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The Transmission of Monetary Policy to Corporate Investment: the Role of Loan Renegotiation*

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Abstract

I construct a novel dataset comprising over 100,000 loan observations from U.S. firms and estimate that renegotiating *existing* loans —rather than originating *new* loans —significantly contributes to the corporate investment response to monetary policy shocks, accounting for half of the aggregate effect. Expansionary monetary policy shocks increase bank credit predominantly through renegotiations, and in turn, firms that renegotiate boost investment the most. By contrast, new loan issuance is driven by the firm's investment growth prior to the shocks, consequently contributing only a tenth to the overall investment response. Notably, renegotiations amplify investment responses for financially constrained firms. These findings unveil novel dimensions of the channels through which monetary policy affects corporate investment.

JEL Classification: E22, E32, E52, G21, G32
Keywords: Monetary policy transmission, Bank debt, Investment, Financial constraints, Renegotiation, Text analysis

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1 Introduction

In the realm of monetary policy's impact on corporate investment, the traditional credit channel stands as a pivotal transmission mechanism, with a primary focus on the role of *new* bank lending (e.g., Kashyap, Stein and Wilcox, 1993).[1] To the best of my knowledge, this is the first study that distinguishes *new* loans from revisions to *existing* loan terms in the transmission channel. This unique perspective is driven by the fact that in the United States, almost 70% of corporate loan contracts are renegotiated prior to maturity, with firms renegotiating existing loans twice as often as issuing new ones, leading to substantial changes in loan terms.[2] By constructing a novel dataset derived from textual analysis of corporate loan agreements, substantially expanding the observations in prior work (e.g., Roberts, 2015), this study reveals that renegotiating existing loans not only explains half of the investment response to monetary policy shocks but also amplifies investment responsiveness for highly leveraged and bank-dependent firms. In contrast, the likelihood of issuing new loans is determined by previous investment growth rather than driving subsequent investment responses. By unravelling the complexities of the credit channel, this study introduces loan renegotiation as a key mechanism for monetary policy affecting corporate investment.

Making this distinction between new and existing loans holds fundamental importance for researchers and policymakers concerned with the aggregate and distributional effects of monetary policy. New loans and the renegotiations of existing ones bear distinct economic implications. Notably, renegotiations of existing loans typically involve lower funding costs with more lenient conditions than issuing new ones (e.g., Gârleanu and Zwiebel, 2009; Denis and Wang, 2014) and provide valuable market information, as seen in their linkage to stock returns in capital markets (e.g., Lummer and McConnell, 1989). Consequently, the choice between acquiring new loans or renegotiating existing ones following monetary policy shocks influences firms' capacity to invest, expand, or withstand economic downturns. In addition, recognizing that firms encounter varying circumstances —some without existing loans, others struggling to obtain new loans or flexibly choosing between new and existing loans, and some relying heavily on bank financing —underscores the potential divergent effects stemming from the same monetary policy shock. Therefore, distinguishing between new loan issuances and renegotiating existing loans contributes signifi-

[1] See also e.g., Bernanke and Blinder, 1988; Bernanke and Gertler, 1995; Kashyap and Stein, 2000; Jiménez et al., 2012; Abuka et al., 2019; Ongena, Schindele and Vonnák, 2021.

[2] On average, typical corporate loan contracts are renegotiated prior to maturity every ten months, despite their average initial maturity being about 5 years. Following renegotiation, the loan amounts, interest rate spreads and maturities undergo significant alterations, typically ranging from 30% to 40% from their initial values on average. For loan contracts based on a floating rate with specified spreads above benchmark interest rates, firms often renegotiate the pricing grid when adjusting the interest rate spread.

cantly to achieving a comprehensive understanding of monetary policy transmission.

This study highlights the crucial role of the renegotiation channel in transmitting monetary policy to corporate investment. Following expansionary monetary policy shocks, firms are more likely to renegotiate than at normal times, driving nearly half of the aggregate investment response, which is significantly larger than the less than 12% contribution of new loan issuance.[3] Specifically, a 25 basis points expansionary shock raises the propensity to renegotiate by almost 2 percentage points immediately, lasting for 3 quarters, indicating a substantial effect given the average renegotiation rate of approximately 10% of valid corporate loans each quarter. This effect is more pronounced in response to expansionary shocks than contractionary ones, revealing an asymmetry in the effects of monetary policy shocks. Importantly, the increase in the propensity to renegotiate is independent of previous investment growth whereas firms with high investment growth prior to the shock are more inclined to issue new loans. Furthermore, the loan volume increases beyond the typical magnitude of adjustments after such renegotiations while the volume of new loan issuance remains at its average level. The relatively larger investment response for firms engaged in renegotiation begins notable in 3 quarters, peaking at 10 quarters, accelerating monetary policy transmission considering the average response peaking at 18 quarters. Therefore, renegotiation, rather than the origination of entirely new loans, serves as the primary channel through which monetary policy affects investment, explaining the subsequent investment response to monetary policy shocks.

The findings further reveal the significant role of the renegotiation channel in elucidating the heterogeneous investment response observed across firms with different financial constraints. Notably, highly leveraged firms (e.g., Jeenas, 2019; Caglio, Darst and Kalemli-Özcan, 2021) and those more reliant on bank financing (e.g., Kashyap, Stein and Wilcox, 1993; Caglio, Darst and Kalemli-Özcan, 2021) exhibit greater responsiveness to monetary policy shocks in terms of investment, primarily driven by their greater sensitivity of renegotiations in the face of such shocks compared to other firms. This suggests that expansionary monetary policy shocks alleviate financial constraints for these firms, resulting in improved access to credit through renegotiations. Consequently, renegotiation acts as a conduit that amplifies the investment response to monetary policy shocks for more financially constrained firms.

To examine the role of new and existing loans in monetary policy transmission, I construct a novel panel dataset that traces each loan path including its origination, renegotiations, and eventual maturity or early termination. To date, little evidence of a renegotiation channel has been documented, due to the lack of reliable data accurately identifying whether a loan is renegotiated

[3]The remaining portion of the investment response, not a focus of this study, is explained by residual factors, including internal financing and alternative external financing sources like equity or bonds.

or originated. By combining automated textual analysis with manual scrutiny of corporate loan contracts filed with the US Securities and Exchange Commission (SEC), this study tracks almost 10,000 unique loans of 3,000 firms from 2005 to 2015, yielding over 100,000 loan-quarter observations. The observations not only significantly extend the previous study that typically studies only a handful of firms (e.g., Roberts, 2015) but also are more comprehensive than supervisory data such as Shared National Credit and Y-14 of the Federal Reserve by incorporating all major types of renegotiations including modifications to the loan amount, price, covenant or maturity. The loan-level observations are matched with quarterly balance sheet information of firms and banks from Compustat and Call report, and linked to monetary policy shocks (Bu, Rogers and Wu, 2021) that effectively connect periods of conventional and unconventional policymaking. This merged dataset comprises a mix of publicly listed and private firms, with approximately 53% of the observations corresponding to private firms. Importantly, this microdata aligns the cyclical properties of investment with national statistics, unconditionally and conditional on monetary policy shocks.

Related Literature. The primary literature where this paper makes a significant contribution is the credit channel. Primarily, it enhances our understanding of the bank lending channel, a key subchannel of the credit channel by investigating the impact of dynamic changes in existing loans, in addition to new loans, on monetary policy transmission. Existing literature mainly focuses on the supply of new bank credit, overlooking the role of renegotiating existing loans in shaping the real effects of monetary policy (e.g., Bernanke and Blinder, 1988; Gertler and Gilchrist, 1994; Kashyap and Stein, 2000; Kishan and Opiela, 2000; Jiménez et al., 2012, 2020; Abuka et al., 2019; Ongena, Schindele and Vonnák, 2021). Only new loans have been measured in prior research, disregarding the substantial changes in credit volume, pricing, maturity, or covenants resulting from frequent loan revisions. This paper addresses this gap by using novel micro-level data to separate renegotiated loans from new loans and highlights their different contributions, emphasizing the significance of the renegotiation channel. This distinction extends the traditional financial economics literature that emphasizes the importance of differentiating between new and renegotiated loans in terms of transmitting information to the capital market (e.g., Lummer and McConnell, 1989).[4]

Furthermore, the renegotiation channel contributes to the firm balance sheet channel, another pivotal subchannel of the credit channel (e.g., Gertler and Gilchrist, 1994; Ashcraft and Campello, 2007; Ciccarelli, Maddaloni and Peydró, 2015). Recent research by Ippolito, Ozdagli and Perez-Orive (2018) documents that investments of firms with a larger share of existing floating-rate bank

[4]Lummer and McConnell (1989) show that modifications of existing bank loans convey significant information to the capital market whereas issuing new loans has no effect on the excess stock return for borrowers. Furthermore, it is worth noting that recent studies examine the importance of household mortgage refinancing in the context of *consumption* response (Wong, 2019; Beraja et al., 2019; Di Maggio, Kermani and Palmer, 2020).

debt display greater responsiveness to monetary policy surprises. This paper expands the discussion by showing that outstanding liabilities experience fluctuations in interest rate payment through transformations of loan terms after renegotiations, which can have a greater impact than the mechanical tie between floating-rate debt and policy rate changes.

In documenting this new channel, there are subsequent implications for many other related literatures for understanding heterogeneous investment responses, the dynamics of financial contracting, the asymmetric effects of monetary policy, and textual analysis in credit agreements.

Notably, this paper contributes to the literature on the heterogeneous impact of monetary policy shocks across firms by highlighting the role of renegotiation as the underlying channel for heightened responsiveness among financially constrained firms. It extends the existing literature on bank dependency (e.g., Kashyap, Stein and Wilcox, 1993; Petersen and Rajan, 1995; Caglio, Darst and Kalemli-Özcan, 2021) and leverage (e.g., Jeenas, 2019; Caglio, Darst and Kalemli-Özcan, 2021), providing direct evidence that renegotiations amplify the investment response of highly leveraged bank-dependent firms.[5] This finding aligns with recent research (Caglio, Darst and Kalemli-Özcan, 2021) which shows the greater responsiveness of highly leveraged small and medium-sized enterprises (SMEs) due to their reliance on banks, complementing previous literature on the responsiveness of financially constrained (Gertler and Gilchrist, 1994) and unconstrained (Ottonello and Winberry, 2020) firms.[6] This paper further complements existing research by revealing that younger firms (Cloyne et al., 2023) are more likely to rely on new loan issuances rather than renegotiations as their primary transmission channel of monetary policy. These insights advance our understanding of the precise mechanism driving heterogeneous responses to monetary policy.

In addition, this paper makes a significant contribution to the literature on financial contracting and its intersection with monetary policy. In particular, it extends the knowledge of the timing and heterogeneity of loan renegotiations across firms by considering monetary policy shocks. In the literature on financial contracting, Hart and Moore (1988) argue that renegotiations occur due to the inherent incompleteness of loan agreements. While extensive theoretical research has explored the broad timing of renegotiation, empirical studies have been limited by data collection

[5]Bank-dependent firms experience more pronounced effects from monetary policy compared to firms with greater flexibility in financing sources (e.g., Kashyap, Stein and Wilcox, 1993; Becker and Ivashina, 2014). Additionally, Petersen and Rajan (1995) find that banks are more inclined to finance financially constrained firms to capitalize on the benefits of assisting these firms that heavily rely on bank financing. Furthermore, highly leveraged firms exhibit greater investment responses than others following monetary policy shocks (e.g., Jeenas, 2019).

[6]Recent findings by Caglio, Darst and Kalemli-Özcan (2021) demonstrate that highly leveraged small private firms and lowly leveraged large public firms exhibit higher responsiveness, thus complementing the higher responsiveness of smaller firms (Gertler and Gilchrist, 1994) and lowly leveraged public firms (Ottonello and Winberry, 2020).

challenges. Theoretical studies have examined renegotiations in the context of firm distress (e.g., Giammarino, 1989; Mella-Barral and Perraudin, 1997; Sundaresan and Wang, 2007; Christiano, Motto and Rostagno, 2014), outside distress (e.g., Bergman and Callen, 1991; Dessein, 2005; Gârleanu and Zwiebel, 2009) or a combination of both (e.g., Arnold and Westermann, 2023). Empirical evidence suggests that renegotiations occur early and frequently outside of firm distress rather than during distress (Roberts and Sufi, 2009; Denis and Wang, 2014; Roberts, 2015). However, loan renegotiation has typically not been considered in the literature on monetary policy. This paper thus complement both strands of literature by introducing that the timing of renegotiation is also influenced by monetary policy shocks.

Moreover, this paper contributes to the literature on the asymmetric effects of monetary policy shocks by demonstrating that both loan activities respond more strongly to expansionary monetary policy shocks compared to contractionary shocks when distinguishing between the effects of originations from those of renegotiations. Prior studies produce mixed findings regarding the asymmetric effects across different directions of monetary policy shocks. Some studies suggest stronger effects of contractionary monetary policy shocks on output (e.g., Cover, 1992; Morgan, 1993; Tenreyro and Thwaites, 2016), while others, such as Weise (1999), find no evidence of asymmetry. The findings of this study align with Kandil (1995) indicating that prices and wages respond more to expansionary monetary policy shocks due to asymmetric nominal rigidities in wage negotiations and price adjustments. Furthermore, the results extend the findings of Abuka et al. (2019) that report asymmetry in loan approval likelihood but not in loan volume or interest rates.

Finally, this paper makes a valuable contribution to the existing literature that utilizes textual analysis in credit agreements. Previous studies(e.g., Nini, Smith and Sufi, 2009, 2012; Akins, De Angelis and Gaulin, 2020; Biguri, 2023) employ keyword searches to identify covenant violations or changes in management restrictions within loan contracts. This study extends the literature by advancing a textual search algorithm to distinguish loan renegotiations from originations and to identify changes in loan terms during renegotiations. It constructs a large-scale dataset through a combination of textual analysis techniques and manual validation, substantially expanding the observations collected manually for only a few firms (e.g., Roberts and Sufi, 2009; Roberts, 2015). This novel approach is crucial for a comprehensive analysis of the role played by these two distinct loan activities in transmitting monetary policy shocks.

The structure of the remaining sections is as follows. Section 2 provides an overview of data construction and the data used in the analysis. Section 3 outlines the main empirical framework employed to address the research questions and presents the corresponding results. Section 4 concludes the paper.

2 Data

The sample for the analysis consists of a quarterly unbalanced panel of US firms from 2005 to 2015 covering both conventional and unconventional monetary policy periods. This sample period is governed by the collection of loan-level data that includes information about loan renegotiations. The renegotiation of corporate bank debt is observed from the Securities and Exchange Commission (SEC) filing. These filings are available from the SEC's EDGAR (Electronic Data Gathering, Analysis, and Retrieval) system as SEC precedent requires firms to provide not only material debt agreements but any material changes to these agreements.[7]

To construct a comprehensive and accurate loan path, this study employs automated text analysis complemented by manual review and corrections. The process begins by acquiring all lists of SEC filings and identifying credit agreements within these filings using a text-search algorithm that scans the initial characters of each document. Once credit agreements are identified, documents are categorized as origination, renegotiation, or early termination based on predefined keyword identification. Additionally, effective dates for loan origination, renegotiation, early termination, and maturity are collected. Extracting loan terms involves three approaches: parsing the contract's summary passage, extracting relevant tables, and locating keywords and units associated with loan amounts and pricing. The collected information allows for the completion of loan paths including borrower and lender details.

Each loan path begins with an origination, includes all renegotiations, and ends with early termination, mature or censor.[8] Renegotiations mainly consist of amendments, amended and restated agreements and replacements. Amendments typically involve minor modifications, mainly focusing on amended sections. Amended and restated agreements are less frequent but entail more comprehensive rewrites of the entire agreement, including modifications to previous terms. Replacements often coincide with early termination when loans are replaced by existing or different lenders. A common trait of these renegotiation types is that they must occur prior to the most recently stated contract maturity and the loan agreement must indicate that the document is making

[7] Item 601(b) of Regulation S-K requires firms to file exhibits and items 4 and 10 under this provision demand disclosure of all material agreements accessible electronically since 1994. To strike a balance between cost and representativeness, I construct a dataset spanning from 2005 to 2015. Given the diverse structures and filing formats of loan agreements across firms and time periods, the data construction process involves managing costs associated with a complex methodology and rigorous manual validation. This choice of period mitigates potential selection bias by encompassing both conventional and unconventional monetary policy periods.

[8] Censor occurs towards the end of the sample period as the remaining loan path is unobservable.

changes to the existing document being referred to. I record all of these types as renegotiations because the distinction among renegotiation types is economically less meaningful(Roberts, 2015). The data collection process does not exclude loans that have not gone through any renegotiation to prevent selection bias. Regarding the end of loan paths, loans are assumed to have matured unless SEC filings provide evidence of a different termination. This is because firms typically do not report matured loans as it is not a material change to the agreement.[9]

Loan contract observations are aggregated quarterly and matched with Standard and Poor's Compustat for balance sheet data. The SEC filing header provides essential details such as the company's name, address, CIK, IRS tax identification number, and reporting date, which are used to map historical records from Compustat. Firms in SEC filings are then linked to DealScan using the DealScan-Compustat link provided by Chava and Roberts (2008). Loan observations in SEC filings are further linked to DealScan based on origination date, renegotiation date, loan type and amount. This allows for the supplementation of the dataset with detailed loan terms at origination and when available, renegotiations. Information on firms' bond issuances is obtained by linking to the Mergent Fixed Income Securities Database (FISD) and Securities Data Company (SDC) Platinum. Bank balance sheet data is incorporated by matching with Compustat and supplementing missing information using the Federal Deposit Insurance Corporation (FDIC) Call Report.[10]

The loan-level sample is constructed by applying standard sample restrictions, resulting in 9,565 loan paths from 2,685 firms, comprising a total of 129,733 loan-quarter observations. To conduct a firm-quarter analysis of the investment response, the sample is further narrowed down to include only firms observed for at least 6 years, aligning with the forecast horizon of impulse response functions and the median time to IPO reported in Wilmer Curtler Pickering Hale and Dorr LLP (2016).[11]

This dataset mitigates the limitation of existing data, enabling the study of monetary policy transmission with consideration of firm heterogeneity. It includes a combination of publicly listed and private firms, with more than half of the observations corresponding to private firms. Previous research on renegotiations has primarily relied on two types of data. The first type involves man-

[9]Certain modifications dictated in the original agreement, such as prespecified interest rate spread increments corresponding to credit rating downgrades, and automated maturity extensions due to Evergreen provisions, are not considered as renegotiations in this study.

[10]Lenders in the dataset are matched to banks in the Call Report using the RSSD-DealScan linking table provided by Jan Keil (https://sites.google.com/site/drjankeil/home?authuser=0) (Keil, 2018).

[11]I exclude financial institutions (SIC 6000-6799), utilities (SIC 4900-4999), public administration (SIC 9000-9999), non-operating establishments (SIC 9995) and industrial conglomerates (SIC 9997), following the standard literature. Observations are dropped if acquisitions exceed 5% of total assets, as detailed in Appendix A. Additionally, Facilities with multiple sub-facilities are excluded to minimize data collection errors. Nonetheless, including these observations does not alter the main findings.

ual collection from loan agreements, providing comprehensive coverage of various renegotiation types but limited observations. While the dataset from Roberts (2015) is widely used, it only covers loan paths for 114 firms. In contrast, my dataset combines manual collection and text-mining techniques, substantially expanding the observations derived from loan agreements. The second type of data comprises confidential reports from selected lenders for supervisory purposes. However, this data has limitations, including the exclusion of major renegotiation types and coverage restricted to low frequency as well as large loans or large banks. For example, the Shared National Credit (SNC) dataset captures renegotiations solely through annual increases in maturity or amount for large syndicated loans. Additionally, the Federal Reserve's quarterly Y-14 dataset has recently started recording only minor amendments of loans from large banks.[12]

Notably, the accuracy of this constructed dataset exceeds 94% based on a comparison with an existing hand-collected dataset by Roberts (2015). While my dataset is constructed through a combination of a textual algorithm and human review, the currently only publicly available dataset providing reliable information on renegotiation documented in Roberts (2015) relies solely on human review. The comparison reveals a strong level of consistency between the two datasets. Around 90% of the approximately 300 matched observations exhibit complete agreement. For the remaining 10% of observations that are matched between the two datasets but exhibit some discrepancies, I conduct a thorough manual investigation to pinpoint the sources of these differences. The findings indicate that approximately 4% of the divergences stem from errors in the dataset of Roberts (2015), while around 1% are attributed to errors in my dataset. Additionally, about 5% of the discrepancies cannot be conclusively determined due to various factors, including unavailable URL addresses or instances of ambiguous interpretations.

Before examining the bank-firm-quarter observations, it is crucial to emphasize a critical aspect of loan-level dynamics: most loans undergo renegotiation before reaching maturity. Panel A of Table 1 reveals that for loans with stated maturities of at least one year, constituting 90% of all loans and thus representative of typical corporate loans, almost 70% experience renegotiation. This phenomenon broadly aligns with previous studies (e.g., Roberts and Sufi, 2009) documenting that over 90% of loans are renegotiated.[13] Furthermore, renegotiation represents the majority of total corporate debt, especially for firms that rely on banks (Appendix Figure A.0.1).

Panel B presents summary statistics for the variables used in the main analysis. The top seg-

[12] Appendix A.1 provides further details on the SNC and Y-14 data. Other than these two types of data, Thomson Reuters's DealScan provides some information on loan amendment but the reporting is sparse and often misreports amended loans as new loans.

[13] The discrepancy may arise from differences in sample size and period; Roberts and Sufi, 2009 analyze a smaller sample of 1,000 loans between 1996 and 2005.

ment of the panel provides information at the bank-firm-quarter level, which is relevant for the regressions examining the impact of monetary policy shocks on credit adjustment.[14] A key variable of interest in the analysis is the loan status at each point in time, indicating whether it is renegotiated, originated, or remains unchanged. Renegotiation occurs approximately twice as frequently as loan origination. Specifically, renegotiations account for around 10.2% of valid loan observations every quarter, compared to 5.5% for loan origination.[15] Furthermore, renegotiation often leads to significant alterations in loan terms such as loan amounts and interest rate spreads, typically in the range of 30% to 40% from their initial values. During renegotiation, loan terms may increase or decrease, with absolute revisions reaching 162 million dollars and 48 basis points.

The main bank balance sheet variable examined in this study is the bank capital ratio, which serves as a measure of the bank's net worth. The ratio is calculated by dividing bank equity and retained earnings by total assets, following the theoretical literature that emphasizes the pivotal role of net worth in governing the bank's ability to secure funding from its financiers (Holmstrom and Tirole, 1997; Holmström and Tirole, 1998; Bernanke, Gertler and Gilchrist, 1999; Gertler and Kiyotaki, 2010). On average, the bank capital stands at 12.2% with a standard deviation of 4.8%.[16]

The middle segment of Panel B displays summary statistics of variables at the firm-quarter level, which are used in the regressions analyzing investment responses. The investment rate is computed as the ratio of the capital expenditure in the current period to the net plant, property, and equipment at the beginning of the period. On average, the investment rate amounts to 0.2. In the regression models, firm size is included as a main control variable of the borrower, measured by taking the logarithm of total assets. This transformation is employed due to the highly right-skewed distribution of asset values. The firm-level renegotiation indicator takes the value of one if a firm renegotiates at least one of its loans during the quarter. The average proportion of firms engaging in renegotiations is 5 percentage points higher than the corresponding figure at the bank-firm-quarter level. This disparity arises because some firms possess multiple loan facilities simultaneously.

To capture a firm's financial position, this study uses an indicator of highly leveraged and bank-dependent. An indicator of a highly leveraged firm takes the value of one when a firm's leverage

[14] To construct the bank-firm-quarter level, loan-level data is aggregated since a firm may have multiple loans from the same bank within the same quarter. A more granular regression at the loan-quarter level is provided in Appendix B.1.2.

[15] The majority of contracts are renegotiated as shown in Panel A but among all loan observations, the likelihood of observing renegotiation at any point in time is low due to the panel nature of data.

[16] A small fraction of observations (less than 0.4%) exhibit negative values, especially during the Global Financial Crisis. To mitigate any potential influence from these infrequent negative-value observations, the final sample excludes them, while the main findings of the study remain unaltered.

level exceeds the median in the sample. Leverage is measured using the debt to asset ratio following previous studies (e.g., Jeenas, 2019; Ottonello and Winberry, 2020). The bank-dependent indicator takes a value of one if a firm relies on bank debt for financing. This is determined by the absence of any public bond issuances in the past three years or the absence of outstanding public bonds, consistent with the definition used in literature (e.g., Santos and Winton, 2008, 2019). On average, bank-dependent and highly leveraged firms represent 15.8% of the firm-quarter observations. To mitigate the potential impact of outliers, I apply a winsorization technique by truncating the top and bottom 1% of firm balance sheet variables.

Lastly, The bottom segment of Panel B shows statistics of key macroeconomic variables used in the analysis. The detailed definitions of variables are presented in Appendix A.

Table 1: Summary statistics

1. Panel A: Distribution of loans by maturity

	Stated maturity at origination (years)			
	< 1	1-3	3-5	5-
(%)	(9.486)	(12.411)	(29.808)	(48.295)
Renegotiated loans	38.818	66.789	71.683	64.073
Matured loans without renegotiations	61.182	33.211	28.317	35.927

2. Panel B: Key variables for regressions

	Mean	Median	S.D.	95th	Obs.
Bank-Firm-Quarter					
Origination	0.055	0.000	0.228	1.000	110,752
Renegotiation	0.102	0.000	0.303	1.000	110,752
New loan ($million)	474.462	202.190	797.228	1,929.608	6,080
Renegotiated amount ($million)	55.957	21.799	378.744	479.478	2,988
|Renegotiated amount|	162.156	56.428	366.320	612.887	2,988
New loan spread (bps)	171.481	132.215	146.805	455.000	5,516
Renegotiated loan spread (bps)	-5.571	-8.641	75.429	121.750	1,622
|Renegotiated loan spread|	47.952	25.219	59.180	150.000	1,622
Bank capital ratio	12.163	12.579	4.751	19.455	84,722
Highly leveraged & Bank-dependent	0.189	0.000	0.392	1.000	110,752

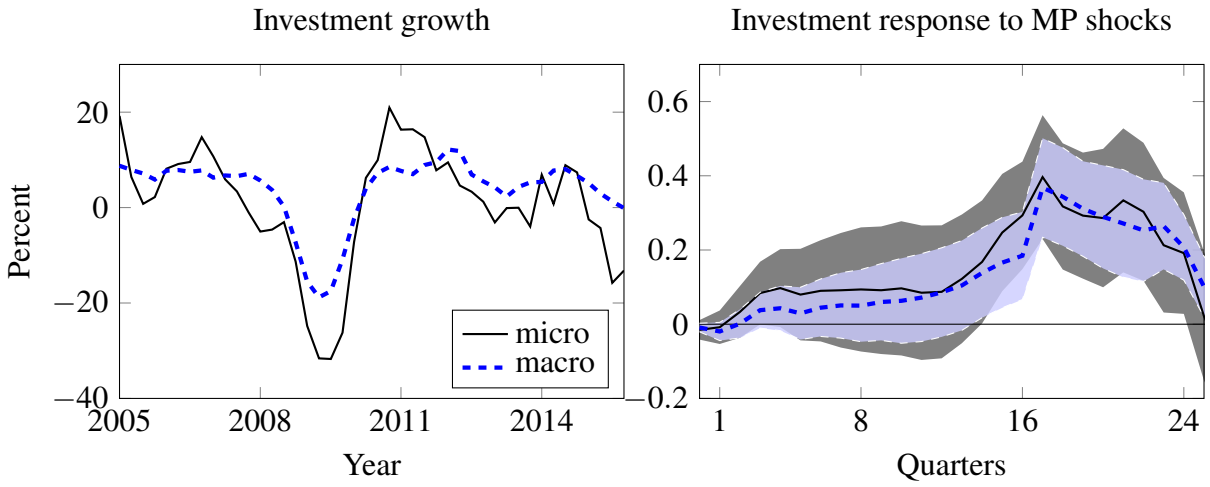
Table 1: (Continued) Summary statistics

	Mean	Median	S.D.	95th	Obs.
Firm-Quarter					
Origination	0.093	0.000	0.291	1.000	59,947
Renegotiation	0.147	0.000	0.354	1.000	59,947
Investment rate	0.236	0.182	0.221	0.602	43,518
Log total real assets	7.367	7.363	1.554	10.068	43,884
Highly leveraged					
& Bank-dependent	0.158	0.000	0.365	1.000	59,947
Macroeconomic conditions					
Real GDP growth	0.004	0.005	0.007	0.012	44
Inflation	0.005	0.006	0.007	0.013	44
Volatility index (VIX)	19.718	16.893	9.088	33.016	44
Banking sector's capital ratio	10.669	11.005	0.543	11.230	44
Tightening lending standards	1.852	-7.250	24.740	57.700	44

Notes: The definition of each variable and details of the sample selection are provided in Appendix A. Renegotiated loans are those that undergo renegotiation at least once between origination and termination, while matured loans reach maturity without any renegotiation since origination. At the bank-firm-quarter level, the 'Origination' (or 'Renegotiation') indicator takes a value of one if at least one loan from a specific bank to a certain firm is originated (or renegotiated) during the quarter. At the firm-quarter level, the 'Origination' (or 'Renegotiation') indicator takes a value of one if a firm originates (or renegotiates) at least one loan during the quarter. Note that the number of observations is smaller for loan terms because the observation is conditional on the event (i.e. issuing new loans or renegotiating to modify loan amount) and the annual spread paid over loan terms is missing for some loans.

The use of micro-level data in this study provides valuable insights into the dynamics of aggregate macro-level data. Figure 1 shows that the estimated investment dynamics using the micro-level data closely align with those estimated for universal firms based on macro-level national statistics which includes both private and publicly listed firms. The left panel reveals a high correlation of approximately 0.9 between the investment growth rates derived from aggregated micro-level data and macro-level data. The right panel confirms the consistency of the investment response to monetary policy shocks estimated from the micro-level data with the response estimated from macro-level data. Specifically, a 25 basis points expansionary monetary policy shock leads to an increase in the investment rate of up to 0.2 percent, peaking within 18 quarters and gradually diminishing thereafter. These findings support the validity and robustness of the analysis, highlighting the consistency between micro-level and macro-level investment dynamics.

Figure 1: Dynamics of investment using aggregated micro-level and macro-level data



Notes: The left panel shows the year-on-year investment growth. The right panel reports the coefficient β_h from the impulse response function after a 25bps expansionary monetary policy shock: $\Delta_h Y_{t+h} = \alpha_h + \beta_h \cdot \varepsilon_t + \nu_{t+h}$, where $\Delta_h Y_{t+h}$ is the difference of logarithmized investment rate Y over the horizon h, α_h includes seasonal fixed effects, and ε_t is the monetary policy shock with normalized positive values indicating expansionary shocks. The solid line corresponds to the estimation using aggregated micro-level data from my sample and the dashed line represents macro-level real private non-residential fixed investment data from the US Bureau of Economic Analysis. Shaded regions denote 90% error bands.

The main impulse of this study is the monetary policy shock series introduced by (Bu, Rogers and Wu, 2021), which provides significant advantages for three primary reasons.[17] Firstly, this shock measure encompasses both conventional and unconventional monetary policy shocks, allowing for a comprehensive analysis of their effects during different policy regimes. This is important because the sample period in this study spans the conventional phase from 2005 to late 2008 and the unconventional phase from late 2008 to 2015, which includes the zero lower bound period when the federal fund rate remained near zero. Secondly, the shock series is constructed to eliminate substantial information effects. This is crucial, as monetary policy announcements often convey both policy actions and the central bank's economic outlook, potentially confounding impulse responses, such as the decrease in output following expansionary shocks, as discussed in other studies (e.g., Nakamura and Steinsson, 2018; Jarociński and Karadi, 2020). Lastly, it is demonstrated to be largely unpredictable from available information on the economy such as Blue Chip forecasts, news releases and consumer sentiment.

The identification of this shock series relies on a two-step procedure by Fama and MacBeth (1973). The underlying assumption is that both monetary and non-monetary policy shocks drive changes in interest rates between the Federal Reserve Federal Open Market Committee (FOMC)

[17] Nonetheless, the main results hold using alternative monetary policy shock series (e.g., Nakamura and Steinsson, 2018; Jarociński and Karadi, 2020).

announcement day and the previous day, with different information effects on short-term and long-term interest rates. The first step of the procedure estimates the sensitivity of interest rates at various maturities from 1 to 30 years to FOMC announcements over a 1-day window, excluding non-monetary policy news using a heteroskedasticity-based partial least squares approach (Rigobon, 2003; Rigobon and Sack, 2004). The following step then derives the policy shock series by regressing the interest rate changes on the sensitivity estimated in the first step. This approach ensures the exogeneity of the monetary policy shock series and mitigates concerns of biased results stemming from the confounding factors of policy and information effects (See Bu, Rogers and Wu (2021) for further details).

To align the monetary policy shock series with firm-level data, I aggregate the available monthly shocks on a quarterly basis. This aggregation is achieved through the application of weights based on the number of days in the quarter following the occurrence of the shock to reflect the amount of time for firms to respond to the shock (Ottonello and Winberry, 2020).[18] This weighted moving average yields similar descriptive statistics to the original monthly shock series. During the sample period, the monthly and quarterly series of monetary policy shocks exhibit a mean close to zero with standard deviations of approximately 4 basis points and 7 basis points, respectively. Alternatively, the quarterly shocks can be constructed by simply aggregating all shocks within a quarter. This aggregation method, however, does not significantly alter the moments of shocks or the main empirical results.[19]

Table 2: Summary statistics of monetary policy shocks

	Mean	Median	S.D.	Min	Max	Observations
Monthly	-0.004	0.000	0.044	-0.189	0.186	132
Quarterly (weighted)	-0.013	-0.012	0.065	-0.148	0.138	44
Quarterly (unweighted)	-0.012	-0.013	0.079	-0.238	0.148	44

Notes: This table uses the monetary policy shock series provided by Bu, Rogers and Wu (2021) for the period 1/1/2005 to 12/31/2015. The weighted quarterly shock is constructed by assigning weights based on the number of days in the quarter following the occurrence of the shock. The unweighted quarterly shock is obtained by simply aggregating all shocks within each quarter.

[18] The weighted quarterly monetary policy shock is defined as follows:

$$\varepsilon_q = \sum_{t \in Q(q-1)} w^a(t)\varepsilon_t + \sum_{t \in Q(q)} w^b(t)\varepsilon_t$$

where $w^a(t) \equiv \frac{\tau_q^d(t)}{\tau_q^T(t)}$, $w^b(t) \equiv \frac{\tau_q^T(t) - \tau_q^d(t)}{\tau_q^T(t)}$, $Q(q)$ is the set of periods in quarter q, $\tau_q^T(t)$ is the number of days in the quarter and $\tau_q^d(t)$ is the number of days elapsed before the monetary policy announcement.

[19] Appendix Figure A.0.2 shows the quarterly monetary policy shock series for the sample period.

3 Empirical Frameworks and Results

The primary focus of this paper is to examine the transmission mechanisms through which monetary policy shocks affect bank credit and, consequently, the real economy, with a particular emphasis on differentiating between the effects on loan originations and renegotiations. First, Section 3.1 estimates the adjustments in bank loans at both extensive and intensive margins in response to monetary policy shocks. This analysis sheds light on how firms alter their credit usage following these shocks. Building on these findings from the previous section, Section 3.2 delves into the investment response of firms that engage in either new bank debt issuance or the renegotiation of existing bank debt following monetary policy shocks. This section offers important insights into the relation between credit adjustments and corporate investment response.

3.1 The role of monetary policy shocks in credit adjustments: Extensive and intensive margins

3.1.1 The effect of monetary policy shocks on credit adjustments

Specification - Extensive margin. The analysis begins by examining whether monetary policy shocks have an impact on the likelihood of originating new loans or renegotiating existing loans, which correspond to the extensive margin of credit. Subsequently, the investigation focuses on the magnitude of changes in the loan amount and spread, representing the intensive margin of credit. To explore these dynamics, I estimate the following linear probability model at the bank-firm-quarter level, employing the local projection approach (Jordà, 2005):

$$P_{bj,t+h} = \alpha_b + \alpha_j + \beta_h \cdot \varepsilon_t + \gamma_h X_{bj,t-1} + \nu_{bj,t+h} \tag{1}$$

where $h \geq 0$, the dependent variable $P_{bj,t+h}$ is an indicator variable that equals one if at least one loan from bank b to firm j is originated/renegotiated from period t to $t+h$, ε_t represents the monetary policy shocks, $X_{bj,t-1}$ is a vector of control variables and $\nu_{bj,t}$ is the residual. The coefficient of interest, β_h, measures the effect of monetary policy shocks on the probability of loan origination or renegotiation from bank b to firm j. This binary analysis of the extensive margin offers several advantages, including its comprehensiveness, comparability across different loan types or sizes, and resilience to the gradual reduction in firm-bank exposures associated with promised amortization schedules. This framework, employing a binary dependent variable, is standard in the literature on bank lending (e.g., Jiménez et al., 2012; Abuka et al., 2019; Ongena, Schindele and Vonnák, 2021). The use of a linear probability model for the binary variable allows for the in-

clusion of high-dimensional fixed effects, unlike logit or probit models.[20] In addition, by using the local projection method, the estimates capture possible delayed and persistent effects of monetary policy shocks as discussed in previous studies (e.g., Kashyap and Stein, 1995; Romer and Romer, 2004).[21]

The vector $X_{bj,t-1}$ includes control variables capturing macroeconomic conditions, lending conditions, and borrower characteristics, all of which are lagged by one quarter. These controls account for potential confounding factors in the analysis. Real GDP growth and the VIX (volatility index) capture macroeconomic conditions, while average lending standard and aggregate bank capital ratio represent aggregate lending conditions. Firm size controls for borrower characteristics, consistent with previous studies (e.g., Ottonello and Winberry, 2020). For robustness, lender-specific bank capital ratio absorbs lender characteristics. These controls help isolate the effect of monetary policy shocks on credit adjustments while considering other factors influencing loan origination or renegotiation decisions.

Apart from these controls, bank (α_b) and firm (α_j) fixed effects capture persistent differences in the lender-specific credit supply and borrower-specific credit demand, respectively. In more demanding specifications, bank-by-firm fixed effects (α_{bj}) control for observed and unobserved time-invariant non-random lending relationships between lenders and borrowers, allowing for time variation in lending within a bank-firm relationship. The inclusion of bank-by-firm fixed effects is nontrivial especially when a firm consistently prefers to borrow from a certain bank whose ex-ante risk assessment of a borrower is persistently distinct from that of other banks. In addition, seasonal fixed effects absorb time-invariant differences in possible seasonalities. Throughout, robust standard errors are two-way clustered to address correlation within firms and banks.

Results - Extensive margin. Table 3 provides the results examining the impact of monetary policy shocks on the likelihood of loan adjustments at the time of the shock (i.e., h=0). The table presents the estimation results of the model specified in equation (1) with progressively saturating with varied sets of fixed effects. Expanding on these findings, Figure 2 shows the dynamic responses using bank and firm fixed effects as a benchmark estimation. The figure depicts the changes in the likelihood of loan adjustments up to three quarters following the shock. Throughout the analysis, the sign of monetary policy shock ε_t is normalized in the regression to ensure that

[20] While a logit or probit model is also suitable for a binary dependent variable, they may encounter an incidental parameter problem when there is a multitude of fixed effects. I thus use a linear probability model that accommodates high-dimensional fixed effects (See Wooldridge (2002), page 484 and Jiménez et al. (2012)). Nevertheless, the results remain robust when using a nonlinear procedure.

[21] Pagan (1984) proves that the standard errors on the generated regressors are asymptotically consistent and valid under the null hypothesis of a zero coefficient. The results also hold when using the series of monetary policy shocks as instruments for interest rates.

positive values correspond to expansionary monetary policy shocks.

Across the specifications in Table 3, the impact of monetary policy shocks on the probability of renegotiation is stronger than that of issuing new loans. Specifically, the last four columns of the table reveal that a 25 basis points expansionary monetary policy shock raises the likelihood of renegotiation by between 1.7 and 2.1 percentage points during the same quarter. This effect is economically significant, given that 10% of valid loans are renegotiated every quarter on average, irrespective of monetary policy shocks as indicated in Table 1. These coefficients remain robust when controlling for time-invariant heterogeneity in borrower and lender characteristics as well as possible non-random matching of lending relationships. The same shock also has a positive impact on the probability of issuing new loans but the estimated coefficients vary across the specifications, ranging from 0.3 to 1.5 in columns 1 to 4. These findings are qualitatively in line with the literature that highlights the role of lower short-term interest rates in increasing the likelihood of loan granting (e.g., Jiménez et al., 2012; Abuka et al., 2019; Ongena, Schindele and Vonnák, 2021).[22] Furthermore, the effect of monetary policy shocks on the propensity to adjust credit persists for about three quarters as shown in Figure 2, indicating a lasting impact beyond the immediate quarter of the shock.

The results are robust to using various alternative specifications. Controlling for lender-specific characteristics, such as bank capital ratio, maintains the robustness of the findings, as demonstrated in Appendix Table B.1.1. Estimating at a more granular level, specifically the loan-quarter level instead of the bank-firm-quarter level, yields consistent results, as shown in Appendix Table B.1.2. In addition, using an alternative construction of zeros for the origination indicator reveals even larger differences between renegotiations and originations compared to the conservative definition used in the main regression. In the main regression, zeros for the origination indicator are assigned only when there is an ongoing loan for a bank-firm pair. In contrast, the alternative construction assigns zeros for all potential bank-firm combinations that have been matched at least once during the sample period, regardless of whether a loan is currently active for the pair. Appendix Table B.1.3 with the alternative construction shows no significant immediate impact of monetary policy shocks on the likelihood of origination, but the response appears with lags.[23]

[22]The estimates of origination in this study are consistent with the literature while the estimates in this study are not directly comparable to previous research as other studies mainly focus on new loan originations or have no distinction between renegotiations and originations. For instance, in Spain, a 100 basis point change (almost one standard deviation) in the Spanish 3-month interbank rate results in a 1.4 percentage point increase in the probability of loan granting (Jiménez et al., 2012). For developing countries, larger interest rate changes are required to achieve a similar impact as in Spain (Abuka et al., 2019).

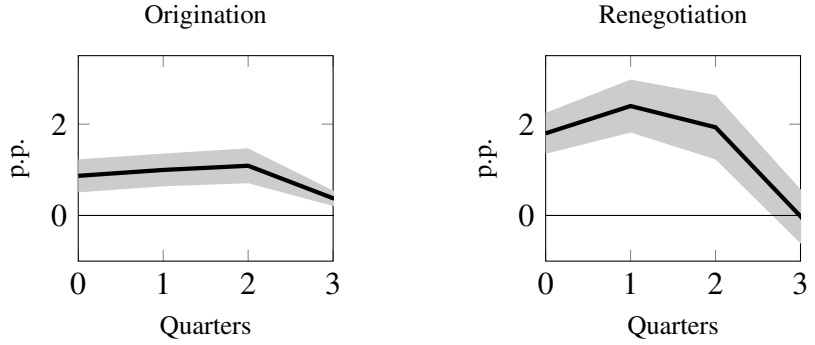
[23]Additionally, in line with the pattern observed in information shocks, Appendix Table B.1.4 reveals that the central bank information shocks derived by Jarociński and Karadi (2020) have an opposite impact on the propensity to originate/renegotiate compared to the effects observed with pure policy shocks.

Table 3: Extensive margin - Immediate effect of monetary policy shocks on origination vs renegotiation likelihood

	Origination$_t$				Renegotiation$_t$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Benchmark				Benchmark	
MP shock$_t$	0.279	0.501	0.868**	1.478***	1.672***	1.803***	1.799***	2.088***
	(0.357)	(0.357)	(0.349)	(0.360)	(0.424)	(0.429)	(0.434)	(0.417)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	Yes	-	No	Yes	Yes	-
Bank FE	No	No	Yes	-	No	No	Yes	-
Firm*Bank FE	No	No	No	Yes	No	No	No	Yes
Observations	110,752	110,752	110,752	110,386	110,752	110,752	110,752	110,386
R^2	0.008	0.042	0.058	0.113	0.026	0.112	0.122	0.184

Notes: The table presents the coefficient β_h from equation (1), after a 25bps expansionary monetary policy shock ε_t: $P_{bj,t+h} = \alpha_h + \beta_h \cdot \varepsilon_t + \gamma_h \cdot X_{bj,t-1} + \nu_{bj,t+h}$, where $h = 0$, $P_{bj,t+h}$ is an origination/renegotiation indicator for a loan from bank b to firm j, $X_{bj,t-1}$ is a vector of controls. Fixed effects are indicated as "yes" (included), "no" (not included), or "-" (part of a wider set). Robust standard errors in parentheses are two way clustered by firm and bank. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 2: Extensive margin - Dynamic effect of monetary policy shocks on origination vs renegotiation likelihood



Notes: The figure presents the coefficient β_h from equation (1), after a 25bps expansionary monetary policy shock ε_t: $P_{bj,t+h} = \alpha_h + \beta_h \cdot \varepsilon_t + \gamma_h \cdot X_{bj,t-1} + \nu_{bj,t+h}$, where $h \geq 0$, $P_{bj,t+h}$ is an origination/renegotiation indicator for a loan from bank b to firm j, $X_{bj,t-1}$ is a vector of controls. Firm and bank fixed effects are included. Standard errors are clustered by firm and bank. The shaded regions are 90% error bands.

Specification - Intensive margin. The estimation of the intensive margin of credit adjustment involves substituting the dependent variable in equation (1) with $\sum_{k=0}^{K}(Q_{bj,t+k} - \mathbb{E}_b j[Q_{bj,t}])$. The dependent variable represents the cumulative standardized deviation from the mean within a bank-firm pair capturing the persistent effect of monetary policy on the probability of credit adjustment as shown in Figure 2. For instance, in the case of origination, the dependent variable represents the cumulative difference in size or spread of new loans from quarter t to $t+3$, relative to the average new loans provided by the same bank to the same firm over the sample period. Similarly, for renegotiation, the dependent variable captures the relative magnitude of the modified loan amount or interest rate spread over the three quarters compared to the average renegotiation within the bank-firm pair. By demeaning a loan term or its change within a bank-firm pair, the estimates quantify

the deviation of loan terms or modifications in response to monetary policy shocks compared to the average level. This specification is estimated by Ordinary Least Squares following the literature (e.g., Jiménez et al., 2012; Abuka et al., 2019).

Results - Intensive margin. Given that most renegotiation is initiated by borrowers in practice, the pronounced response of renegotiation to expansionary monetary policy shocks may be attributed to the larger surplus of renegotiation compared to origination as indicated in Table 4.[24] Following a surprise monetary expansion, renegotiation leads firms to significantly increase their borrowing without incurring a statistically significant increase in the spread paid over the loan rate (columns 3-4). Specifically, renegotiation in response to a 25 basis points expansionary monetary policy shock leads to an expansion in loan amount by 0.2 standard deviations compared to average renegotiations (column 3). In contrast, there is limited evidence of an increase in new loan volume relative to the usual level (column 1). These findings suggest that borrowers derive greater benefits from renegotiation compared to issuing in response to accommodative monetary policy shocks, prompting them to pursue renegotiations rather than new loan origination.[25]

Table 4: Intensive margin - Impact of monetary policy shocks on standardized demeaned changes in loan volume and spread

	Origination		Renegotiation	
	Amount	Spread	Amount	Spread
	(1)	(2)	(3)	(4)
MP shocks	-0.184*	-0.152	0.194***	0.109
	(0.111)	(0.117)	(0.066)	(0.156)
Observations	6,608	5,879	7,031	2,289
R^2	0.120	0.170	0.088	0.240
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes

Notes: The table presents the coefficient β from the variant of equation (1), after a 25bps expansionary monetary policy shock ε_t: $\sum_{k=0}^{K}(Q_{bj,t+k} - \mathbb{E}_b j[Q_{bj,t}]) = \alpha + \beta \cdot \varepsilon_t + \gamma \cdot X_{bj,t-1} + \nu_{bj,t}$, where the dependent variable is defined as the cumulative (i.e. $K = 3$) standardized deviation from the mean for loan amount or interest rate spread within a bank-firm pair, $X_{bj,t-1}$ is a vector of controls. The inclusion of fixed effects is denoted by "yes" or "no". Robust standard errors in parentheses are two way clustered by firm and bank. Note that the number of observations is smaller in this table compared to Table 3 because the regression is conditional on the event and the spread paid over loan terms is missing on some loans. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

[24] Denis and Wang (2014) and Roberts (2015) also highlight that borrowers typically initiate loan renegotiations.

[25] Renegotiation also affects other major loan terms, such as covenants. While the specific outcomes of covenant changes are not the primary focus of this study, previous research reports that covenants are typically more restrictive at loan origination and are subsequently relaxed through renegotiation (e.g., Smith, 1993; Gârleanu and Zwiebel, 2009; Denis and Wang, 2014). In addition, there is a weak indication of an increase in maturity after renegotiation, which is not reported due to a smaller number of observations.

The observed credit outcome aligns with previous research, indicating that the increase in loan amount is associated with improved borrowing capacity and liquidity management. Specifically, monetary policy stimulates corporate sales thereby enhancing borrowing capacity through the general equilibrium effect on aggregate demand (Benmelech and Bergman, 2012), resulting in a higher loan volume. The estimates are qualitatively consistent with the literature documenting the positive relation between lower short-term interest rates and higher loan volume (e.g., Jiménez et al., 2012; Abuka et al., 2019).

Compared to originating new loans, renegotiation not only yields favorable outcomes for borrowers but also incurs lower costs (Gârleanu and Zwiebel, 2009; Denis and Wang, 2014). Typically, borrowers pay a renegotiation fee of 0.1% to 0.3% of the loan amount or a small flat fee, excluding cases involving bankruptcy. Conversely, issuing a new loan involves an origination fee ranging from 0.5% to 5% of the principal on average, in addition to various fees such as application fees, processing fees, interest by-down fees, and syndication fees when applicable (Marsh and Shaiman, 2022).[26] Origination also entails search and matching costs, along with expenses associated with establishing relationships with potential new lenders.

3.1.2 Heterogeneous credit demand across firm characteristics

Having assessed the existence of a credit channel, particularly through renegotiation, this section shifts its focus to examining how credit demand factors affect the extensive and intensive margins of credit while controlling for credit supply factors.

To investigate the dependency of the extensive or intensive margin on firm heterogeneity, I extend equation (1) as follows:

$$P_{bj,t+h} = \alpha_j + \alpha_{bt} + \beta_h \cdot D_{j,t-1} \cdot \varepsilon_t + \gamma_h X_{j,t-1} + \nu_{bj,t+h} \tag{2}$$

, where monetary policy shocks ε_t interact with the firm's ex-ante financial position, $D_{j,t-1}$, using two measures. The first measure is the corporate leverage and the firms' bank dependency on external financing to determine whether the effect of monetary policy shocks on credit differs depending on borrowers' financial constraints. Corporate leverage is relevant for understanding financial constraints and financial policy decisions (e.g., Jeenas, 2019; Ottonello and Winberry,

[26] See also the 2003 Survey of Small Business Finances and Technical Codebook (www.federalreserve.gov/pubs/oss/oss3/ssbf03/ssbf03home.html). In the case of leveraged loans, the arranger fee alone typically amounts to 1% to 5% of the loan volume (See "LCD loan primer", Standard and Poor's (2017), https://www.spglobal.com/marketintelligence/en/documents/lcd-loan-primer.pdf).

2020; Caglio, Darst and Kalemli-Özcan, 2021). In addition, firms' bank dependency is considered significant, as existing literature suggests that firms relying more on external financing from banks are more affected by monetary policy compared to firms with greater flexibility to substitute their bank loans with alternative sources of financing (e.g., Kashyap, Stein and Wilcox, 1993; Caglio, Darst and Kalemli-Özcan, 2021). The second measure is the firm's ex-ante investment growth, aiming to determine whether a firm's investment growth prior to monetary policy shocks affects the likelihood of credit adjustment in response to such shocks. Appendix B.1.4 uses other measures proposed in the literature to proxy for financial constraints: firm size (Gertler and Gilchrist, 1994), age (Haltiwanger, Jarmin and Miranda, 2013; Cloyne et al., 2023) and dividend payments (Cloyne et al., 2023) and distance to default (Gilchrist and Zakrajšek, 2012; Ottonello and Winberry, 2020).

The inclusion of bank-by-time fixed effects (α_{bt}) in addition to the baseline firm fixed effects helps absorb the variation in credit supply, allowing the estimates to identify demand-side variation. The vector $X_{bj,t-1}$ comprises uninteracted terms such as firm size and the interaction of financial position with real GDP growth to account for variations in cyclical sensitivities across firms.

For intensive margin regressions, the dependent variable is replaced with the standardized demeaned loan volume as in Section 3.1.1. Given the significant average effect of monetary policy shocks on loan amount rather than spread (Table 4), this section focuses on loan amount regressions.

Results - Extensive margin. The findings in Table 5 reveal that bank-dependent firms with high leverage implying financially constrained exhibit a higher likelihood of issuing new loans or renegotiating existing loans following expansionary monetary policy shocks (columns 1 and 3). Following a 25 basis points expansionary monetary policy shock, these firms have approximately 3-4 percentage points higher semi-elasticity of origination/renegotiation propensity relative to other firms. These estimates indicate an economically meaningful degree of heterogeneity considering the magnitude of the average effect of monetary policy shocks as previously presented in Table 3.

Appendix Figure B.1.4 shows additional analyses using alternative proxies for financial constraints consistently support the finding that financially constrained firms, such as smaller (e.g., Gertler and Gilchrist, 1994) or highly leveraged (e.g.,Jeenas, 2019; Caglio, Darst and Kalemli-Özcan, 2021) firms have a higher likelihood of issuing new loans or renegotiating existing loans following expansionary monetary policy shocks. Moreover, younger firms (Cloyne et al., 2023), often with fewer existing loans compared to older firms tend to issue new loans in response to expansionary monetary policy shocks. Similarly, firms closer to default demonstrate a higher like-

lihood of seeking new loans to address their additional financing needs (See Appendix Figure B.1.3). The response patterns may differ for firms further from default (Ottonello and Winberry, 2020) who often have access to alternative financing avenues beyond traditional bank lending, potentially relying more on non-bank lending channels.

Examining firms' ex-ante investment records, columns 2 and 4 reveal that preceding investment significantly determines the sensitivity of issuing new loans after monetary policy shocks, while no such relation is observed for renegotiation. After a 25 basis points expansionary monetary policy shock, firms with previous investment to assets exceeding one standard deviation from the average are approximately 0.7 percentage points more likely to originate new loans. This indicates that investments made before monetary policy shocks influence the probability of issuing new loans, suggesting that issuing new loans is unlikely to serve as a channel for transmitting monetary policy shocks to subsequent investment responses, as further confirmed in Section 3.2. In contrast, firms are more likely to renegotiate after expansionary monetary policy shocks, regardless of previous investment growth. Once renegotiation occurs, they adjust future investment as presented in Section 3.2.3.[27]

Table 5: Extensive margin - Immediate effect of monetary policy shocks on the likelihood of credit adjustment by ex-ante firm characteristics

	Origination$_t$		Renegotiation$_t$	
	(1)	(2)	(3)	(4)
Highly leveraged & Bank-dependent$_{t-1}$	3.563***		2.457**	
$\times$MP shock$_t$	(0.493)		(1.199)	
Investment$_{t-1}\times$MP shock$_t$		0.676**		-0.703
		(0.329)		(0.561)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Bank*Time FE	Yes	Yes	Yes	Yes
Observations	100,097	95,275	100,097	95,275
R^2	0.166	0.151	0.202	0.202

Notes: The table shows the coefficient β_h from $P_{bj,t+h} = \alpha_h + \beta_h \cdot D_{j,t-1} \cdot \varepsilon_t + \gamma_h \cdot X_{bj,t-1} + \nu_{bj,t+h}$ after a 25bps expansionary monetary policy shock ε_t, where $h = 0$, $P_{bj,t+h}$ is an origination/renegotiation indicator, $D_{j,t-1}$ is an indicator of highly leveraged & bank-dependent firms or the standardized within-firm demeaned ratio of investment to asset, $X_{bj,t-1}$ is a vector of controls. Fixed effects are included ("yes") or not included ("no"). Robust standard errors in parentheses are two-way clustered by firm and bank. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Results - Intensive margin. Unlike the findings for extensive margin, there is no evidence that

[27] Table 5 focuses on the immediate impact of monetary policy shocks. Appendix B.1.1 and B.1.2 demonstrate the robustness of these findings to the dynamic effect of monetary policy shocks.

the intensive margin depends on heterogeneity across firms in response to monetary policy shocks. Table 6 presents that neither the indicator of highly leveraged & bank-dependent nor previous investment growth significantly alters the response of loan volume.

Table 6: Intensive margin - Effect of monetary policy shocks on standardized demeaned loan amount by ex-ante firm characteristics

	Origination		Renegotiation	
	(1)	(2)	(3)	(4)
Highly leveraged & Bank-dependent$_{t-1}$	-0.294		-0.165	
$\times$MP shock$_t$	(0.440)		(0.231)	
Investment$_{t-1}\times$MP shock$_t$		-0.066		-0.013
		(0.129)		(0.061)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Bank*Time FE	Yes	Yes	Yes	Yes
Observations	4,601	4,351	0.457	4,378
R^2	0.353	0.367	0.457	0.455

Notes: The table shows the coefficient β from $\sum_{k=0}^{K}(Q_{bj,t+k} - \mathbb{E}_b j[Q_{bj,t}]) = \alpha + \beta \cdot D_{j,t-1} \cdot \varepsilon_t + \gamma \cdot X_{bj,t-1} + \nu_{bj,t}$ after a 25bps expansionary monetary policy shock ε_t, where the dependent variable is defined as cumulative ($K = 3$) standardized deviation from the mean for loan amount, $D_{j,t-1}$ is an indicator of highly leveraged & bank-dependent firms or the standardized within-firm demeaned ratio of investment to asset, $X_{bj,t-1}$ is a vector of controls. Fixed effects are included ("yes") or not included ("no"). Robust standard errors in parentheses are two-way clustered by firm and bank. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.1.3 The asymmetric effect of monetary policy

While the analysis so far employs linear specifications for monetary policy shocks, this section allows for asymmetric effects by introducing a spline of the monetary policy shocks variable, ε_t, for expansionary, ε_t^e, and contractionary, ε_t^c in equation (1). Table 7 presents the results with p-values from a Wald test that assesses the equality of coefficients on the spline terms under the null hypothesis of symmetric effects.

Results - Extensive and intensive margins. The coefficients on the spline terms in the extensive margin regression are statistically different from each other, both for renegotiation and, to a lesser extent, origination. This finding provides empirical support for the presence of asymmetric effects of monetary policy shocks on the probability of origination and renegotiation bank debt (Panel A). Furthermore, the results suggest that the impact of expansionary monetary policy shocks is stronger compared to contractionary shocks, consistent with prior research (e.g., Kandil, 1995). On the other hand, Panel B shows no evidence of asymmetric effects in the intensive margin regression —neither for loan amount nor spread (Panel B). This finding aligns with Abuka et al.

(2019) that similarly find asymmetric effects of interest rate changes on the extensive margin of granting new loans but no asymmetric effects on the intensive margin.

Table 7: Extensive and intensive margins - Asymmetric effects of monetary policy shocks

(A) Extensive margin: likelihood of loan adjustment		
	Origination	Renegotiation
	(1)	(2)
Expansionary monetary policy shock$_t$	2.593***	4.640***
	(0.602)	(0.915)
Contractionary monetary policy shock$_t$	0.717	3.794***
	(0.925)	(1.243)
Observations	110,752	110,752
R^2	0.084	0.283
Controls	Yes	Yes
Firm FE	Yes	Yes
Bank FE	Yes	Yes
p-value (Ho: No asymmetry)	0.013**	0.000***

(B) Intensive margin: loan amount or spread				
	Origination		Renegotiation	
	Amount	Spread	Amount	Spread
	(1)	(2)	(3)	(4)
Expansionary monetary policy shock$_t$	0.025	0.080	0.220**	0.573
	(0.099)	(0.169)	(0.089)	(0.375)
Contractionary monetary policy shock$_t$	0.444*	0.441*	-0.161	0.412
	(0.267)	(0.226)	(0.119)	(0.346)
Observations	6,608	5,879	7,031	2,289
R^2	0.120	0.170	0.088	0.243
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
p-value (Ho: No asymmetry)	0.142	0.101	0.712	0.136

Notes: The null hypothesis for the Wald test is that the coefficient on expansionary monetary policy shocks $|\beta_h^e|$ equals that on contractionary shocks $|\beta_h^c|$ in the extensive margin regression: $P_{bj,t+h} = \alpha_b + \alpha_j + \beta_h^e \cdot \varepsilon_t^e + \beta_h^c \cdot \varepsilon_t^c + \gamma_h X_{bj,t-1} + \nu_{bj,t+h}$, where $h = 3$, the dependent variable is an indicator of origination/renegotiation over t to $t+h$. For the intensive margin, the equation is $\sum_{k=0}^{K}(Q_{bj,t+k} - \mathbb{E}_b j[Q_{bj,t}]) = \alpha + \beta^e \varepsilon_t^e + \beta^c \cdot \varepsilon_t^c + \gamma \cdot X_{bj,t-1} + \nu_{bj,t}$, where $K = 3$, the dependent variable is the standardized within-firm demeaned loan amount or spread, cumulated from t to $t+k$. R obust standard errors in parentheses are two-way clustered by firm and bank. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

3.2 The investment response to monetary policy shocks

3.2.1 Bank credit and investment response

Specification. This section further examines how the impact of monetary policy shocks on bank debt documented in Section 3.2 transmits to the real economy. Specifically, I analyze the dynamic investment responses based on whether firms initiate origination, renegotiation or maintain their existing bank financing. The origination/renegotiation channel of monetary policy is considered potent if monetary policy shocks affect not merely the likelihood of origination/renegotiation but also the real economy. The hypothesis posits that the impact of monetary policy on real economic activity depends on how firms structure their financing regarding bank debt. For instance, when a firm renegotiates a loan, a monetary expansion is expected to have a relatively greater effect on its investment. The comparative significance of renegotiation on investment response is estimated between firms that renegotiate and those that do not. Furthermore, I also estimate the equation substituting origination for renegotiation to examine the effect of origination on the investment response. The estimation is conducted at the firm-quarter level using a local projection approach (Jordà, 2005) as follows:

$$\Delta_h Y_{j,t+h} = \alpha_{j,h} + \alpha_{st,h} + \beta_h \cdot \mathbb{1}[\sum_{k=0}^{K} R_{j,t+k}] \cdot \varepsilon_t + \gamma_h \cdot X_{j,t-1} + \nu_{i,t+h} \tag{3}$$

where $h \geq 0$ refers to h quarters ahead. The dependent variable $\Delta_h Y_{j,t+h}$ is the difference in the logarithm of the investment rate Y over the horizon h for a firm j. The investment rate is measured as the capital expenditure at time t relative to a net plant, property, and equipment at the beginning of the period. $\sum_{k=0}^{K} R_{j,t+k}$ is the sum of the origination/renegotiation indicator of firm j during quarter t to $t+k$. The indicator function takes a value of 1 if a firm j originates/renegotiates at least once over the specified period. The value of K corresponds to the degree of persistence in the impact of monetary policy shocks on origination/renegotiation as shown in Figure 2. The coefficient of interest β_h measures how the cumulative response of investment in quarter $t+h$ to the monetary policy shock ε_t, depends on the origination/renegotiation activity.[28]

A vector $X_{j,t-1}$ controls for other factors that may affect financial positions and investment simultaneously. Variables such as the previous quarter's real GDP growth, inflation, and their interaction with the renegotiation indicator capture macroeconomic conditions and the differences in cyclical sensitivities across firms. As the main measures of firm characteristics, firm size and

[28] While using the generated monetary policy shock as an instrument for changes in interest rates instead of directly using the monetary policy shocks may mitigate potential issues related to generated regressor inference (See Wooldridge (2002), page 117), the result remains qualitatively unchanged.

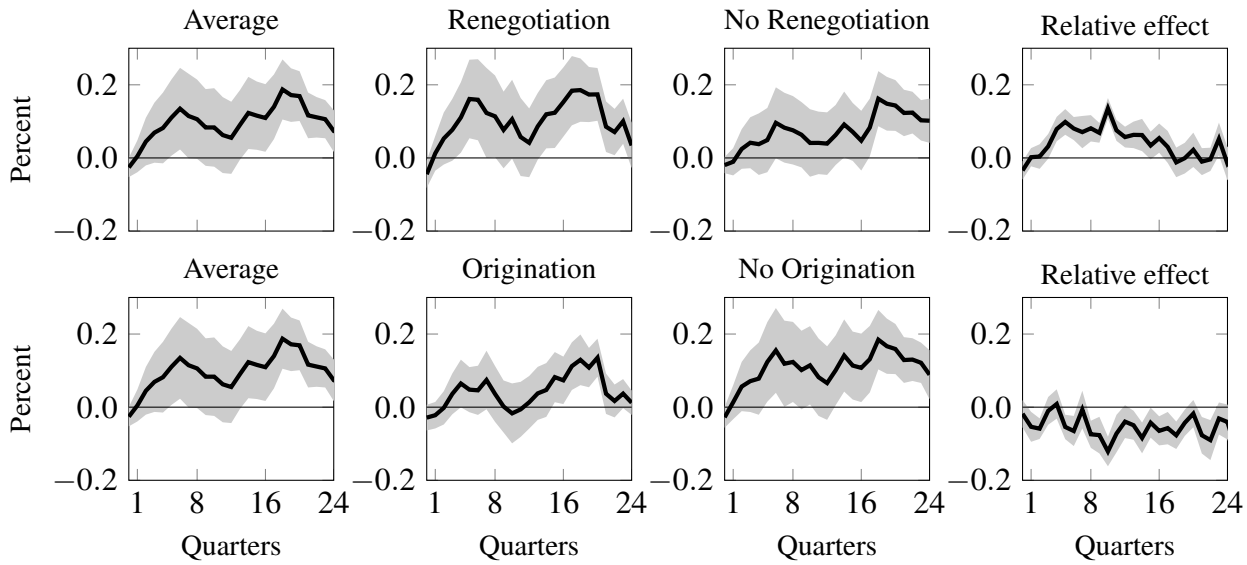
default risk are controlled using total book assets and distance to default. The vector also includes other uninteracted terms and a seasonal dummy. Other than these controls, firm fixed effects $\alpha_{j,h}$ absorb the time-invariant differences in investment behaviour across firms while sector by time fixed effects $\alpha_{st,h}$ account for time-varying investment by sector. Standard errors are two-way clustered by firm and time to account for correlation within firms and within time.

Results. Figure 3 presents the investment responses to monetary policy shocks for firms that renegotiate compared to firms that do not renegotiate. The first column provides the benchmark average investment response to a 25 basis points expansionary monetary policy shock estimated by using equation (3) without including the origination/renegotiation indicator. The subsequent two columns estimate the same function as the first column, but the sample is split based on whether a firm originates/renegotiates.

In the top panel of the figure, columns 2-3 show that firms that renegotiate during the three quarters following expansionary monetary policy shocks increase their investment more than firms that never renegotiate over the same period. To assess the statistical significance of this result, the last column conducts a formal test using equation (3), with the base group being firms that never renegotiate within three quarters after the shock. The last column confirms that the larger investment response of firms that renegotiate, compared to those that never renegotiate, is statistically significant. The investment response for firms engaged in renegotiation becomes relatively notable in 3 quarters, peaking at 10 quarters. This indicates that renegotiation accelerates the transmission of monetary policy to investment, compared to the average investment response, which reaches its peak in 18 quarters.

By contrast, the bottom panel presents that the investment response of firms that issue new loans is less pronounced compared to firms that do not issue new loans following the monetary policy shock. These findings suggest that the overall average investment response is primarily driven by firms that renegotiate rather than firms that issue new loans. The contribution of firms that renegotiate to the aggregate investment response is formally assessed in Section 3.2.4.

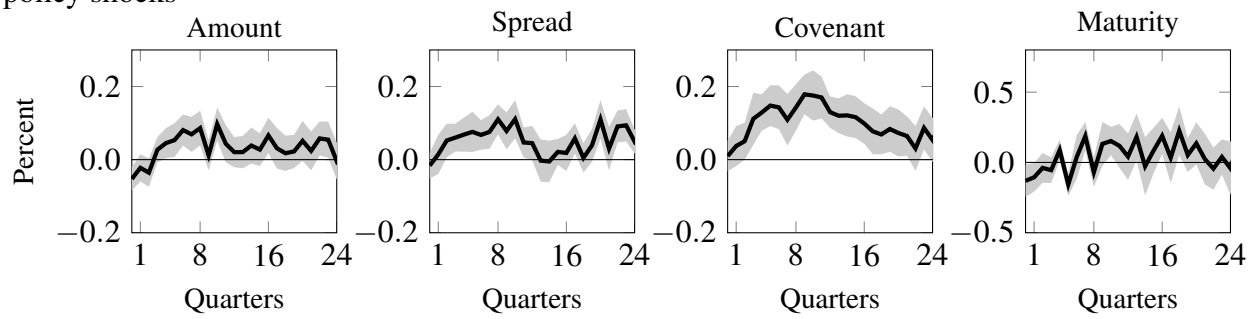
Figure 3: Investment response to monetary policy shocks



Notes: The first three columns present β_h estimates after a 25bps expansionary monetary policy shock ε_t from $\Delta_h Y_{i,t+h} = \alpha_{i,h} + \alpha_{st,h} + \beta_h \cdot \varepsilon_t + \gamma_h \cdot X_{i,t-1} + \nu_{i,t+h}$, where $h \geq 0$, $\Delta_h Y_{j,t+h}$ is the difference in the investment rate over the horizon h for a firm j, $X_{i,t-1}$ is a vector of controls. The second and third columns report β_h estimates after splitting the sample into two groups depending on origination/renegotiation. The last column shows the difference in slopes across two groups from separate impulse response functions in which the base group is the firms that never originate/renegotiate over the K(=3) period as specified by $\Delta_h Y_{i,t+h} = \alpha_{i,h} + \alpha_{st,h} + \beta_h \cdot \mathbb{1}[\sum_{k=0}^{K} R_{i,t+k}] \cdot \varepsilon_t + \gamma_h \cdot X_{i,t-1} + \nu_{i,t+h}$, where $\mathbb{1}[\sum_{k=0}^{K} R_{i,t+k}]$ takes a value of 1 if a firm j originates/renegotiates at least once over the specified period. The shaded regions are 90% error bands.

Looking further into the subtypes of renegotiation, Figure 4 reports that the investment response of most subtypes of renegotiation aligns qualitatively with that of overall renegotiation. Specifically, firms that adjust the amount, spread, or covenant experience a relatively greater increase in investment compared to those that do not modify these terms (columns 1-3). However, there is no evidence to suggest that the investment response differs for firms that change the maturity term compared to those that do not alter it (column 4). These findings align with the consequential changes in each loan term after renegotiation, as discussed in Section 3.1.1. Notably, expansionary monetary policy shocks enable firms to borrow more without a significant increase in spread while relaxing covenant requirements through renegotiation, thereby stimulating investment response.

Figure 4: Investment response - Interaction coefficient of subtypes of renegotiation and monetary policy shocks



Notes: The figure shows the interaction coefficient β_h of a renegotiation indicator and a 25bps monetary policy shock ε_t. The base group is the firms that never adjust the loan term over the K(=3) period as specified by the equation $\Delta_h Y_{i,t+h} = \alpha_{i,h} + \alpha_{st,h} + \beta_h \cdot \mathbb{1}[\sum_{k=0}^{K} R_{i,t+k}] \cdot \varepsilon_t + \gamma_h \cdot X_{i,t-1} + \nu_{i,t+h}$, where $h \geq 0$, $\Delta_h Y_{j,t+h}$ is the difference in the investment rate over the horizon h for a firm j, $\mathbb{1}[\sum_{k=0}^{K} R_{i,t+k}]$ takes a value of 1 if a firm j renegotiates at least once over the specified period, $X_{i,t-1}$ is a vector of controls. The shaded regions are 90% error bands.

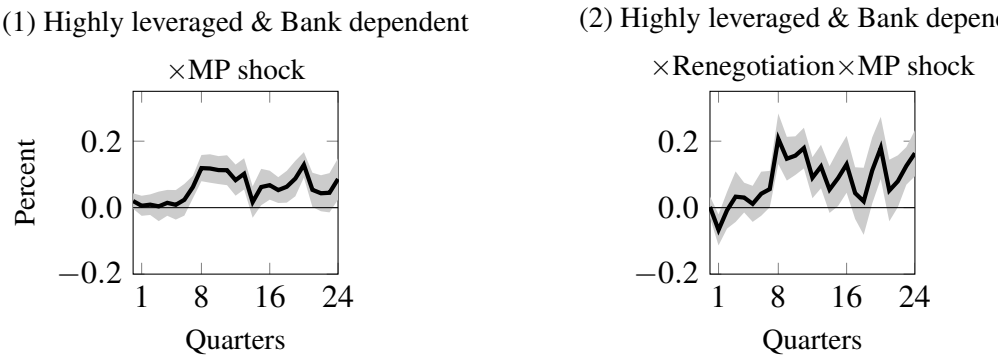
3.2.2 Firm characteristics and investment response

Building on the findings from Section 3.2.1, which indicate a relatively stronger investment response from firms that renegotiate compared to issuing, this section investigates whether renegotiation amplifies or mitigates the heterogeneous investment response across firms' financial constraints. To explore this, a triple interaction term is introduced into equation (3), encompassing a proxy for financial constraints $D_{j,t-1}$, monetary policy shocks, and the renegotiation indicator $\mathbb{1}[\sum_{k=0}^{K} R_{j,t+k}]$. The variable $D_{j,t-1}$ serves as an indicator for highly leveraged bank-dependent firms. Previous studies have demonstrated that the investment responses of such highly leveraged (e.g., Jeenas, 2019; Caglio, Darst and Kalemli-Özcan, 2021 and bank-dependent (e.g., Kashyap, Stein and Wilcox, 1993; Caglio, Darst and Kalemli-Özcan, 2021) firms are more sensitive to monetary policy shocks. The vector $X_{j,t-1}$ includes uninteracted terms such as firm characteristics as well as double and triple interactions of financial position with macroeconomic conditions and the renegotiation indicator.

Figure 5 provides evidence that the renegotiation amplifies the differential investment response of bank-dependent firms with higher debt levels. The figure shows that these firms exhibit a relatively stronger investment response to monetary policy shocks compared to other firms (column 1), and this heterogeneous response is significantly magnified by renegotiation (column 2). This suggests that expansionary monetary policy shocks alleviate financial constraints for more constrained firms, enabling them to improve their credit access through renegotiation and resulting in a more pronounced investment response. Consistent with the findings in Section 3.1.2 that highly leveraged bank-dependent firms are more inclined to renegotiate following expansionary monetary policy shocks, their subsequent investment response is further augmented upon renegotiation. This

finding implies that renegotiation amplifies the investment response to monetary policy shocks for financially constrained firms.

Figure 5: Investment response - Interaction coefficients of firm characteristics, monetary policy shocks and renegotiation



Notes: This figure reports the interaction coefficient β_h estimated from the following specifications:
(1) $\Delta_h Y_{j,t+h} = \alpha_{j,h} + \alpha_{st,h} + \beta_h \cdot D_{j,t-1} \cdot \varepsilon_t + \gamma_h \cdot X_{j,t-1} + \nu_{j,t+h}$
(2) $\Delta_h Y_{j,t+h} = \alpha_{j,h} + \alpha_{st,h} + \beta_h \cdot D_{j,t-1} \cdot \mathbb{1}[\sum_{k=0}^{K} R_{j,t+k}] \cdot \varepsilon_t + \gamma_h \cdot X_{j,t-1} + \nu_{j,t+h}$, where $h \geq 0$, $\Delta_h Y_{j,t+h}$ is the difference in the investment rate over the horizon h for a firm j, $\mathbb{1}[\sum_{k=0}^{K} R_{i,t+k}]$ takes a value of 1 if a firm j renegotiates at least once over the specified period, $D_{j,t-1}$ is an indicator of a highly leveraged & bank-dependent firm and $X_{i,t-1}$ is a vector of controls. The shaded regions are 90% error bands.

3.2.3 Decomposition of investment response

This section investigates the interpretation of the substantial investment responsiveness observed among firms that renegotiate. Two potential explanations are explored: first, renegotiation may predict a stronger subsequent investment response to monetary policy shocks, and second, firms may choose to renegotiate when their investment growth is already on an upward trajectory. To test these hypotheses, I estimate a regression model that regresses investment growth over different time horizons on the interaction between monetary policy shocks and an indicator of origination/renegotiation.

The total investment growth is computed as the discounted cumulative sum of investment growth from $t-1$ to $t+18$ considering the period when the cumulative response reaches its peak. This total investment growth is decomposed into two components: "lagged" investment growth representing the investment performance before a monetary policy shock occurs (from $t-1$ to t), and "lead" investment growth, capturing the period from the quarter impacted by the shock until the final period of total investment (from t to $t+18$).[29]

Results. The findings presented in Table 8 provide support for the first hypothesis that rene-

[29]The discount rate is the quarterly real interest rate based on the market yield on U.S. Treasury securities with a 3-month constant maturity, quoted on an investment basis.

gotiation is associated with a stronger subsequent investment response to monetary policy shocks. Among renegotiating firms, a significant portion of the total investment response (column 4) is driven by future investment growth (column 5) rather than previous investment growth (column 6). In contrast, there is no such evidence for firms issuing new loans (columns 1-3). These results suggest that renegotiation acts as the transmission channel through which monetary policy shocks influence subsequent investment responses. Firms opting for loan renegotiation are more inclined to adjust their investment plans in response to monetary policy shocks, rather than being solely driven by pre-existing high investment growth. These findings align with existing research on the credit cycle (Mian and Santos, 2018), which emphasizes the strong association between renegotiating loan maturity and subsequent capital expenditure growth.

Table 8: Decomposition of the investment response

Indicator:	Origination			Renegotiation		
	(1)	(2)	(3)	(4)	(5)	(6)
ΔInvestment:	Total	Lead	Lagged	Total	Lead	Lagged
Indicator×MP shock	0.151	0.262	-0.114	0.537**	0.707***	-0.178
	(0.216)	(0.247)	(0.135)	(0.246)	(0.233)	(0.144)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector×Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,245	10,245	10,121	17,121	17,121	16,929
R^2	0.432	0.435	0.091	0.374	0.366	0.058

Notes: This table presents estimates β after a 25bps expansionary monetary policy shock ε_t from $\Delta Y_{j,t} = \alpha_j + \alpha_{st} + \beta \cdot \varepsilon_t + \gamma \cdot X_{j,t-1} + \nu_{j,t}$ for origination and renegotiation groups. A firm j belongs to the origination/renegotiation group if it originates/renegotiates a loan at least once over quarters t to $t+3$. The dependent variable, $\Delta Y_{j,t}$, represents the discounted cumulative change in investment, computed over different periods: from $t-1$ to $t+18$ (Total), from t to $t+18$ (Lead) or from $t-1$ to t (Lagged). $X_{j,t-1}$ is a vector of controls. Significance levels are denoted as * $p<0.10$, ** $p<0.05$, *** $p<0.01$

3.2.4 Contribution to the aggregate response

This section investigates the contribution of firms that originate/renegotiate to the aggregate investment response to monetary policy shocks. The contribution to the average response over the forecast horizon is computed by first multiplying the discounted average investment response of each group by the number of firms in that group and then dividing it by the product of the discounted average response of all firms and the total number of firms in the sample. This contribution is comparable with the overall aggregate response as Figure 1 shows the substantial share of aggregate investment response explained by the firms in my sample.

Table 9 shows that firms that renegotiate play a crucial role in driving the average investment

response and thus contribute a substantial share to the aggregate investment response to monetary policy shocks. Specifically, the first column reports that the investment response of firms that renegotiate following a 25 basis points expansionary monetary policy shock accounts for almost half of the average investment response in my sample. In contrast, firms that originate a new loan contribute less to the average response, representing only a quarter of the contribution made by renegotiation (column 2). Considering both renegotiation and origination, the combined contribution amounts to approximately 55% of the total contribution as some firms may engage in both activities simultaneously (column 3).

These findings have important implications for understanding the transmission mechanism of monetary policy and the role of corporate bank debt in driving investment response. Renegotiation emerges as a significant channel through which monetary policy shocks influence aggregate investment. Firms that renegotiate their loans make a significant contribution to the average investment response, suggesting that renegotiation enables them to effectively adjust their investment plans in response to monetary policy changes. In contrast, issuing new loans may not be as strongly associated with firms' investment adjustments following monetary policy shocks. Overall, these results highlight the relevance of considering firms' financing choices, particularly renegotiation in analyzing the impact of monetary policy on investment behavior.

Table 9: Contribution of each group to the average investment response

Renegotiation	Origination	Renegotiation or Origination
47.4%	11.9%	55.1%
[43.6, 51.4]	[8.5, 15.2]	[51.3, 58.8]

Notes: The contribution of each group to the average response of investment is computed using the following method: I multiply the discounted cumulative investment response of each group by its share in the total sample. This product is then divided by the average discounted cumulative investment response of all groups in the sample, yielding the group's contribution to the average effect. The 95% confidence interval presented in square brackets is derived from 500 bootstrap repetitions. The discount rate used is the average quarterly real interest rate observed over the sample period.

4 Conclusion

This paper significantly advances the understanding of the monetary policy transmission mechanism by highlighting the role of renegotiation as a key channel influencing firm investment. The empirical analysis based on unique micro-level loan data provides robust evidence supporting the hypothesis that renegotiation behavior predicts the investment response to monetary policy shocks.

Specifically, this study demonstrates the crucial role of monetary policy shocks in driving firms' renegotiation, and firms that choose to renegotiate play a dominant role in driving the aggregate investment response to monetary policy shocks. In contrast, the contribution of firms issuing new loans is relatively smaller and the likelihood of issuing is more closely tied to previous investment growth rather than the subsequent investment response. These results underscore the importance of distinguishing between renegotiation and origination in understanding the impact of monetary policy on investment behavior.

To provide further insights into the findings, this study examines whether the renegotiation channel helps explain how financial constraints amplify or dampen the investment response to monetary policy shocks. Empirical evidence supports the notion that financial constraints amplify the investment response of financially constrained firms through the renegotiation channel. Particularly, bank-dependent firms with higher levels of debt exhibit greater responsiveness to monetary policy shocks, primarily due to their heightened sensitivity to renegotiation opportunities. These findings suggest that monetary policy can alleviate financial constraints, with renegotiation acting as a crucial mechanism that magnifies the investment response for the most severely affected firms. The renegotiation channel is particularly vital, as it may be the sole lifeline for these firms, underscoring the significance of monetary policy shocks in boosting their investment response. This revelation provides a profound implication for grasping the heterogeneous investment responses to monetary policy.

Overall, the findings emphasize the critical need to incorporate firms' financing decisions, notably renegotiation, into the analysis of monetary policy's impact on investment. Researchers and policymakers, for instance, should vigilantly monitor not only changes in total loan balances but also the dynamics within these components, with particular attention to renegotiation as a key informational variable. As monetary policy shocks transmit to corporate investment with a time lag, and renegotiation responds immediately, renegotiation can be an important predictor of whether monetary policy transmits effectively. Furthermore, this study offers valuable insights into the strategic coordination between micro and macroprudential policies and monetary policy, especially considering that prudential regulation can influence lending conditions for renegotiation (Thakor and Furlong Wilson, 1995). Depending on policy objectives and prevailing economic conditions, policymakers may contemplate either relaxing or tightening conditions for renegotiating existing loans. This synchronized approach to micro and macroprudential policies holds significant potential for enhancing the effectiveness of monetary policy while preserving financial stability.

Future research could delve into scrutinizing potential discrepancies in the renegotiation channel's role during unconventional monetary policy periods versus conventional ones. Notably, the

sample period of this study spans both conventional and unconventional monetary policy phases. It covers the period from late 2008 to 2015, which includes the aftermath of the global financial crisis and a subsequent prolonged period of near-zero federal fund rates. Given the distinctiveness of this timeframe, the efficacy of monetary policy shocks may have exhibited variations compared to more conventional periods. Further exploration of this aspect stands as a promising avenue for future investigation.

References

Abuka, Charles, Ronnie K. Alinda, Camelia Minoiu, José-Luis Peydró, and Andrea F. Presbitero. 2019. "Monetary Policy and Bank Lending in Developing Countries: Loan Applications, Rates, and Real Effects." *Journal of Development Economics*, 139: 185–202.

Akins, Brian, David De Angelis, and Maclean Gaulin. 2020. "Debt Contracting on Management." *The Journal of Finance*, 75(4): 2095–2137.

Altman, Edward I. 1968. "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy." *The Journal of Finance*, 23(4): 589–609.

Arnold, Marc, and Ramona Westermann. 2023. "Debt Renegotiations Outside Distress." *Review of Finance*, 27(4): 1183–1228.

Ashcraft, Adam B., and Murillo Campello. 2007. "Firm Balance Sheets and Monetary Policy Transmission." *Journal of Monetary Economics*, 54(6): 1515–1528.

Becker, Bo, and Victoria Ivashina. 2014. "Cyclicality of Credit Supply: Firm Level Evidence." *Journal of Monetary Economics*, 62: 76–93.

Benmelech, Efraim, and Nittai K Bergman. 2012. "Credit Traps." *American Economic Review*, 102(6): 3004–3032.

Beraja, Martin, Andreas Fuster, Erik Hurst, and Joseph Vavra. 2019. "Regional Heterogeneity and the Refinancing Channel of Monetary Policy." *The Quarterly Journal of Economics*, 134(1): 109–183.

Bergman, Yaacov Z., and Jeffrey L. Callen. 1991. "Opportunistic Underinvestment in Debt Renegotiation and Capital Structure." *Journal of Financial Economics*, 29(1): 137–171.

Bernanke, Ben S., and Alan S. Blinder. 1988. "Credit, Money, and Aggregate Demand." *The American Economic Review*, 78(2): 435–439.

Bernanke, Ben S., and Mark Gertler. 1995. "Inside the Black Box: The Credit Channel of Monetary Policy Transmission." *The Journal of Economic Perspectives*, 9(4): 27–48.

Bernanke, Ben S, Mark Gertler, and Simon Gilchrist. 1999. "The Financial Accelerator in a Quantitative Business Cycle Framework." *Handbook of Macroeconomics*, 1: 1341–1393.

Biguri, Kizkitza. 2023. "How Does Access to the Unsecured Debt Market Affect Investment?" *Journal of Banking & Finance*, 152: 106856.

Brown, James R., Matthew T. Gustafson, and Ivan T. Ivanov. 2021. "Weathering Cash Flow Shocks." *The Journal of Finance*, 76(4): 1731–1772.

Bu, Chunya, John Rogers, and Wenbin Wu. 2021. "A Unified Measure of Fed Monetary Policy Shocks." *Journal of Monetary Economics*, 118: 331–349.

Caglio, Cecilia R., R. Matthew Darst, and Ṣebnem Kalemli-Özcan. 2021. "Risk-Taking and Monetary Policy Transmission: Evidence from Loans to SMEs and Large Firms." National Bureau of Economic Research Working Paper 28685.

Chava, Sudheer, and Michael R. Roberts. 2008. "How Does Financing Impact Investment? The Role of Debt Covenants." *The Journal of Finance*, 63(5): 2085–2121.

Chodorow-Reich, Gabriel, Olivier Darmouni, Stephan Luck, and Matthew Plosser. 2022. "Bank Liquidity Provision across the Firm Size Distribution." *Journal of Financial Economics*, 144(3): 908–932.

Christiano, Lawrence J., Roberto Motto, and Massimo Rostagno. 2014. "Risk Shocks." *American Economic Review*, 104(1): 27–65.

Ciccarelli, Matteo, Angela Maddaloni, and José-Luis Peydró. 2015. "Trusting the Bankers: A New Look at the Credit Channel of Monetary Policy." *Review of Economic Dynamics*, 18(4): 979–1002.

Cloyne, James, Clodomiro Ferreira, Maren Froemel, and Paolo Surico. 2023. "Monetary Policy, Corporate Finance, and Investment." *Journal of the European Economic Association*, jvad009.

Cover, James Peery. 1992. "Asymmetric Effects of Positive and Negative Money-Supply Shocks." *The Quarterly Journal of Economics*, 107(4): 1261–1282.

Denis, David J., and Jing Wang. 2014. "Debt Covenant Renegotiations and Creditor Control Rights." *Journal of Financial Economics*, 113(3): 348–367.

Dessein, Wouter. 2005. "Information and Control in Ventures and Alliances." *The Journal of Finance*, 60(5): 2513–2549.

Di Maggio, Marco, Amir Kermani, and Christopher J Palmer. 2020. "How Quantitative Easing Works: Evidence on the Refinancing Channel." *The Review of Economic Studies*, 87(3): 1498–1528.

Fama, Eugene F., and James D. MacBeth. 1973. "Risk, Return, and Equilibrium: Empirical Tests." *Journal of Political Economy*, 81(3): 607–636.

Gârleanu, Nicolae, and Jeffrey Zwiebel. 2009. "Design and Renegotiation of Debt Covenants." *The Review of Financial Studies*, 22(2): 749–781.

Gertler, Mark, and Nobuhiro Kiyotaki. 2010. "Chapter 11 - Financial Intermediation and Credit Policy in Business Cycle Analysis." In *Handbook of Monetary Economics*. Vol. 3, , ed. Benjamin M. Friedman and Michael Woodford, 547–599. Elsevier.

Gertler, Mark, and Simon Gilchrist. 1994. "Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms." *The Quarterly Journal of Economics*, 109(2): 309–340.

Giammarino, Ronald M. 1989. "The Resolution of Financial Distress." *The Review of Financial Studies*, 2(1): 25–47.

Gilchrist, Simon, and Egon Zakrajšek. 2012. "Credit Spreads and Business Cycle Fluctuations." *American Economic Review*, 102(4): 1692–1720.

Haltiwanger, John, Ron S. Jarmin, and Javier Miranda. 2013. "Who Creates Jobs? Small versus Large versus Young." *The Review of Economics and Statistics*, 95(2): 347–361.

Hart, Oliver, and John Moore. 1988. "Incomplete Contracts and Renegotiation." *Econometrica : journal of the Econometric Society*, 56(4): 755–785.

Holmstrom, Bengt, and Jean Tirole. 1997. "Financial Intermediation, Loanable Funds, and the Real Sector." *The Quarterly Journal of Economics*, 112(3): 663–691.

Holmström, Bengt, and Jean Tirole. 1998. "Private and Public Supply of Liquidity." *Journal of Political Economy*, 106(1): 1–40.

Ippolito, Filippo, Ali K. Ozdagli, and Ander Perez-Orive. 2018. "The Transmission of Monetary Policy through Bank Lending: The Floating Rate Channel." *Journal of Monetary Economics*, 95: 49–71.

Jarociński, Marek, and Peter Karadi. 2020. "Deconstructing Monetary Policy Surprises—The Role of Information Shocks." *American Economic Journal: Macroeconomics*, 12(2): 1–43.

Jeenas, Priit. 2019. "Firm Balance Sheet Liquidity, Monetary Policy Shocks, and Investment Dynamics." *mimeo, New York University*.

Jiménez, Gabriel, Atif Mian, José-Luis Peydró, and Jesús Saurina. 2020. "The Real Effects of the Bank Lending Channel." *Journal of Monetary Economics*, 115: 162–179.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina. 2012. "Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications." *American Economic Review*, 102(5): 2301–2326.

Jordà, Òscar. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *The American Economic Review*, 95(1): 161–182.

Kandil, Magda. 1995. "Asymmetric Nominal Flexibility and Economic Fluctuations." *Southern Economic Journal*, 61(3): 674–695.

Kashyap, Anil K., and Jeremy C. Stein. 1995. "The Impact of Monetary Policy on Bank Balance Sheets." *Carnegie-Rochester Conference Series on Public Policy*, 42: 151–195.

Kashyap, Anil K., and Jeremy C. Stein. 2000. "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?" *American Economic Review*, 90(3): 407–428.

Kashyap, Anil K., Jeremy C. Stein, and David W. Wilcox. 1993. "Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance." *The American Economic Review*, 83(1): 78–98.

Keil, Jan. 2018. "Do Relationship Lenders Manage Loans Differently?" *Unpublished Working Paper*.

Kishan, Ruby P., and Timothy P. Opiela. 2000. "Bank Size, Bank Capital, and the Bank Lending Channel." *Journal of Money, Credit and Banking*, 32(1): 121–141.

Lummer, Scott L., and John J. McConnell. 1989. "Further Evidence on the Bank Lending Process and the Capital-Market Response to Bank Loan Agreements." *Journal of Financial Economics*, 25(1): 99–122.

Marsh, Bridget K., and Lee M. Shaiman. 2022. "The Handbook of Loan Syndications & Trading." In *The Handbook of Loan Syndications & Trading*. . Second edition. ed. New York:McGraw Hill.

Mella-Barral, Pierre, and William Perraudin. 1997. "Strategic Debt Service." *The Journal of Finance*, 52(2): 531–556.

Merton, Robert C. 1974. "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates." *The Journal of Finance*, 29(2): 449–470.

Mian, Atif, and João A. C. Santos. 2018. "Liquidity Risk and Maturity Management over the Credit Cycle." *Journal of Financial Economics*, 127(2): 264–284.

Morgan, Donald P. 1993. "Asymmetric Effects of Monetary Policy." *Economic Review*, 78(Q II): 21–33.

Nakamura, Emi, and Jón Steinsson. 2018. "High-Frequency Identification of Monetary Non-Neutrality: The Information Effect." *The Quarterly Journal of Economics*, 133(3): 1283–1330.

Nikolaev, Valeri V. 2018. "Scope for Renegotiation in Private Debt Contracts." *Journal of Accounting and Economics*, 65(2): 270–301.

Nini, Greg, David C. Smith, and Amir Sufi. 2009. "Creditor Control Rights and Firm Investment Policy." *Journal of Financial Economics*, 92(3): 400–420.

Nini, Greg, David C. Smith, and Amir Sufi. 2012. "Creditor Control Rights, Corporate Governance, and Firm Value." *The Review of Financial Studies*, 25(6): 1713–1761.

Ongena, Steven, Ibolya Schindele, and Dzsamila Vonnák. 2021. "In Lands of Foreign Currency Credit, Bank Lending Channels Run Through?" *Journal of International Economics*, 129: 103435.

Ottonello, Pablo, and Thomas Winberry. 2020. "Financial Heterogeneity and the Investment Channel of Monetary Policy." *Econometrica : journal of the Econometric Society*, 88(6): 2473–2502.

Pagan, Adrian. 1984. "Econometric Issues in the Analysis of Regressions with Generated Regressors." *International Economic Review*, 25(1): 221–247.

Paligorova, Teodora, and João A. C. Santos. 2018. "Nonbank Investors and Loan Renegotiations." Social Science Research Network SSRN Scholarly Paper ID 2892068, Rochester, NY.

Petersen, Mitchell A., and Raghuram G. Rajan. 1995. "The Effect of Credit Market Competition on Lending Relationships." *The Quarterly Journal of Economics*, 110(2): 407–443.

Rigobon, Roberto. 2003. "Identification Through Heteroskedasticity." *Review of Economics and Statistics*, 85(4): 777–792.

Rigobon, Roberto, and Brian Sack. 2004. "The Impact of Monetary Policy on Asset Prices." *Journal of Monetary Economics*, 51(8): 1553–1575.

Roberts, Michael R. 2015. "The Role of Dynamic Renegotiation and Asymmetric Information in Financial Contracting." *Journal of Financial Economics*, 116(1): 61–81.

Roberts, Michael R., and Amir Sufi. 2009. "Renegotiation of Financial Contracts: Evidence from Private Credit Agreements." *Journal of Financial Economics*, 93(2): 159–184.

Romer, Christina D., and David H. Romer. 2004. "A New Measure of Monetary Shocks: Derivation and Implications." *American Economic Review*, 94(4): 1055–1084.

Santos, João A. C., and Andrew Winton. 2008. "Bank Loans, Bonds, and Information Monopolies across the Business Cycle." *The Journal of Finance*, 63(3): 1315–1359.

Santos, João A C, and Andrew Winton. 2019. "Bank Capital, Borrower Power, and Loan Rates." *The Review of Financial Studies*, 32(11): 4501–4541.

Smith, Clifford W. 1993. "A Perspective on Accounting-Based Debt Covenant Violations." *The Accounting Review*, 68(2): 289–303.

Sundaresan, Suresh, and Neng Wang. 2007. "Investment under Uncertainty with Strategic Debt Service." *American Economic Review*, 97(2): 256–261.

Tenreyro, Silvana, and Gregory Thwaites. 2016. "Pushing on a String: US Monetary Policy Is Less Powerful in Recessions." *American Economic Journal: Macroeconomics*, 8(4): 43–74.

Thakor, Anjan V., and Patricia Furlong Wilson. 1995. "Capital Requirements, Loan Renegotiation and the Borrower's Choice of Financing Source." *Journal of Banking & Finance*, 19(3): 693–711.

Weise, Charles L. 1999. "The Asymmetric Effects of Monetary Policy: A Nonlinear Vector Autoregression Approach." *Journal of Money, Credit and Banking*, 31(1): 85–108.

Wilmer Curtler Pickering Hale and Dorr LLP. 2016. "2016 IPO Report." https://www.wilmerhale.com/en/insights/publications/2016-ipo-report.

Wong, Arlene. 2019. "Refinancing and The Transmission of Monetary Policy to Consumption." *mimeo, Princeton University*.

Wooldridge, Jeffrey. 2002. "Econometric Analysis of Cross Section and Panel Data." *MIT University Press*.

Appendix

A Variable definition and sample restrictions

This section provides a detailed definition of the main variables and sample restrictions used in the paper. To construct the quarterly series, cumulative variables within a firm's fiscal year in Compustat are differenced within that fiscal year. The variable definition and sample selection criteria adhere to standard practices in the existing literature.

(Borrower characteristics)

Variables measured in levels, such as assets, are deflated using the implicit price deflator of the nonfarm business sector from the Bureau of Labor Statistics (BLS) available in the Federal Reserve Economic Data (FRED) database (series IPDNBS). This adjustment ensures that the variables are expressed in real terms, accounting for changes in general price levels.

- Investment rate: The investment rate is defined as the ratio of capital expenditures in the current period to the level of physical capital, as measured by net plant, property and equipment at the beginning of the period (*capxq**4 / lagged *ppentq* in Compustat).
- Total assets: Total assets are expressed in real terms and obtained from the Compustat database, deflated using the appropriate price deflator. A four-quarter moving average of total assets is used in the regression analysis.
- Cash to asset: The cash-to-asset ratio is computed as the ratio of cash (*cheq*) to book assets (*atq*) from the Compustat database. Similar to total assets, a four-quarter moving average is employed.
- Bank-dependent: Bank-dependent firms do not have outstanding public bonds or they have not issued public bonds during the recent three years by using $privateplacement$, $offering\ date$ and $bondmaturity$ in Mergent Fixed Income Securities Database (FISD) and $market\ place$, $issuedate$ and $maturity$ in Securities Data Company (SDC) Platinum.
- Leverage: Leverage is measured as the ratio of total debt (*dlcq* + *dlttq*) to book assets (*atq*) from the Compustat database.

- Altman's Zscore: $1.2[(atcq-lctq)/atq]+1.4(req/atq)+3.3(piq/atq)+0.6[(prccq\times cshoq)/ltq]+0.999(saleq/atq)$ in Compustat. It gauges the likelihood of bankruptcy for a publicly-traded company. A four-quarter moving average is used in the regression analysis.

- Distance to default: The distance to default is defined as $\frac{log(V/D)+(\mu_V-0.5\sigma^2_V)}{\sigma_V}$ following Merton (1974), Gilchrist and Zakrajšek (2012) and Ottonello and Winberry (2020). V denotes the total value of the firm, μ_V is the annual expected return on V, σ_V is the annual volatility of the firm's value, and D is the firm's debt. An iterative procedure, as suggested by Ottonello and Winberry (2020), is employed to estimate the firm's value V. The standardized distance to default is used in the regression analysis. A four-quarter moving average is used.

- Firm age: The firm age is determined using the incorporation date from the WorldScope database as the primary source. Additional information from the Center for Research in Security Price (CRSP) and Compustat can be used to complement the incorporation date. For instance, if available, the date when a firm's stocks started trading (variable *begdat* in CRSP) is considered. The firm age is defined as the maximum of the years since the incorporation date from WorldScope, the CRSP date, and the date when the firm first appears in Compustat.

- Public firm: An observation is classified as belonging to a public firm if it is observed before the firm's initial public offering (IPO) date (*ipodate* in Compustat). If the firm transitions from public to private status (i.e., it is observed after the firm deletion date (*dldte* in Compustat) and the reason for deletion is going private (*dlrsn* is '09: Now a private company' in Compustat)), the observation is labelled as private. In cases where the information is missing, the *PublicPrivate* variable in DealScan is used.

(Lender characteristics)

- Bank capital ratio: The bank capital ratio is calculated as the bank's total equity capital divided by its total assets. It is obtained from the Compustat database as $(ceqq+req)/atq$. In cases where the information is missing in Compustat, the bank capital ratio is estimated using $(RCFD3230+RCFD3839+RCFD3632+RCFD8434)/RCFD2170$ from the FDIC Reports of Condition and Income (Call Report).

(Macroeconomic conditions)

- Volatility index: Chicago Board Options Exchange volatility index gauges the market expectation of near-term volatility conveyed by stock index option prices. It serves as an indicator of market uncertainty and risk perception.
- Capital ratio banking sector: The sum of equity held by banks with average assets greater than zero is divided by the average assets of these banks. The data for this variable is sourced from the EQTA series in the Federal Reserve Economic Data (FRED).
- Lending standard: Lending standards characterize banks' policies for approving applications for a certain loan category measured by the Federal Reserve's SLOOS (Senior Loan Officer Opinion Survey) on Bank Lending Practices of up to eighty large domestic banks and twenty-four U.S. branches and agencies of foreign banks. The Federal Reserve generally conducts the survey quarterly. The lending standard index used in the analysis focuses on large and middle-market firms, with sales of 50 million or more, based on the average sales in the sample. The index ranges from -100 to 100, providing insights into the tightness or looseness of bank lending practices.

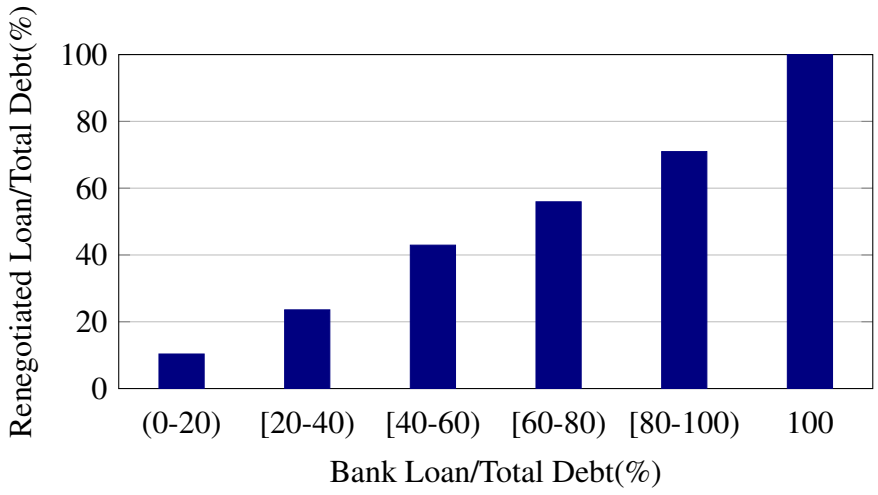
(Sample restrictions)

To ensure the robustness of the analysis and address potential data issues, the following sample restrictions and data treatment are applied. Winsorization is conducted by calendar year.

- Winsor the top and bottom 1% of loan volume, spread and maturity.
- Winsor the top and bottom 0.5% of the bank capital ratio.
- Drop observation of negative capital, assets, sales, leverage or liquidity.
- Drop observation if acquisitions (based on *aqcy* in Compustat) are more than 5% of total assets.
- Winsor the top and bottom 1% of investment rate and real total asset.
- Winsor the top and bottom 0.5% of leverage and distance to default.
- Drop firm-quarter observations if the investment spell is shorter than 24 quarters.

(The share of renegotiations in total corporate debt)

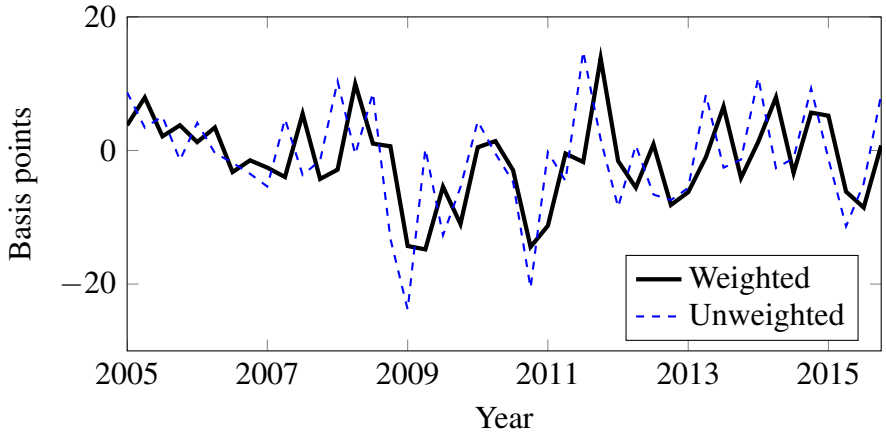
Figure A.0.1: The relation between renegotiated bank loans and all bank loan



Notes: This figure shows the relation between bank loans and renegotiated bank loans as a percentage of a firm's total debt. On the horizontal axis, the firm-year observations are grouped by the bank debt as a percentage of total debt. The vertical axis reports the corresponding renegotiated bank debt as a percentage of total debt.

(Monetary policy shock series)

Figure A.0.2: Quarterly monetary policy shocks



Notes: This figure uses the monetary policy shock series provided by Bu, Rogers and Wu (2021) for the period 1/1/2005 to 12/31/2015. The weighted quarterly shock is constructed by assigning weights based on the number of days in the quarter following the occurrence of the shock. The unweighted quarterly shock is obtained by simply aggregating all shocks within each quarter.

A.1 Supplemental details of the alternative dataset

(SNC dataset)

The Shared National Credit (SNC) data provides changes in amount or maturity, but it does not identify other major types of renegotiation such as price or covenant renegotiation. Furthermore, loans may disappear from the SNC dataset over time if their size falls below 20 million dollars or if they are not held by three federally supervised institutions —Federal Deposit Insurance Corporation, the Federal Reserve, and the Office of the Comptroller of the Currency. Previous research using this data includes studies such as Mian and Santos (2018) and Paligorova and Santos (2018).

(Y-14 dataset)

Since the last quarter of 2014, the Federal Reserve has been collecting renegotiation information from large banks with total assets exceeding 100 billion dollars. The reporting criteria are outlined in the manual "Instructions for the Capital Assessments and Stress Testing information collection (Reporting Form FR Y-14Q)". The Federal Reserve requires banks to record renegotiation when there are only minor modifications to agreements. Additionally, banks are instructed to report amended and restated credit agreements as new loans, although they represent modifications of existing loans along with the restatements of previous changes for practical reasons. In practice, amended and restated agreements are often utilized to facilitate future reference to previous changes, particularly when amendments occur frequently or result in substantial changes in loan terms. Other studies thus define amended and restated credit agreements as renegotiated loans (e.g., Roberts, 2015; Nikolaev, 2018). Previous research employing this data includes studies by Brown, Gustafson and Ivanov (2021) and Chodorow-Reich et al. (2022).

B Supplementary Results

B.1 Robustness - Extensive margin regressions: Effect of monetary policy shocks on the likelihood of credit adjustment

Table B.1.1: Extensive margin - Immediate effect of monetary policy shocks on credit adjustment controlling for bank specific capital ratio

	Origination$_t$				Renegotiaton$_t$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Benchmark				Benchmark	
MP shock$_t$	0.277	0.535	0.934**	1.404***	1.828***	2.036***	1.980***	2.262***
	(0.418)	(0.416)	(0.409)	(0.424)	(0.440)	(0.461)	(0.468)	(0.440)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	Yes	-	No	Yes	Yes	-
Bank FE	No	No	Yes	-	No	No	Yes	-
Firm*Bank FE	No	No	No	Yes	No	No	No	Yes
Observations	84,710	84,710	84,710	84,401	84,710	84,710	84,710	84,401
R^2	0.007	0.045	0.055	0.115	0.025	0.113	0.119	0.183

Notes: The table presents the probability of origination/renegotiation after a 25bps expansionary monetary policy shock. The coefficient β_h is estimated for quarter h using equation (1), $P_{bj,t+h} = \alpha_h + \beta_h \cdot \varepsilon_t + \gamma_h \cdot X_{bj,t-1} + \nu_{bj,t+h}$, where $h = 0$, all specifications are equivalent to Table 3 except that bank specific capital ratio is added to $X_{bj,t-1}$. The table includes fixed effects, which are indicated as "yes" (included), "no" (not included), or "-" (comprised in the wider set of fixed effects). The robust standard errors in parentheses are two-way clustered by firm and bank. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.1.2: Extensive margin - Immediate effect of monetary policy shocks on the likelihood of loan adjustment at loan-quarter level

	Origination$_t$				Renegotiation$_t$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Benchmark				Benchmark	
MP shock$_t$	0.349	0.569*	0.918***	1.479***	1.602***	1.633***	1.617***	1.896***
	(0.340)	(0.339)	(0.333)	(0.346)	(0.400)	(0.410)	(0.409)	(0.395)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	Yes	-	No	Yes	Yes	-
Bank FE	No	No	Yes	-	No	No	Yes	-
Firm*Bank FE	No	No	No	Yes	No	No	No	Yes
Observations	128,903	128,903	128,903	128,555	128,903	128,903	128,903	128,555
R^2	0.008	0.041	0.056	0.110	0.028	0.113	0.124	0.185

Notes: The table presents the probability of origination/renegotiation after a 25bps expansionary monetary policy shock. The coefficient β_h is estimated for quarter h using equation 1, $P_{ibj,t+h} = \alpha_h + \beta_h \cdot \varepsilon_t + \gamma_h \cdot X_{ibj,t-1} + \nu_{ibj,t+h}$, where $h = 0$ and $P_{ibj,t+h}$ is zero when a loan i by bank b to firm j is in progress for the loan-quarter combinations and is replaced one when at least one origination/renegotiation takes place at t. The table includes fixed effects, which are indicated as "yes" (included), "no" (not included), or "-" (comprised in the wider set of fixed effects). The robust standard errors in parentheses are two-way clustered by firm and bank. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.1.3: Extensive margin - Impact of monetary policy shocks on the likelihood of issuing using an alternative definition of an issuing indicator

	$t+0$				$t+1$	$t+2$	$t+3$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Benchmark				
MP shock$_t$	0.033	0.139	0.136	0.113	0.464**	0.781***	1.121***
	(0.159)	(0.165)	(0.164)	(0.167)	(0.231)	(0.286)	(0.335)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	Yes	-	Yes	Yes	Yes
Bank FE	No	No	Yes	-	Yes	Yes	Yes
Firm*Bank FE	No	No	No	Yes	No	No	No
Observations	272,783	272,783	272,783	272,783	272,783	272,783	272,783
R^2	0.001	0.010	0.012	0.022	0.022	0.032	0.042

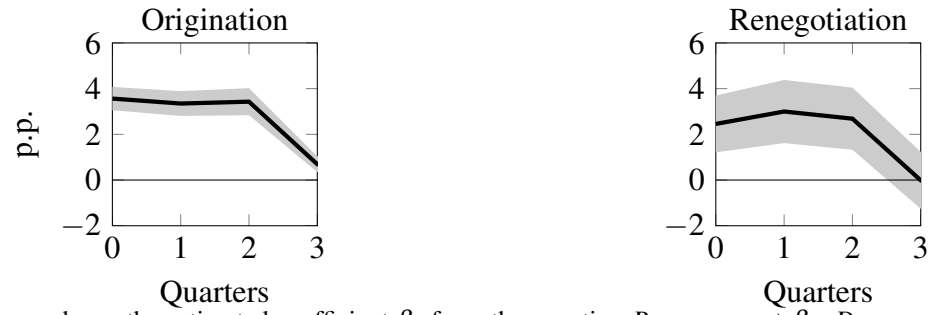
Notes: The table presents the probability of origination/renegotiation after a 25bps expansionary monetary policy shock. The coefficient β_h is estimated for quarter h using equation 1, $P_{bj,t+h} = \alpha_h + \beta_h \cdot \varepsilon_t + \gamma_h \cdot X_{bj,t-1} + \nu_{bj,t+h}$, where $h = 0$ and $P_{bj,t+h}$ is zero for all bank-firm-quarter combinations and is replaced with one when at least one origination takes place between t to $t+h$. A bank-firm combination refers to the pair at least once matched during the sample periods but it is not necessarily active at t. The table includes fixed effects, which are indicated as "yes" (included), "no" (not included), or "-" (comprised in the wider set of fixed effects). The robust standard errors in parentheses are two-way clustered by firm and bank.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.1.4: Extensive margin - Immediate effect of monetary policy shocks on credit adjustment using central bank information shock

	Origination$_t$				Renegotiation$_t$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Benchmark				Benchmark	
MP shock$_t$	-2.895***	-1.721*	-2.358**	-4.030***	-7.444***	-4.927***	-4.667***	-4.335***
	(0.943)	(1.015)	(0.997)	(1.003)	(1.043)	(1.236)	(1.238)	(1.243)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	Yes	-	No	Yes	Yes	-
Bank FE	No	No	Yes	-	No	No	Yes	-
Firm*Bank FE	No	No	No	Yes	No	No	No	Yes
Observations	110,752	110,752	110,752	110,386	110,752	110,752	110,752	110,386
R^2	0.008	0.042	0.058	0.113	0.027	0.112	0.122	0.184

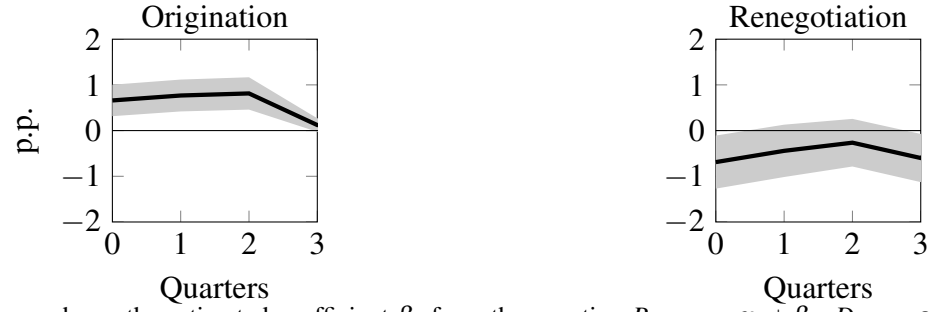
Notes: The table presents the probability of origination/renegotiation, the coefficient β_h over quarter h from equation (1), after a 25bps expansionary central bank information shocks from Jarociński and Karadi (2020): $P_{bj,t+h} = \alpha_h + \beta_h \cdot \varepsilon_t + \gamma_h \cdot X_{bj,t-1} + \nu_{bj,t+h}$, where $h = 0$, all specifications are equivalent to those presented in Table 3. The table includes fixed effects, which are indicated as "yes" (included), "no" (not included), or "-" (comprised in the wider set of fixed effects). The robust standard errors in parentheses are two-way clustered by firm and bank. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure B.1.1: Extensive margin - Dynamic effect of monetary policy shocks on credit adjustment by ex-ante firm characteristics (i.e. highly leveraged bank-dependent firm)



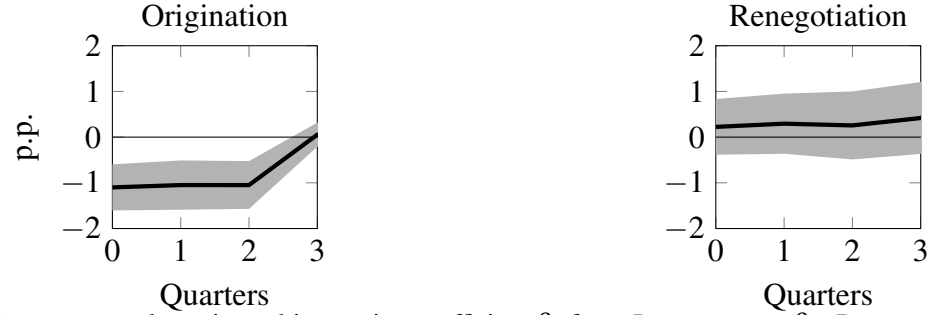
Notes: The figure shows the estimated coefficient β_h from the equation $P_{bj,t+h} = \alpha_h + \beta_h \cdot D_{j,t-1} \cdot \varepsilon_t + \gamma_h \cdot X_{bj,t-1} + \nu_{bj,t+h}$, where $D_{j,t-1}$ is an indicator variable for highly leveraged & bank-dependent. The indicator variable takes a value of one if a firm's leverage is above the median of distribution and if the firm has no outstanding public bonds or has not issued public bonds for the last three years. The shaded regions are 90% error bands.

Figure B.1.2: Extensive margin - Dynamic effect of monetary policy shocks on credit adjustments by ex-ante firm characteristics (i.e. lagged investment)



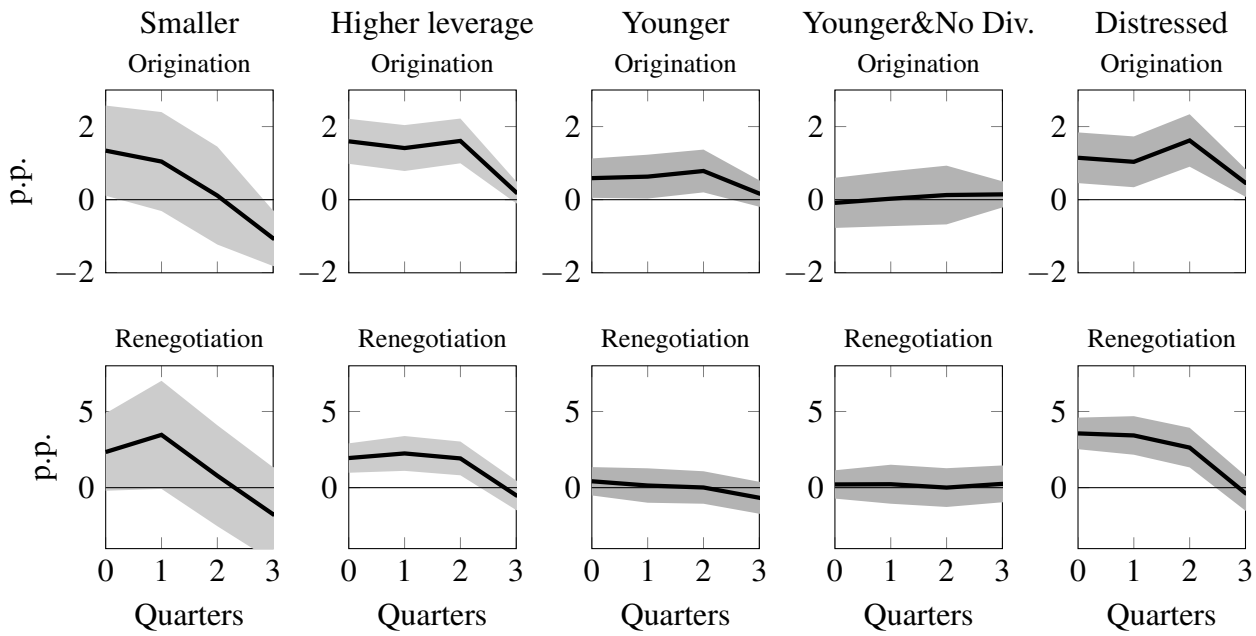
Notes: The figure shows the estimated coefficient β_h from the equation $P_{bj,t+h} = \alpha_h + \beta_h \cdot D_{j,t-1} \cdot \varepsilon_t + \gamma_h \cdot X_{bj,t-1} + \nu_{bj,t+h}$, where $D_{j,t-1}$ is lagged investment to asset ratio which is measured as a within-firm demeaned ratio of investment to assets and is standardized. The shaded regions are 90% error bands.

Figure B.1.3: Extensive margin - Dynamic effect of monetary policy shocks on extensive margins of credit adjustment by firm's ex-ante distance to default



Notes: This figure reports the estimated interaction coefficient β_h from $P_{bj,t+h} = \alpha_h + \beta_h \cdot D_{j,t-1} \cdot \varepsilon_t + \gamma_h \cdot X_{bj,t-1} + \nu_{bj,t+h}$, where $h \geq 0$ and D represents the distance to default within firm deviation, as measured in Ottonello and Winberry (2020). A higher distance to default indicates a greater level of distance from default. The shaded regions are 90% error bands.

Figure B.1.4: Extensive margin - Dynamic effect of monetary policy shocks on credit adjustment by alternative firm characteristics



Notes: This figure reports the interaction coefficient β_h from the equation $P_{bj,t+h} = \alpha_h + \beta_h \cdot D_{j,t-1} \cdot \varepsilon_t + \gamma_h \cdot X_{bj,t-1} + \nu_{bj,t+h}$, where $h \geq 0$ and D represents an indicator for each group. The groups are defined as follows: (1) Small firms with average sales over the past 10 years below the 30th percentile of the distribution (Gertler and Gilchrist, 1994). (2) Highly leveraged firms, where leverage is defined as the debt-to-asset ratio, with debt being the sum of short-term and long-term debt, and assets being the book value of assets. (3) Younger and non-dividend paying firms, defined as firms less than 15 years since incorporation and did not pay cash dividends during the previous year (Cloyne et al., 2023). (4) Distressed firms, identified as firms with Altman's Z-score below 1.1 (i.e., distress zone with a very high probability of bankruptcy within two years) (Altman, 1968). The shaded regions are 90% error bands.