1.93
	(1.50)	(1.72)	(1.58)	(1.68)	(1.64)
Observations	405,893	405,893	405,438	405,893	410,318
R-squared	0.357	0.357	0.357	0.357	0.359
C. Large firms					
Productivity	-2.35	1.35	-0.74	1.60	-1.72
	(7.63)	(8.71)	(8.24)	(8.31)	(8.08)
Productivity × (*tight* = 1)	-13.33*	-24.99***	-17.52**	-19.85**	-15.83*
	(7.61)	(9.47)	(8.82)	(9.14)	(8.77)
Observations	26,306	26,306	26,283	26,306	26,781
R-squared	0.431	0.431	0.431	0.431	0.433
Control set in all panels					
Balance-sheet variables	✓	✓	✓	✓	✓
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table reports the estimated coefficients (multiplied by 100) of the lagged value of the log of productivity and its interaction with the tightness indicator, resulting from the estimation of equation (2) where the dependent variable is credit growth. Sample is restricted to state bank loans. Tightness is a binary indicator which takes the value 1 when credit is tight and 0 otherwise. In columns (1)–(4), productivity refers to a different TFP measure as indicated and column (5) refers to real labor productivity. See Section 2.2 for the construction of variables. Panels A, B, C show the results for all firms, SMEs (firms with 10–249 employees), and large firms (with employment ≥250), respectively. All specifications include balance-sheet variables, bank×firm and bank×industry×province×year fixed effects. Standard errors in parentheses are clustered at bank level. Industries are based on 4-digit economic activity codes of NACE Rev. 2. Provinces include all 81 of the official divisions (*il*) corresponding to EUROSTAT's NUTS-3 classification. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

same tendency for SME loans by private banks. For large firms, however, the evidence suggests the opposite: the support to low productivity firm credit tends to increase in tight conditions. However, overall the evidence is weak as cyclicality of private loans lacks statistical significance consistently across all specifications.

For state banks, however, the evidence summarized in Table 7 suggests a tendency toward providing more credit to lower productivity firms in tight conditions. The negatively estimated interaction terms lack statistical significance at 10% in panel A and B. State banks, which otherwise do not particularly support low-productivity large firms (first line of panel C), dramatically shift toward providing more credit to low-productivity borrowers when credit conditions are tight

(second row of panel C). Interaction coefficients range from -13 to -25 basis points, significant at varying levels. The range implied by the combined effect in credit-tight years, sum of first and second rows of Table 7, corresponds to 1.5% to 2.3% of the mean credit growth rate of large firms in this subsample over the sample period and 3% to 4.5% of the mean credit growth over the credit tightening period.

4.5 Taking stock

We summarize the observed heterogeneity and connect to the main results in this subsection. Overall, the evidence of this section confirms that the negative productivity response of credit growth is not driven specifically from a subset of relationships covered here. It seems to be widespread throughout bank types and firm sizes.

However, there is an interesting interplay between bank and firm types. Private banks show a pronounced tendency to support large borrowers which exclusively work with them. State banks behave somewhat in a complementary way. The evidence suggests that state banks provide significantly more credit to lower productivity SMEs.

The subsample cyclicality estimations provide increased resolution to interpret the results in the previous section more clearly. All types of firms have their share in driving the pattern observed for the entirety of manufacturing loans, but it is a more strong phenomenon for large borrowers which are supported against low productivity by private banks at all times and by state banks when aggregate credit conditions are tight.

The full sample results mask the larger response observed in the key part of manufacturing. Following a modest 1% decrease in productivity, large borrowers of private banks face about 7.1% to 10.7% stronger credit relative to the mean growth rate, compared to 2.1% for the full sample. When aggregate financial conditions are restrictive, the corresponding negative responses for large borrowers in a lending relationship with state banks point to the ballpark of 3% to 4.5% higher growth relative to the mean growth rate. Overall, large firms account for about 65% of loans, 70% of net sales, and 55% of employment in our sample. The economic significance of large firms is possibly even higher in production networks.

The concentration of large responses in a small number of important borrowers of private banks may be related to the granular risk they potentially impose (Galaasen et al., 2020).[18] This is an aspect that suggests an evergreening interpretation given the firm also becomes much more important for the bank (Faria-e Castro et al., 2024). A counter-cyclical support by state banks complements the intuition in the sense that state banks may weigh in with concerns of financial stability during tightening financial conditions, when the weaker large borrowers imply greater potential risks (Brei and Schclarek, 2013; Bertay et al., 2015).

[18]The average loan share of large borrower in private bank sample is 64%.

5 Relationship Intensity and the Supply Channel

We explore the potential role of supply in driving the negative response of bank credit to productivity and connect our results to existing theories in this section.

5.1 Results on the intensity of relationships

Table 8 summarizes the estimation results of equation (3) which investigates the productivity response of credit growth according to the relationship intensity variable debt share. The first row reports mixed results on the debt share alone—negative and significant in columns (1) and (3), insignificant in (2) and (4), positive and significant in (5). We are particularly interested in the second row, which presents the relationship–productivity interaction term, ρ. When the bank owns all of the debt of a firm, i.e., the debt share is 1, a 1% fall in lagged productivity increases firm credit growth in a range of 3–15 basis points across columns (1)–(5). Multiplying the mean debt share (32.8%) with the mean of these estimates (8.5 basis points), the response for an average bank–firm pair corresponds to 2.78 basis points higher credit growth, which is very close to the within-relationship estimates reported in Table 2.[19]

Table 8 provides direct evidence consistent with a bank driven effect, i.e., result of the lender's allocation decision, rather than firm demand. We also examine interest rates and maturities, which provides an additional, indirect test of the interpretation.

Using interest rates and maturities in the framework of equation (3) highlights a related but nuanced interpretation. Firm–year fixed effects already capture the firm demand assuming homogenous demand of firms with different productivity states. However, borrower demand potentially varies across different levels of productivities. Again, checking the response of interest rates and maturities helps address this concern.

The remaining panels of Table 8 report the coefficient on debt share and its interaction with productivity when dependent variables are interest rate change (panel B) and log change in maturity (panel C). The estimated coefficient on the interaction is positive and statistically significant for interest rate and negative for maturity, which is less precisely estimated.

These results strikingly support the dominance of the supply channel in the negative credit response to firm productivity. As the importance of bank–firm relationship increases, banks allocate even more credit to lower productivity firms and offer them lower interest rates and longer maturities.

5.2 Connecting with the theory

In Section 3.1, we find that stronger balance-sheets raise credit, while higher productivity reduces it. The former is consistent with the large collateral-constraint models, where greater pledgeable income relaxes borrowing limits (e.g., Kiyotaki and Moore, 1997; Bernanke et al., 1999; Holmstrom and Tirole, 1997). In these frameworks, *pledgeability*—the share of future returns that can be credibly promised to lenders—directly scales the borrowing capacity. However, the latter

[19] See Section 7.1 for an extension adding bank–firm fixed effects to this empirical setting.

Table 8: *Response of lending to firm productivity according to relationship intensity*

	(1)	(2)	(3)	(4)	(5)
A. Credit	*ACF*	*LP*	*OP*	*W*	*RLP*
Debt share	-101.20***	-13.10	-69.05***	-16.70	58.07***
	(12.80)	(14.22)	(13.44)	(13.33)	(21.84)
Debt share × productivity	-3.23**	-11.89***	-6.69***	-11.40***	-14.88***
	(1.60)	(1.49)	(1.55)	(1.39)	(1.76)
Observations	571,829	571,829	571,190	571,829	578,760
R-squared	0.474	0.474	0.474	0.474	0.475
B. Interest rate					
Debt share	-1.79**	-2.59***	-2.03**	-1.48*	-3.99***
	(0.76)	(0.90)	(0.80)	(0.80)	(1.41)
Debt share × productivity	0.26***	0.30***	0.27***	0.18**	0.34***
	(0.10)	(0.09)	(0.09)	(0.08)	(0.11)
Observations	285,883	285,883	285,526	285,883	288,398
R-squared	0.835	0.835	0.835	0.835	0.836
C. Maturity					
Debt share	-32.33***	-10.80	-27.95**	-19.00	1.30
	(11.82)	(14.10)	(12.59)	(12.81)	(21.85)
Debt share × productivity	-0.50	-2.69*	-1.00	-1.80	-3.05*
	(1.48)	(1.48)	(1.46)	(1.32)	(1.75)
Observations	283,077	283,077	282,718	283,077	285,570
R-squared	0.540	0.540	0.540	0.540	0.541
Control set in all panels					
Firm×Year FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table reports the estimated coefficients (multiplied by 100) of the lagged value of the corresponding variables and their interactions in rows, resulting from the estimation of equation (3), where the dependent variables are credit growth, interest rate (annual change) and maturity (annual log change) in panels A, B, and C respectively. Debt share is the bank's share in total credit of the firm in a year. In columns (1)–(4), productivity refers to a different TFP measure as indicated and column (5) refers to real labor productivity. See Section 2.2 for the construction of variables. All specifications include firm×year and bank×industry×province×year fixed effects. Standard errors in parentheses are clustered at bank level. Industries are based on 4-digit economic activity codes of NACE Rev. 2. Provinces include all 81 of the official divisions (*il*) corresponding to EUROSTAT's NUTS-3 classification. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

is the opposite of what these models predict because higher productivity raises the marginal product of capital and increases the value of collateral, resulting in credit growth. This contrast points to mechanisms in which banks may continue or expand lending to low-productivity borrowers.

In the relationship-lending literature, several dynamic models hint this behavior: after a negative borrower state or quality shock, the bank may lend more to preserve the option value of the relationship or to protect the value of past exposures (Bruche and Llobet, 2014; Dewatripont and Maskin, 1995; Hu and Varas, 2021). These models, however, do not treat productivity as a separate technological shifter, nor do they distinguish it from balance-sheet strength.

A recent exception is Faria-e Castro et al. (2024) who make that distinction explicit in a

simple setting and a tractable stylized model.[20] Their model features that all bank–firm pairs in a relationship can operate in either normal lending, which yields the same result in a competitive dispersed lending environment, or an evergreening state that is more likely to happen when the firm is closer to default, potentially driven by higher legacy debt and lower productivity or another idiosyncratic shock. The key intuition is that the bank internalizes the debt and offers more credit to convince firm to stay out of default by offering just the minimum value the firm is willing to accept given the initial state, while the bank is still being better off compared to firm's default. We present the relevant discussion through simple derivations from their model and compare this paper to their empirical approach in Online Appendix A2.

In both the normal lending and evergreening states, the relaxation of the pledgeability constraint, which we proxy by the balance-sheet variables (Almeida and Campello, 2007), has the expected sign on credit growth—increasing with financial performance of the firm. Changes in productivity, however, have a state-dependent effect. In the normal lending relationship, consistent with the standard intuition, lower productivity reduces the marginal product of capital, value of the collateral and the amount of credit. In contrast, in the evergreening relationship, the positive direct impact of productivity on investment is reversed by the firm's elevated need for better lending terms which are accommodated by the bank—predicting a higher credit volume and lower interest rate for lower levels of productivity. Our within-relationship results in Section 4, which strengthen on the intensive margin of relationships presented in this section, are consistent with the bank behavior in the evergreening state in this model.

Our empirical finding using the universe of manufacturing suggests that this phenomenon is widespread. Even in the simple environment of Faria-e Castro et al. (2024), the boundary between normal and evergreening relationship depends on many factors such as the bank's and firm's discount factors, the severity of credit constraints, productivity and parameters of the production function. While evergreening is definitely observed when the firm is close enough to default, as empirically shown by Faria-e Castro et al. (2024), it can potentially be observed even when the firm is not distressed. Hence, the state where banks seem to support firms against losses in productivity can be widespread, a feature of an average relationship that becomes stronger with the intensity of relationship. In the next section, we reinforce this insight by showing that our results are not driven by distressed firms.

6 Results for Non-Distressed Firms

Our baseline of equation (1) already conditions on leverage and liquidity—canonical balance-sheet proxies for financial stress in credit-supply and default-risk studies (Altman, 1968;

[20] Faria-e Castro et al. (2024) use this model to motivate how relationship lending may lead to evergreening without assuming large common shocks or limited liability problem. They focus on their model's prediction on legacy debt and empirically show how a bank's debt share of a distressed firm leads to higher credit and lower interest rates. Here, we focus on the productivity aspect of their static model. Through a dynamic version of this model, they also study the economy-wide implications and find negative impacts on aggregate TFP. The focus of our paper is to systematically investigate the bank lending patterns with respect to productivity. Answering whether our finding is a substantial driver of an overall resource misallocation in the economy is outside our scope.

Table 9: *Zombie firms excluded: The within-relationship response*

	(1)	(2)	(3)	(4)	(5)
	ACF	*LP*	*OP*	*W*	*RLP*
A. Zombies defined as in Albuquerque and Iyer (2024)					
Productivity	-4.47***	-4.01***	-4.32***	-4.23***	-4.76***
	(0.97)	(1.03)	(0.99)	(1.01)	(1.05)
Observations	588,433	588,433	587,623	588,433	596,143
R-squared	0.308	0.308	0.308	0.308	0.310
B. Zombies defined as in Adalet McGowan et al. (2018)					
Productivity	-4.58***	-4.06***	-4.33***	-4.25***	-4.97***
	(1.00)	(1.06)	(1.02)	(1.04)	(1.09)
Observations	571,288	571,288	570,469	571,288	578,561
R-squared	0.311	0.311	0.311	0.311	0.313
All panels include					
Balance-sheet variables	✓	✓	✓	✓	✓
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table reports the estimated coefficients (multiplied by 100) of the lagged value of the corresponding variables in rows, resulting from the estimation of equation (1), where the dependent variable is credit growth. Panels A and B drop zombie firms from the sample as defined in Albuquerque and Iyer (2024) and Adalet McGowan et al. (2018), respectively. In columns (1)–(4), productivity refers to a different TFP measure as indicated and column (5) refers to real labor productivity. See Section 2.2 for the construction of variables. All specifications include balance-sheet variables, bank×firm and bank×industry×province×year fixed effects. Standard errors in parentheses are clustered at bank level. Results on all variables are reported in Online Appendix Table A9. Industries are based on 4-digit economic activity codes of NACE Rev. 2. Provinces include all 81 of the official divisions (*il*) corresponding to EUROSTAT's NUTS-3 classification. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Bernanke et al., 1999; Campbell et al., 2008). A remaining concern is that the negative credit–productivity gradient we document could be driven by severely distressed borrowers; to probe this, we re-estimate after excluding 'zombie' firms (See Caballero et al. (2008)). We use alternative zombie definitions from the literature based on age, interest coverage ratio (ICR) and/or leverage (Albuquerque and Iyer, 2024; Adalet McGowan et al., 2018). In the taxonomy of Álvarez et al. (2023), zombies are a subset of financially distressed firms that continue to receive credit, so this exercise removes the tail of severe distress and shows the result holds for ordinary, non-distressed borrowers.[21]

6.1 Estimation results excluding zombie firms

We follow two definitions of zombie firms from the literature. First, Albuquerque and Iyer (2024) require a firm to be zombie if its ICR, computed as the ratio of EBIT to interest expenses, is below one and its leverage ratio is above the median firm in the same two-digit industry. Second, in Adalet McGowan et al. (2018), a firm is defined as zombie if it is aged 10 years or older and the interest coverage ratio is less than one in three consecutive years.[22]

[21] Also see Faria-e Castro et al. (2024) for the association between financial distress indicators such as probability of default and alternative definitions of zombie firms in the US data.

[22] Álvarez et al. (2023) define financially distressed firms as those at least 5 years old, with ICR below one and negative equity. A distressed firm is classified as zombie if it receives new credit. The definitions we use are less restrictive and span a relatively larger set of distressed borrowers, in line with the aim of this section.

Table 10: *Zombie firms excluded: Results on relationship intensity*

	(1)	(2)	(3)	(4)	(5)
	ACF	*LP*	*OP*	*W*	*RLP*
A. Zombies defined as in Albuquerque and Iyer (2024)					
Debt share	-103.12***	-12.40	-69.64***	-16.40	58.72***
	(12.98)	(14.40)	(13.63)	(13.50)	(22.13)
Debt share × productivity	-3.07*	-12.02***	-6.69***	-11.49***	-14.97***
	(1.62)	(1.51)	(1.57)	(1.40)	(1.78)
Observations	557,552	557,552	556,913	557,552	564,317
R-squared	0.474	0.474	0.474	0.475	0.476
B. Zombies defined as in Adalet McGowan et al. (2018)					
Debt share	-97.66***	-6.20	-66.49***	-10.70	64.10***
	(13.28)	(14.74)	(13.91)	(13.79)	(22.59)
Debt share × productivity	-3.82**	-12.72***	-7.11***	-12.13***	-15.44***
	(1.65)	(1.55)	(1.60)	(1.43)	(1.82)
Observations	541,291	541,291	540,662	541,291	547,673
R-squared	0.477	0.477	0.477	0.477	0.479
All panels include					
Firm×Year FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table reports the estimated coefficients (multiplied by 100) of the lagged value of the corresponding variables in rows, resulting from the estimation of equation (3), where the dependent variable is credit growth. Panels A and B drop zombie firms from the sample as defined in Albuquerque and Iyer (2024) and Adalet McGowan et al. (2018), respectively. In columns (1)–(4), productivity refers to a different TFP measure as indicated and column (5) refers to real labor productivity. See Section 2.2 for the construction of variables. All specifications include firm×year and bank×industry×province×year fixed effects. Standard errors in parentheses are clustered at bank level. Industries are based on 4-digit economic activity codes of NACE Rev. 2. Provinces include all 81 of the official divisions (*il*) corresponding to EUROSTAT's NUTS-3 classification. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Table 9 shows the robustness of Table 2 when zombie firms are excluded. In fact, the within-relationship response is estimated slightly stronger, consistently ranging from -4 to -5 basis points with statistical significance at 1% across both panels by different zombie definitions.[23]

Table 10 excludes zombie firms in the intensive margin setting and establishes the robustness of Table 8. The patterns we document are not confined to the narrow group of severely distressed firms typically labelled as zombies. Rather, they reflect a systematic allocation pattern across ordinary borrowers, consistent with the perspective of a more subtle and widespread increase in bank credit following negative productivity innovations.

7 Extensions and Robustness

This section discusses a set of extensions and robustness to our main results, for which the relevant tables are presented in the Online Appendix.

[23]Estimated coefficients of balance-sheet variables, reported in Online Appendix Table A9, are quite close to the full sample results too.

7.1 Extension: Firm–year *and* bank–firm fixed effects

We extend equation (3) by further saturating the firm–time fixed effect setting with the bank–firm fixed effects as follows.

$$\begin{aligned}\Delta credit_{b,f,t} = \gamma\ debt\ share_{b,f,t-1} + \theta\ debt\ share_{b,f,t-1} \times productivity_{f,t-1} \\ + \alpha_{b,s,l,t} + \alpha_{f,t} + \alpha_{b,f} + \varepsilon_{b,f,t}\end{aligned} \tag{4}$$

In equation (4), both firm–time and time-invariant pair characteristics are removed. The identifying variation for θ comes from same-firm, same-year cross-lender differences in prior debt share net of bank–firm traits. This angle is particularly relevant for us because it connects more directly to the baseline within-relationship response on the intensive margin. θ measures how the credit response varies with a relationship's intensity (the bank's prior debt share) at different productivity states, holding common firm–time factors (e.g., firm demand) fixed.

Online Appendix Table A1 reports the estimated γ and our parameter of interest, θ, in panel A. The interaction estimate is remarkably lower with bank–firm fixed effects—implying an even stronger negative credit response. The estimated responses by different productivity measures ranges from 5 to 40 basis points, with the median of 26.8 basis points, lower credit growth following 1% increase in productivity. Evaluated at the mean prior debt share, the implied marginal effect for the median estimate is 8.79 basis points (26.8×0.328). This is much larger than the within-relation estimate, providing further support to its supply-side interpretation.[24]

Panels B and C report for the alternative specifications with interest rates and maturities being the dependent variable. The estimates on the interaction term is negative for the interest rate and positive for maturity, small and mostly imprecisely estimated.

7.2 Firm-level results

Our baseline results are estimated at the bank–firm level. A natural question is whether our results survive aggregation to the firm level. To assess this, we collapse all bank–firm–year observations to the firm–year level and estimate the following.

$$\Delta credit_{f,t} = \beta\ productivity_{f,t-1} + \Gamma X_{f,t-1} + \alpha_{s,l,t} + \alpha_f + \varepsilon_{b,f,t} \quad , \tag{5}$$

which is the firm-level analogue of equation (1).

The firm-level estimates of equation (5) shown in Online Appendix Table A3 panel A confirm that the estimated response survives aggregation—firms experiencing negative productivity innovations obtain faster growth in total bank credit. Panel B relaxes the fixed effects controls by adding industry–year and province–year fixed effects separately and showing robustness. The magnitude of firm-level estimates on productivity are all statistically significant and quite close to Table 2. Also, compared with balance-sheet variable estimates the productivity estimates are much more robust to firm-level aggregation.

[24] These results are robust to excluding zombie firms from the estimation sample, reported in Online Appendix Table A2.

7.3 Sample extended to the entire loan market

Since firm-level productivity is the main focus of this paper, in the presentation of results we restrict our sample to manufacturing in order to avoid measurement problems in services due to prices, output, and capital (Syverson, 2011). However, our dataset spans the universe of loans of all non-financial firms for which our variables can be similarly computed. Online Appendix Table A4 reports the baseline within-relationship results from the estimation of equation (1) in the extended sample.

The total number of observations reach about two million when all sectors are included. The response of productivity is estimated in a narrow interval of -1.9 – -2.2 basis points across different productivity measures. The balance-sheet performance (higher tangibility, profitability, liquidity and lower leverage and short-term debt ratio) also performs similar to the baseline in terms of direction. This shows that our result extends beyond manufacturing.

7.4 Export status

Exporting firms directly face shocks to foreign demand and exchange rates, and may rely on specialized credit lines such as trade finance or rediscount facilities. Measured productivity innovations might partly reflect fluctuations in external markets, and credit supplied through export-linked programs could behave differently from standard working-capital or investment lending.

To assess this, in Online Appendix Table A5 we split the sample by exporter status and re-estimate equation (1). We observe the same pattern in both samples with a slightly stronger negative productivity response in non-exporters, suggesting that our results are not particularly driven by trade with external markets. Close estimates in both groups further implies that export status is not a significant aspect of response heterogeneity.

7.5 FX loans

The FX corporate debt is concentrated among a small number of firms (5% of firms on average) over the sample period. FX loans are priced off international benchmarks, often linked to trade-finance or rediscount facilities, are subject to different regulations, and may follow distinct risk-management rules within banks that could in principle affect our results in both directions.

To address this, we implement two complementary checks in Online Appendix Table A6. In the first, we exclude all FX-denominated loans and re-estimate the equation (1) on loans denominated Turkish liras only (panel A). In the second, we exclude all firm–years in which a borrower holds any FX loan (panel B). Estimates in both panels are similar, implying that the negative productivity response of credit growth is not an artifact of FX lending but applies equally in the core domestic-currency lending market.

7.6 Alternative fixed effects and clustering

In Online Appendix Table A7, we maintain bank–firm fixed effects in all cases but progressively relax the bank–time dimension. Panel A replaces the baseline bank–industry–province–year fixed effects with bank–industry–year, while Panel B uses only bank–year. The coefficients are stable across these lighter specifications, indicating that the baseline results are not driven by over-saturated bank–time controls.

In Online Appendix Table A8, we then vary the clustering scheme for standard errors. While the baseline clusters at the bank level, Panel A clusters at the bank–year level and Panel B implements two-way clustering by bank and year. Across all approaches, the statistical significance of the estimates are unaffected.

Taken together, these checks show that the main results are not an artifact of fixed-effect saturation or clustering choice, and remain robust under alternative specifications.

8 Conclusion

We examine how idiosyncratic productivity innovations shape bank lending inside bank–firm relationships. Using the universe of Turkish bank–firm data, we document a clear pattern: after a firm's productivity declines, its banks expand loan quantities without worsening lending terms, whereas credit responds positively to balance-sheet performance. This pattern becomes even stronger as relationship intensity increases. The absence of interest rate increases and the estimates when we control for firm–year factors support a lender-driven channel rather than firm demand.

Our results have implications regarding the credit-allocation narrative by showing that evergreening is not necessarily confined to firms in distress. Relationship banks subtly tilt credit toward lower-productivity firms while at the same time rewarding better balance-sheets. In this sense, firm productivity, productivity declines in specific, becomes a key factor in how relationship banks allocate credit—potentially a margin of misallocation. While our analysis is on the Turkish economy, many banking systems in other economies share similar features, so our findings also raise the question of whether such productivity-conditioned lending behavior is prevalent elsewhere.

We observe substantial heterogeneity in the productivity response of credit growth. The estimated response is several-fold stronger for large firms borrowing from private banks—a pattern that also emerges in state banks during periods of tight credit. This might be consequential on the performance of smaller and potentially more productive firms, e.g., through reduced credit availability and market competition. This motivates exploring the granular aspect of our results in future research.

References

Ackerberg, D. A., K. Caves, and G. Frazer (2015). Identification properties of recent production function estimators. *Econometrica 83*(6), 2411–2451.

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.

Aghion, P., P. Askenazy, N. Berman, G. Cette, and L. Eymard (2012). Credit constraints and the cyclicality of investment: Evidence from France. *Journal of the European Economic Association 10*(5), 1001–1024.

Albuquerque, B. and R. Iyer (2024). The rise of the walking dead: Zombie firms around the world. *Journal of International Economics 152*, 104019.

Alfaro, L., M. García-Santana, and E. Moral-Benito (2021). On the direct and indirect real effects of credit supply shock. *Journal of Financial Economics 139*(3), 895–921.

Almeida, H. and M. Campello (2007). Financial constraints, asset tangibility, and corporate investment. *The Review of Financial Studies 20*(5), 1429–1460.

Altman, E. I. (1968). Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance 23*(4), 589–609.

Álvarez, L., M. García-Posada, and S. Mayordomo (2023). Distressed firms, zombie firms and zombie lending: A taxonomy. *Journal of Banking & Finance 149*, 106762.

Amiti, M. and D. E. Weinstein (2018). How much do idiosyncratic bank shocks affect investment? Evidence from matched bank-firm loan data. *Journal of Political Economy 126*(2), 525–587.

Amore, M. D., C. Schneider, and A. Žaldokas (2013). Credit supply and corporate innovation. *Journal of Financial Economics 109*(3), 835–855.

Bai, J. J., D. Carvalho, and G. M. Phillips (2018). The impact of bank credit on labor reallocation and aggregate industry productivity. *The Journal of Finance 73*(6), 2787–2836.

Banerjee, R. and B. Hofmann (2018). The rise of zombie firms: Causes and consequences. *BIS Quarterly Review*, 67–78.

Beck, T., A. Demirgüç-Kunt, and V. Maksimovic (2008). Financing patterns around the world: Are small firms different? *Journal of Financial Economics 89*(3), 467–487.

Behr, P., D. Foos, and L. Norden (2017). Cyclicality of SME lending and government involvement in banks. *Journal of Banking & Finance 77*, 64–77.

Berger, A. N. and G. F. Udell (1995). Relationship lending and lines of credit in small firm finance. *The Journal of Business 68*(3), 351–381.

Berger, A. N. and G. F. Udell (2006). A more complete conceptual framework for SME finance. *Journal of Banking & Finance 30*(11), 2945–2966.

Bernanke, B. S., M. Gertler, and S. Gilchrist (1999). The financial accelerator in a quantitative business cycle framework. In *Handbook of Macroeconomics*, Volume 1, pp. 1341–1393. Elsevier.

Bertay, A. C., A. Demirgüç-Kunt, and H. Huizinga (2015). Bank ownership and credit over the business cycle: Is lending by state banks less procyclical? *Journal of Banking & Finance 50*, 326–339.

Bolton, P., X. Freixas, L. Gambacorta, and P. E. Mistrulli (2016). Relationship and transaction lending in a crisis. *The Review of Financial Studies 29*(10), 2643–2676.

Boot, A. W. A. (2000). Relationship banking: What do we know? *Journal of Financial Intermediation 9*(1), 7–25.

Brei, M. and A. Schclarek (2013). Public bank lending in times of crisis. *Journal of Financial Stability 9*(4), 820–830.

Brei, M. and A. Schclarek (2015). A theoretical model of bank lending: Does ownership matter in times of crisis? *Journal of Banking & Finance 50*, 298–307.

Bruche, M. and G. Llobet (2014). Preventing zombie lending. *The Review of Financial Studies 27*(3), 923–956.

Caballero, R. J., T. Hoshi, and A. K. Kashyap (2008). Zombie lending and depressed restructuring in Japan. *The American Economic Review 98*(5), 1943–1977.

Campbell, J. Y., J. Hilscher, and J. Szilagyi (2008). In search of distress risk. *The Journal of Finance 63*(6), 2899–2939.

Carlstrom, C. T. and T. S. Fuerst (1997). Agency costs, net worth, and business fluctuations: A computable general equilibrium analysis. *The American Economic Review 87*(5), 893–910.

Chava, S., A. Oettl, A. Subramanian, and K. V. Subramanian (2013). Banking deregulation and innovation. *Journal of Financial Economics 109*(3), 759–774.

Chen, M. and R. Matousek (2020). Do productive firms get external finance? evidence from Chinese listed manufacturing firms. *International Review of Financial Analysis 67*, 101422.

Coleman, N. and L. Feler (2015). Bank ownership, lending, and local economic performance during the 2008–2009 financial crisis. *Journal of Monetary Economics 71*, 50–66.

Cooley, T. F. and V. Quadrini (2001). Financial markets and firm dynamics. *The American Economic Review 91*(5), 1286–1310.

Cull, R. and M. S. Martínez Pería (2013). Bank ownership and lending patterns during the 2008–2009 financial crisis: Evidence from Latin America and Eastern Europe. *Journal of Banking & Finance 37*(12), 4861–4878.

De Loecker, J. and C. Syverson (2021). An industrial organization perspective on productivity. In *Handbook of Industrial Organization, Volume 4*, Volume 4 of *Handbook of Industrial Organization*, pp. 141–223. Elsevier.

Degryse, H., M. Kim, and S. Ongena (2009). *Microeconometrics of Banking: Methods, applications, and results*. Oxford University Press.

Dekle, R. and M. Lee (2015). Do foreign bank affiliates cut their lending more than the domestic banks in a financial crisis? *Journal of International Money and Finance 50*, 16–32.

Dewatripont, M. and E. Maskin (1995). Credit and efficiency in centralized and decentralized economies. *The Review of Economic Studies 62*(4), 541–555.

Dinç, I. S. (2000). Bank reputation, bank commitment, and the effects of competition in credit markets. *The Review of Financial Studies 13*(3), 781–812.

Doerr, S., M. Raissi, and A. Weber (2018). Credit-supply shocks and firm productivity in Italy. *Journal of International Money and Finance 87*, 155–171.

Duquerroy, A., C. Mazet-Sonilhac, J.-S. Mésonnier, and D. Paravisini (2022). Bank local specialization. Sciences Po Department of Economics Working Paper No. 2022-06.

Elsas, R. and J. P. Krahnen (1998). Is relationship lending special? Evidence from credit-file data in Germany. *Journal of Banking & Finance 22*(10), 1283–1316.

Er, T. A., B. Deniz, and I. Yarba (2025). Loan spreads over the credit cycle. *Emerging Markets Review 67*, 101313.

European Central Bank (2024). Financial integration and structure in the Euro Area. Biennial report, European Central Bank, Frankfurt am Main. Approved by the ECB Governing Council on 14 June 2024.

Faria-e Castro, M., P. Paul, and J. M. Sánchez (2024). Evergreening. *Journal of Financial Economics 153*, 103778.

Fungáčová, Z., R. Herrala, and L. Weill (2013). The influence of bank ownership on credit supply: Evidence from the recent financial crisis. *Emerging Markets Review 15*, 136–147.

Galaasen, S., R. Jamilov, R. Juelsrud, and H. Rey (2020). Granular credit risk. Technical report, National Bureau of Economic Research.

George, S., D. Kirti, M. S. Martinez Peria, and R. Vijayaraghavan (2023). Banks: Lending to productive firms? In A. Schipke, J. Turunen, N. Choueiri, and A. Gulde-Wolf (Eds.), *India's Financial System: Building the Foundation for Strong and Sustainable Growth*, Chapter 4, pp. 69–85. Washington, DC: International Monetary Fund.

Gong, D., J. Xu, and J. Yan (2023). National development banks and loan contract terms: Evidence from syndicated loans. *Journal of International Money and Finance 130*, 102763.

Gopinath, G., Ş. Kalemli-Özcan, L. Karabarbounis, and C. Villegas-Sanchez (2017). Capital allocation and productivity in South Europe. *The Quarterly Journal of Economics 132*(4), 1915–1967.

Graham, J. R., M. T. Leary, and M. R. Roberts (2015). A century of capital structure: The leveraging of corporate America. *Journal of Financial Economics 118*(3), 658–683.

He, Z. and W. Xiong (2012). Rollover risk and credit risk. *The Journal of Finance 67*(2), 391–430.

Holmstrom, B. and J. Tirole (1997). Financial intermediation, loanable funds, and the real sector. *The Quarterly Journal of Economics 112*(3), 663–691.

Hoshi, T., A. Kashyap, and D. Scharfstein (1990). The role of banks in reducing the costs of financial distress in Japan. *Journal of Financial Economics 27*(1), 67–88.

Hsieh, C.-T. and P. J. Klenow (2009). Misallocation and manufacturing TFP in China and India. *The Quarterly Journal of Economics 124*(4), 1403–1448.

Hu, Y. and F. Varas (2021). A theory of zombie lending. *The Journal of Finance 76*(4), 1813–1867.

Jaffee, D. M. and T. Russell (1976). Imperfect information, uncertainty, and credit rationing. *The Quarterly Journal of Economics 90*(4), 651–666.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina (2014). Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking? *Econometrica 82*(2), 463–505.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina (2012). Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications. *The American Economic Review 102*(5), 2301–26.

Kashyap, A. K. and J. C. Stein (2000). What do a million observations on banks say about the transmission of monetary policy? *The American Economic Review 90*(3), 407–428.

Khwaja, A. I. and A. Mian (2005). Do lenders favor politically connected firms? Rent provision in an emerging financial market. *The Quarterly Journal of Economics 120*(4), 1371–1411.

Khwaja, A. I. and A. Mian (2008). Tracing the impact of bank liquidity shocks: Evidence from an emerging market. *The American Economic Review 98*(4), 1413–42.

Kishan, R. P. and T. P. Opiela (2000). Bank size, bank capital, and the bank lending channel. *Journal of Money, Credit and Banking 32*(1), 121–141.

Kiyotaki, N. and J. Moore (1997). Credit cycles. *Journal of Political Economy 105*(2), 211–248.

La Porta, R., F. Lopez-de Silanes, and A. Shleifer (2002). Government ownership of banks. *The Journal of Finance 57*(1), 265–301.

Levinsohn, J. and A. Petrin (2003). Estimating production functions using inputs to control for unobservables. *The Review of Economic Studies 70*(2), 317–341.

Li, Y., R. Lu, and A. Srinivasan (2019). Relationship bank behavior during borrower distress. *Journal of Financial and Quantitative Analysis 54*(3), 1231–1262.

Manaresi, F. and N. Pierri (2024). The asymmetric effect of credit supply on firm-level productivity growth. *Journal of Money, Credit and Banking 56*(4), 677–704.

Micco, A. and U. Panizza (2006). Bank ownership and lending behavior. *Economics Letters 93*(2), 248–254.

Olley, G. S. and A. Pakes (1996). The dynamics of productivity in the telecommunications equipment industry. *Econometrica 64*(6), 1263–1297.

Ongena, S. and D. C. Smith (2000). What determines the number of bank relationships? Cross-country evidence. *Journal of Financial intermediation 9*(1), 26–56.

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

Petersen, M. A. and R. G. Rajan (1994). The benefits of lending relationships: Evidence from small business data. *The Journal of Finance 49*(1), 3–37.

Petersen, M. A. and R. G. Rajan (1995). The effect of credit market competition on lending relationships. *The Quarterly Journal of Economics 110*(2), 407–443.

Rajan, R. G. (1992). Insiders and outsiders: The choice between informed and arm's-length debt. *The Journal of Finance 47*(4), 1367–1400.

Rajan, R. G. and L. Zingales (1998). Financial dependence and growth. *The American Economic Review 88*(3), 559–586.

Santos, J. A. and A. Winton (2019). Bank capital, borrower power, and loan rates. *The Review of Financial Studies 32*(11), 4501–4541.

Schäfer, L. (2019). "Forgive but not forget": The behavior of relationship banks when firms are in distress. *Review of Finance 23*(6), 1079–1114.

Sharpe, S. A. (1990). Asymmetric information, bank lending, and implicit contracts: A stylized model of customer relationships. *The Journal of Finance 45*(4), 1069–1087.

Stiglitz, J. E. and A. Weiss (1981). Credit rationing in markets with imperfect information. *The American Economic Review 71*(3), 393–410.

Syverson, C. (2011). What determines productivity? *Journal of Economic Literature 49*(2), 326–365.

Van Beveren, I. (2012). Total factor productivity estimation: A practical review. *Journal of Economic Surveys 26*(1), 98–128.

Vander Bauwhede, H., M. De Meyere, and P. Van Cauwenberge (2015). Financial reporting quality and the cost of debt of SMEs. *Small Business Economics 45*(1), 149–164.

Von Thadden, E.-L. (1995). Long-term contracts, short-term investment and monitoring. *The Review of Economic Studies 62*(4), 557–575.

Wang, C.-W., W.-C. Chiu, and T.-H. D. King (2020). Debt maturity and the cost of bank loans. *Journal of Banking & Finance 112*, 105235.

Wooldridge, J. M. (2009). On estimating firm-level production functions using proxy variables to control for unobservables. *Economics Letters 104*(3), 112–114.

Yarba, I. and B. Deniz (2024). Bank loan maturity and corporate investment. *Central Bank Review 24*(4), 100178.

Zins, A. and L. Weill (2018). Cyclicality of lending in Africa: The influence of bank ownership. *Emerging Markets Review 37*, 164–180.

Online Appendix

A1 Online Appendix Tables

Table A1: *Extension: Firm–year and bank–firm fixed effects*

	(1)	(2)	(3)	(4)	(5)
A. Credit	*ACF*	*LP*	*OP*	*W*	*RLP*
Debt share	-309.14***	-94.74***	-244.35***	-79.02***	152.03***
	(22.05)	(25.37)	(23.34)	(24.09)	(37.14)
Debt share × productivity	-5.42**	-26.83***	-12.45***	-28.16***	-40.45***
	(2.75)	(2.66)	(2.70)	(2.50)	(2.99)
Observations	510,586	510,586	509,989	510,586	516,523
R-squared	0.616	0.616	0.616	0.616	0.618
B. Interest rate					
Debt share	-1.90	-1.80	-3.22**	-0.30	-1.80
	(1.37)	(1.65)	(1.47)	(1.48)	(2.45)
Debt share × productivity	0.20	0.20	0.36**	0.00	0.10
	(0.17)	(0.17)	(0.17)	(0.15)	(0.20)
Observations	230,023	230,023	229,736	230,023	231,849
R-squared	0.883	0.883	0.883	0.883	0.884
C. Maturity					
Debt share	-81.96***	-54.28*	-95.72***	-64.25**	-16.30
	(23.88)	(30.10)	(26.07)	(27.57)	(43.90)
Debt share × productivity	-3.80	-6.09*	-2.00	-4.98*	-7.72**
	(2.99)	(3.15)	(3.01)	(2.84)	(3.50)
Observations	227,307	227,307	227,018	227,307	229,125
R-squared	0.666	0.666	0.666	0.666	0.666
All panels include					
Bank×Firm FE	✓	✓	✓	✓	✓
Firm×Year FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table shows extension of the results on the intensive margin with additional bank–firm fixed effects. All specifications include bank×firm, firm×year, and bank×industry×province×year fixed effects. See the main text and table notes for definitions. Standard errors in parentheses are clustered at bank level. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Table A2: *Zombie firms excluded: Results on relationship intensity (including bank–firm fixed effects)*

	(1)	(2)	(3)	(4)	(5)
	ACF	*LP*	*OP*	*W*	*RLP*
A. Zombies defined as in Albuquerque and Iyer (2024)					
Debt share	-305.08***	-84.85***	-236.17***	-70.60***	175.68***
	(22.65)	(25.96)	(23.94)	(24.63)	(37.97)
Debt share × productivity	-6.02**	-27.92***	-13.48***	-29.08***	-42.38***
	(2.82)	(2.72)	(2.76)	(2.55)	(3.06)
Observations	495,845	495,845	495,251	495,845	501,626
R-squared	0.619	0.619	0.618	0.619	0.620
B. Zombies defined as in Adalet McGowan et al. (2018)					
Debt share	-301.82***	-71.09***	-233.06***	-56.21**	181.39***
	(23.32)	(26.78)	(24.65)	(25.45)	(39.26)
Debt share × productivity	-6.64**	-29.51***	-14.02***	-30.73***	-42.96***
	(2.90)	(2.81)	(2.84)	(2.64)	(3.16)
Observations	479,384	479,384	478,782	479,384	484,779
R-squared	0.622	0.622	0.622	0.622	0.624
All panels include					
Bank×Firm FE	✓	✓	✓	✓	✓
Firm×Year FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table shows robustness of the results when zombie firms are not included in the estimation sample following alternative zombie definitions from the literature. All specifications include bank×firm, firm×year and bank×industry×province×year fixed effects. See the main text and table notes for definitions. Standard errors in parentheses are clustered at bank level. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Table A3: *Firm-level results*

	(1)	(2)	(3)	(4)	(5)
A.	*ACF*	*LP*	*OP*	*W*	*RLP*
Productivity	-2.93***	-2.28**	-2.74***	-2.74***	-3.83***
	(1.02)	(1.07)	(1.03)	(1.05)	(1.09)
Tangibility	0.34	0.38	0.36	0.38	0.35
	(0.73)	(0.73)	(0.74)	(0.73)	(0.73)
Profitability	5.79	4.85	6.04*	5.56	7.81**
	(3.53)	(3.58)	(3.55)	(3.56)	(3.56)
Liquidity	8.42**	8.36**	8.15*	8.36**	8.07*
	(4.18)	(4.18)	(4.18)	(4.18)	(4.15)
Leverage	-61.41***	-61.42***	-61.42***	-61.44***	-61.50***
	(2.62)	(2.62)	(2.62)	(2.62)	(2.60)
Short-term debt ratio	-21.15***	-21.10***	-21.06***	-21.09***	-20.90***
	(1.38)	(1.38)	(1.38)	(1.38)	(1.37)
Total assets	-16.04***	-15.85***	-15.89***	-15.75***	-15.44***
	(0.93)	(0.96)	(0.94)	(0.96)	(0.95)
Age	-35.58***	-35.45***	-35.17***	-35.44***	-35.71***
	(2.39)	(2.39)	(2.40)	(2.39)	(2.38)
Firm FE	✓	✓	✓	✓	✓
Industry×Province×Year FE	✓	✓	✓	✓	✓
Observations	246,664	246,664	246,213	246,664	250,880
R-squared	0.217	0.217	0.217	0.217	0.220
B.					
Productivity	-3.31***	-2.67***	-3.15***	-3.06***	-4.06***
	(0.91)	(0.96)	(0.92)	(0.94)	(0.97)
Tangibility	-0.05	-0.01	-0.03	-0.01	0.06
	(0.67)	(0.67)	(0.67)	(0.67)	(0.66)
Profitability	8.39***	7.48**	8.63***	8.09**	9.67***
	(3.21)	(3.25)	(3.23)	(3.24)	(3.22)
Liquidity	7.46*	7.38*	7.14*	7.37*	7.87**
	(3.83)	(3.83)	(3.83)	(3.83)	(3.79)
Leverage	-60.09***	-60.11***	-60.13***	-60.12***	-60.15***
	(2.40)	(2.40)	(2.40)	(2.40)	(2.38)
Short-term debt ratio	-19.44***	-19.38***	-19.40***	-19.37***	-19.25***
	(1.22)	(1.22)	(1.22)	(1.22)	(1.21)
Total assets	-15.59***	-15.35***	-15.40***	-15.26***	-14.85***
	(0.83)	(0.86)	(0.84)	(0.85)	(0.84)
Age	-34.69***	-34.53***	-34.25***	-34.51***	-34.75***
	(2.15)	(2.15)	(2.15)	(2.15)	(2.13)
Firm FE	✓	✓	✓	✓	✓
Industry×Year FE	✓	✓	✓	✓	✓
Province×Year FE	✓	✓	✓	✓	✓
Observations	261,484	261,484	261,046	261,484	267,593
R-squared	0.153	0.153	0.153	0.153	0.155

Note: Table shows extension of the results to the firm level. All specifications include balance-sheet variables and firm fixed effects. In addition, panel A includes industry×province×year fixed effects; panel B includes industry×year and province×year fixed effects. See the main text and table notes for definitions. Standard errors in parentheses are clustered at bank level. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Table A4: *Results on all non-financial firm loans*

	(1)	(2)	(3)	(4)	(5)
	ACF	*LP*	*OP*	*W*	*RLP*
Productivity	-2.07***	-1.87***	-1.94***	-1.91***	-2.24***
	(0.44)	(0.46)	(0.44)	(0.45)	(0.47)
Tangibility	1.80***	1.82***	1.81***	1.82***	1.81***
	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)
Profitability	4.21***	4.00***	4.15***	4.04***	4.26***
	(1.27)	(1.27)	(1.27)	(1.27)	(1.27)
Liquidity	23.04***	22.99***	22.90***	22.98***	23.20***
	(2.16)	(2.16)	(2.16)	(2.16)	(2.15)
Leverage	-20.01***	-19.99***	-20.05***	-19.99***	-20.01***
	(0.88)	(0.88)	(0.88)	(0.88)	(0.88)
Short-term debt ratio	-7.43***	-7.40***	-7.47***	-7.40***	-7.41***
	(0.44)	(0.44)	(0.44)	(0.44)	(0.44)
Total assets	-14.48***	-14.27***	-14.30***	-14.26***	-14.29***
	(0.50)	(0.51)	(0.51)	(0.51)	(0.51)
Age	-20.77***	-20.64***	-20.47***	-20.63***	-20.67***
	(1.46)	(1.46)	(1.47)	(1.46)	(1.45)
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓
Observations	2,004,505	2,004,505	1,998,982	2,004,505	2,018,550
R-squared	0.298	0.298	0.298	0.298	0.300

Note: Table shows extension of the results to all firms in all sectors of the economy. All specifications include balance-sheet variables, bank×firm and bank×industry×province×year fixed effects. See the main text and table notes for definitions. Standard errors in parentheses are clustered at bank level. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Table A5: *Results by export status*

	(1)	(2)	(3)	(4)	(5)
A. Exporters	*ACF*	*LP*	*OP*	*W*	*RLP*
Productivity	-4.17***	-3.12**	-3.55***	-3.08**	-3.49**
	(1.27)	(1.35)	(1.29)	(1.32)	(1.38)
Tangibility	1.77*	1.83*	1.87*	1.84*	1.69*
	(1.03)	(1.03)	(1.03)	(1.03)	(1.02)
Profitability	7.92*	6.40	7.65*	6.33	6.45
	(4.54)	(4.59)	(4.54)	(4.58)	(4.56)
Liquidity	10.52*	10.41*	10.34*	10.39*	10.67**
	(5.38)	(5.38)	(5.38)	(5.38)	(5.35)
Leverage	-45.04***	-45.10***	-44.99***	-45.09***	-45.32***
	(3.62)	(3.62)	(3.62)	(3.62)	(3.60)
Short-term debt ratio	-16.21***	-16.13***	-16.14***	-16.13***	-16.15***
	(1.98)	(1.98)	(1.98)	(1.98)	(1.97)
Total assets	-12.70***	-12.47***	-12.55***	-12.50***	-12.39***
	(1.32)	(1.35)	(1.33)	(1.35)	(1.34)
Age	-25.96***	-25.74***	-25.60***	-25.76***	-26.08***
	(3.61)	(3.61)	(3.61)	(3.61)	(3.60)
Observations	347,435	347,435	347,011	347,435	352,884
R-squared	0.318	0.318	0.318	0.318	0.321
B. Non-exporters					
Productivity	-5.39***	-5.98***	-5.72***	-6.32***	-6.77***
	(1.84)	(1.93)	(1.87)	(1.90)	(1.98)
Tangibility	-0.14	-0.08	-0.14	-0.08	0.03
	(1.29)	(1.29)	(1.29)	(1.29)	(1.29)
Profitability	-1.61	-0.61	-1.58	-0.08	0.56
	(6.45)	(6.52)	(6.45)	(6.48)	(6.51)
Liquidity	19.51**	19.50**	19.42**	19.46**	19.52**
	(7.93)	(7.93)	(7.93)	(7.93)	(7.92)
Leverage	-42.53***	-42.58***	-42.65***	-42.62***	-42.82***
	(4.89)	(4.89)	(4.89)	(4.89)	(4.88)
Short-term debt ratio	-12.08***	-12.00***	-12.16***	-11.98***	-11.71***
	(2.23)	(2.23)	(2.24)	(2.23)	(2.23)
Total assets	-13.76***	-13.13***	-13.32***	-13.06***	-13.14***
	(1.84)	(1.87)	(1.85)	(1.87)	(1.86)
Age	-17.18***	-16.92***	-17.27***	-16.91***	-17.00***
	(4.97)	(4.97)	(4.99)	(4.97)	(4.97)
Observations	182,168	182,168	181,834	182,168	183,065
R-squared	0.412	0.412	0.413	0.412	0.413
All panels include					
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table shows robustness of the results by export status. All specifications include balance-sheet variables, bank×firm and bank×industry×province×year fixed effects. See the main text and table notes for definitions. Standard errors in parentheses are clustered at bank level. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Table A6: *Results without FX loans*

	(1)	(2)	(3)	(4)	(5)
A. Excludes FX loans	*ACF*	*LP*	*OP*	*W*	*RLP*
Productivity	-3.60***	-3.16***	-3.57***	-3.40***	-3.66***
	(1.07)	(1.13)	(1.08)	(1.10)	(1.15)
Tangibility	1.72**	1.77**	1.74**	1.77**	1.75**
	(0.79)	(0.79)	(0.79)	(0.79)	(0.78)
Profitability	6.12	5.51	6.44*	5.89	6.03
	(3.74)	(3.78)	(3.74)	(3.77)	(3.78)
Liquidity	21.58***	21.52***	21.42***	21.51***	21.50***
	(4.38)	(4.38)	(4.39)	(4.38)	(4.37)
Leverage	-42.93***	-42.98***	-43.01***	-42.97***	-43.28***
	(2.88)	(2.88)	(2.88)	(2.88)	(2.87)
Short-term debt ratio	-14.78***	-14.72***	-14.85***	-14.70***	-14.60***
	(1.46)	(1.46)	(1.46)	(1.46)	(1.46)
Total assets	-10.54***	-10.24***	-10.34***	-10.20***	-10.21***
	(1.04)	(1.07)	(1.05)	(1.06)	(1.06)
Age	-28.54***	-28.33***	-28.44***	-28.33***	-28.55***
	(2.87)	(2.87)	(2.88)	(2.87)	(2.86)
Observations	521,347	521,347	520,637	521,347	527,223
R-squared	0.330	0.330	0.330	0.330	0.333
B. Excludes firms with FX loan					
Productivity	-3.27**	-3.23**	-3.55**	-4.13***	-4.42***
	(1.36)	(1.44)	(1.38)	(1.42)	(1.48)
	(1.78)	(1.78)	(1.78)	(1.78)	(1.77)
Tangibility	-0.84	-0.80	-0.84	-0.80	-0.62
	(0.95)	(0.95)	(0.95)	(0.95)	(0.94)
Profitability	3.50	3.51	4.23	4.95	5.34
	(4.58)	(4.66)	(4.60)	(4.65)	(4.66)
Liquidity	25.21***	25.16***	24.90***	25.13***	24.97***
	(5.38)	(5.38)	(5.38)	(5.38)	(5.36)
Leverage	-41.11***	-41.16***	-41.27***	-41.19***	-41.15***
	(3.54)	(3.54)	(3.54)	(3.54)	(3.53)
Short-term debt ratio	-10.81***	-10.75***	-11.05***	-10.72***	-10.80***
Total assets	-10.78***	-10.46***	-10.62***	-10.26***	-10.31***
	(1.31)	(1.34)	(1.32)	(1.34)	(1.33)
Age	-17.16***	-16.97***	-17.20***	-16.96***	-17.20***
	(3.58)	(3.58)	(3.59)	(3.58)	(3.57)
Observations	311,464	311,464	310,893	311,464	313,861
R-squared	0.361	0.361	0.361	0.361	0.362
All panels include					
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table shows robustness of the results when FX loans and firms with FX loans are excluded. All specifications include balance-sheet variables, bank×firm and bank×industry×province×year fixed effects. See the main text and table notes for definitions. Standard errors in parentheses are clustered at bank level. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Table A7: *Alternative fixed effects*

	(1)	(2)	(3)	(4)	(5)
A.	*ACF*	*LP*	*OP*	*W*	*RLP*
Productivity	-3.80***	-2.85***	-3.41***	-3.20***	-3.56***
	(0.78)	(0.82)	(0.80)	(0.80)	(0.84)
Tangibility	0.68	0.74	0.70	0.74	0.70
	(0.59)	(0.59)	(0.59)	(0.59)	(0.59)
Profitability	8.22***	6.80**	7.88***	7.36***	7.65***
	(2.84)	(2.87)	(2.84)	(2.86)	(2.86)
Liquidity	16.37***	16.29***	16.18***	16.28***	16.44***
	(3.40)	(3.40)	(3.41)	(3.40)	(3.38)
Leverage	-42.58***	-42.62***	-42.71***	-42.62***	-42.84***
	(2.16)	(2.16)	(2.16)	(2.16)	(2.14)
Short-term debt ratio	-12.79***	-12.73***	-12.75***	-12.71***	-12.73***
	(1.07)	(1.07)	(1.07)	(1.07)	(1.06)
Total assets	-10.84***	-10.61***	-10.65***	-10.54***	-10.57***
	(0.78)	(0.80)	(0.78)	(0.79)	(0.79)
Age	-23.74***	-23.53***	-23.47***	-23.52***	-23.84***
	(2.08)	(2.08)	(2.09)	(2.08)	(2.06)
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Year FE	✓	✓	✓	✓	✓
Observations	722,952	722,952	722,066	722,952	739,029
R-squared	0.188	0.188	0.188	0.188	0.192
B.					
Productivity	-3.31***	-2.32***	-2.97***	-2.50***	-2.75***
	(0.75)	(0.79)	(0.76)	(0.74)	(0.81)
Tangibility	0.69	0.74	0.70	0.74	0.70
	(0.58)	(0.58)	(0.58)	(0.58)	(0.57)
Profitability	8.48***	7.02**	8.18***	7.44***	7.75***
	(2.72)	(2.76)	(2.74)	(2.75)	(2.76)
Liquidity	15.11***	15.06***	14.97***	15.09***	15.74***
	(3.34)	(3.34)	(3.35)	(3.34)	(3.30)
Leverage	-42.15***	-42.19***	-42.33***	-42.19***	-42.27***
	(2.11)	(2.11)	(2.11)	(2.11)	(2.08)
Short-term debt ratio	-13.00***	-12.95***	-12.96***	-12.93***	-12.93***
	(1.05)	(1.05)	(1.05)	(1.05)	(1.04)
Total assets	-9.70***	-9.53***	-9.53***	-9.48***	-9.47***
	(0.75)	(0.77)	(0.75)	(0.76)	(0.76)
Age	-25.56***	-25.42***	-25.41***	-25.48***	-25.92***
	(2.01)	(2.01)	(2.01)	(2.01)	(1.99)
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Year FE	✓	✓	✓	✓	✓
Observations	727,171	727,171	726,285	727,171	745,321
R-squared	0.158	0.158	0.158	0.158	0.158

Note: Table shows the robustness of the results to alternative fixed effects. All specifications include balance-sheet variables and bank×firm fixed effects. In addition, panel A includes bank×industry×year fixed effects; panel B includes bank×year fixed effects. See the main text and table notes for definitions. Standard errors in parentheses are clustered at bank level. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Table A8: *Alternative clusters*

	(1)	(2)	(3)	(4)	(5)
A. Bank–year clusters	*ACF*	*LP*	*OP*	*W*	*RLP*
Productivity	-3.82***	-3.11***	-3.58***	-3.38***	-3.82***
	(1.11)	(1.12)	(1.07)	(1.12)	(1.19)
Tangibility	1.36*	1.41*	1.41*	1.41*	1.39*
	(0.73)	(0.73)	(0.73)	(0.73)	(0.72)
Profitability	6.65**	5.65*	6.65**	6.06*	6.41*
	(3.31)	(3.36)	(3.33)	(3.34)	(3.28)
Liquidity	15.73***	15.67***	15.66***	15.65***	15.86***
	(3.81)	(3.81)	(3.84)	(3.81)	(3.82)
Leverage	-43.68***	-43.72***	-43.74***	-43.72***	-43.83***
	(3.22)	(3.23)	(3.21)	(3.23)	(3.16)
Short-term debt ratio	-13.81***	-13.75***	-13.85***	-13.73***	-13.74***
	(1.36)	(1.36)	(1.38)	(1.36)	(1.36)
Total assets	-11.39***	-11.12***	-11.19***	-11.07***	-11.04***
	(1.30)	(1.26)	(1.29)	(1.27)	(1.27)
Age	-24.03***	-23.84***	-23.71***	-23.84***	-24.09***
	(3.21)	(3.22)	(3.24)	(3.21)	(3.17)
Observations	604,757	604,757	603,943	604,757	612,687
R-squared	0.305	0.305	0.305	0.305	0.307
B. Two-way (bank and firm) clusters					
Productivity	-3.82***	-3.11**	-3.58***	-3.38***	-3.82***
	(1.05)	(1.13)	(1.12)	(1.06)	(1.17)
Total assets	-11.39***	-11.12***	-11.19***	-11.07***	-11.04***
	(1.49)	(1.44)	(1.43)	(1.45)	(1.45)
Short-term debt ratio	-13.81***	-13.75***	-13.85***	-13.73***	-13.74***
	(1.56)	(1.55)	(1.59)	(1.56)	(1.62)
Tangibility	1.36**	1.41**	1.41**	1.41**	1.39**
	(0.60)	(0.60)	(0.60)	(0.59)	(0.62)
Profitability	6.65**	5.65*	6.65*	6.06*	6.41*
	(3.21)	(3.28)	(3.36)	(3.34)	(3.38)
Liquidity	15.73***	15.67***	15.66***	15.65***	15.86***
	(5.05)	(5.04)	(5.08)	(5.03)	(5.14)
Leverage	-43.68***	-43.72***	-43.74***	-43.72***	-43.83***
	(2.30)	(2.30)	(2.32)	(2.30)	(2.33)
Age	-24.03***	-23.84***	-23.71***	-23.84***	-24.09***
	(2.69)	(2.71)	(2.55)	(2.71)	(2.65)
Observations	604,757	604,757	603,943	604,757	612,687
R-squared	0.305	0.305	0.305	0.305	0.307
All panels include					
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table shows robustness of the results under alternative clustering. Standard errors are clustered by bank–year in panel A and two-way clustered by bank and firm in panel B. All specifications include balance-sheet variables, bank×firm and industry×province×year fixed effects. See the main text and table notes for definitions. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Table A9: *Zombie firms excluded: The within-relationship response (full results)*

	(1)	(2)	(3)	(4)	(5)
	ACF	*LP*	*OP*	*W*	*RLP*
A. Zombies defined as in Albuquerque and Iyer (2024)					
Productivity	-4.47***	-4.01***	-4.32***	-4.23***	-4.76***
	(0.97)	(1.03)	(0.99)	(1.01)	(1.05)
Tangibility	1.37*	1.43*	1.43*	1.43*	1.41*
	(0.74)	(0.74)	(0.74)	(0.74)	(0.73)
Profitability	7.20**	6.59*	7.31**	6.93**	7.46**
	(3.45)	(3.49)	(3.46)	(3.48)	(3.48)
Liquidity	15.73***	15.65***	15.66***	15.64***	15.84***
	(4.08)	(4.08)	(4.09)	(4.08)	(4.07)
Leverage	-43.33***	-43.39***	-43.42***	-43.39***	-43.47***
	(2.66)	(2.66)	(2.67)	(2.66)	(2.65)
Short-term debt ratio	-13.89***	-13.81***	-13.91***	-13.80***	-13.79***
	(1.35)	(1.35)	(1.35)	(1.35)	(1.34)
Total assets	-11.86***	-11.46***	-11.62***	-11.43***	-11.38***
	(0.96)	(0.98)	(0.96)	(0.98)	(0.97)
Age	-24.49***	-24.26***	-24.16***	-24.26***	-24.51***
	(2.60)	(2.60)	(2.60)	(2.60)	(2.59)
Observations	588,433	588,433	587,623	588,433	596,143
R-squared	0.308	0.308	0.308	0.308	0.310
B. Zombies defined as in Adalet McGowan et al. (2018)					
Productivity	-4.58***	-4.06***	-4.33***	-4.25***	-4.97***
	(1.00)	(1.06)	(1.02)	(1.04)	(1.09)
Tangibility	1.22	1.28*	1.28*	1.28*	1.23*
	(0.75)	(0.75)	(0.75)	(0.75)	(0.75)
Profitability	7.25**	6.56*	7.26**	6.84*	7.60**
	(3.54)	(3.58)	(3.54)	(3.56)	(3.57)
Liquidity	15.93***	15.86***	15.87***	15.85***	15.99***
	(4.15)	(4.15)	(4.15)	(4.15)	(4.13)
Leverage	-42.95***	-43.01***	-43.01***	-43.01***	-43.11***
	(2.77)	(2.77)	(2.77)	(2.77)	(2.76)
Short-term debt ratio	-13.71***	-13.62***	-13.76***	-13.61***	-13.63***
	(1.39)	(1.39)	(1.39)	(1.39)	(1.38)
Total assets	-11.82***	-11.43***	-11.60***	-11.40***	-11.30***
	(0.98)	(1.00)	(0.98)	(1.00)	(0.99)
Age	-25.83***	-25.60***	-25.54***	-25.61***	-25.92***
	(2.61)	(2.61)	(2.62)	(2.61)	(2.61)
Observations	571,288	571,288	570,469	571,288	578,561
R-squared	0.311	0.311	0.311	0.311	0.313
All panels include					
Bank×Firm FE	✓	✓	✓	✓	✓
Bank×Industry×Province×Year FE	✓	✓	✓	✓	✓

Note: Table shows robustness of the results when zombie firms are not included in the estimation sample following alternative zombie definitions from the literature. All specifications include balance-sheet variables, bank×firm and bank×industry×province×year fixed effects. See the main text and table notes for definitions. Standard errors in parentheses are clustered at bank level. *, **, *** indicate statistical significance at 10%, 5%, and 1%, respectively.

A2 Theoretical Connections

Firms, with discount factor ξ^f, produce with Cobb–Douglas with capital share $\nu \in (0,1)$, have productivity z, carry legacy (beginning of the period) debt b, and face a collateral constraint allowing at most a fraction $\kappa \in (0,1)$ of future (end of period) capital value to be pledged.[25] Banks' discount factor is ξ^k and they optimally decide on the lending terms. They show that in equilibrium, the credit constraint binds and two types of lending takes place within a relationship: normal lending, which offers the same terms with lending outside the relationship, and evergreening which is peculiar to relationships. The end of period credit, b', is given by the following in two modes of lending.[26]

Normal (also dispersed) lending:

$$b'(\kappa, z) = \kappa \left(\frac{\xi^f \nu z}{1 - \kappa(\xi^k - \xi^f)} \right)^{\frac{1}{1-\nu}} \tag{A1}$$

Evergreening:

$$b'(\kappa, z, b) = \kappa \left[\frac{b}{(1-\nu)\,\xi_f\, z} \right]^{\frac{1}{\nu}} \tag{A2}$$

Equation (A1) suggests that pledgeability (κ) boosts lending as well as productivity (z) in normal lending mode. In contrast, equation (A2) predicts that productivity is inversely related to credit while pledgeability continues to affect positively (though attenuated) in evergreening relationships.

Equation (1) of this paper has a natural reduced-form interpretation according to this model. A time-varying κ is proxied by balance-sheet variables and z by our firm-level productivity measures. The within-relationship productivity coefficient, β, measures the average response across both states in each relationship. If all relationships show normal lending feature our estimate should be positive, $\beta > 0$. Instead, we estimate $\beta < 0$, implying from the lens of this model that on average the evergreening zone dominates relationships.

Faria-e Castro et al. (2024) empirically investigate the cases where both b is high enough and z is low enough through a proxy variable, the probability of default (PD). In particular, to make sure they identify the evergreening zone of the model, they compare the outcomes of the firms with a PD that is higher than a certain threshold to others. Our approach differs such that (i) we focus on a specific aspect of their model, z; (ii) we explore the continuous productivity response instead of distressed firms outcomes.

[25] We use letters different than Faria-e Castro et al. (2024) only to avoid confusion with the coefficients in the main text.

[26] Derivation is straightforward and requires substituting the threshold debt price, Q^{min}, below which a firm chooses default, implied by proposition 1 of Faria-e Castro et al. (2024) into their optimal capital stock equation (A1). Whether a bank–firm pair ends up with normal lending or evergreening is given by their proposition 3. It depends on how the time preference compares to the optimally determined minimum acceptable price by the firm. Liquidation within a relationship only happens when the minimum acceptable price by the firm is greater than the maximum price bank is willing to pay, i.e., $Q^{min} > Q^{max}$.