Financial Constraints and the Transmission of Monetary Policy: Evidence from Relaxation of Collateral Constraints*

Nishant Vats†

Abstract

How do financial constraints affect the transmission of monetary policy? I examine this question using the staggered enactment of anti-recharacterization legislation as a source of exogenous variation in creditor rights that loosens firm-financial constraints. A 25 basis-point expansionary monetary policy shock results in a 2 percentage-point higher investment growth among treated (unconstrained) firms. Using a Heterogeneous-Firm-New-Keynesian model, I estimate that the law relaxed firm collateral constraint by 16%. The model highlights the mechanism that the relaxation of collateral constraint flattens the firm marginal cost curve, which amplifies responses to shifts in the marginal benefit curve due to monetary policy shocks.

*I am grateful to my advisors Raghuram Rajan, Amir Sufi, Scott Nelson, Constantine Yannelis, Emanuele Colonnelli, Pascal Noel, Elizabeth Kempf, and Michael Weber. I thank Isha Agarwal, John Barrios, Indraneel Chakraborty, Steven J. Davis, Douglas W. Diamond, Mohit Desai, Wenxin Du, Josh Felman, David Finer, Todd Gormley, Lars Peter Hansen, Kilian Huber, Erik Hurst, Sai Krishna Kamepalli, Elisabeth Kempf, Ralph Koijen, Randall S. Kroszner, Shohini Kundu, Yueran Ma, Prachi Mishra, Stefan Nagel, Ali Ozdagli, Nagpurnanand Prabhala, Arkodipta Sarkar, Varun Sharma, Joseph Vavra, Lauren Vollon and Thomas Winberry as well as the seminar participants at the Summer Research Conference 2020 at the Indian School of Business, CMI Field Workshop on Firm Finance/Behaviour 2020, the Economic Dynamics and Financial Markets Working Group and the Finance Brownbag seminar at the University of Chicago for helpful conversations and valuable feedback. I am grateful to John Rogers for sharing the data on his monetary policy surprise measure, and to Laura Xiaolei Liu and Mike Mao for sharing their data on firms' SPVs. I take full responsibility for any errors. I have no conflicts of interest to disclose. This paper was previously circulated under the title – "What Does Financial Heterogeneity Say about the Transmission of Monetary Policy?"

†Nishant Vats is at the Olin Business School at Washington University in St Louis. Send correspondence to Simon Hall, Room 222, Olin Business School, WUSTL, St Louis, MO 63105, e-mail: vats@wustl.edu.

1 Introduction

Do financial frictions affect the transmission of monetary policy to real investments? Are firms facing greater financial frictions more responsive to monetary policy shocks? The answer to these questions is theoretically unclear. Monetary policy shocks affect firm investment through two channels. First, expansionary monetary policy shocks relax financial constraints resulting in the flattening of the marginal cost curve of investment. This channel, built on the financial accelerator mechanism, suggests that monetary policy sensitivity is greater for financially constrained firms. Second, expansionary monetary policy shocks decrease firm discount rates resulting in an outward shift in the marginal benefit curve of investment. This second channel of monetary transmission is muted for financially constrained firms as movements in the marginal benefit curve have little effect on firms that face a steep marginal cost curve of investment. The theoretical ambiguity around the question and the rich heterogeneity in financial positions across firms makes understanding the role of financial frictions in the transmission of monetary policy an interesting research question imperative to policy design, especially targeted monetary policy.

While the significance of financial frictions in monetary transmission has been studied extensively since the seminal work of Bernanke, Gertler, and Gilchrist (1999), the role of financial frictions in the transmission of monetary policy remains ambiguous.[1] The extant empirical literature studying the role of financial frictions in monetary transmission has documented mixed results. These mixed empirical results can be attributed to two identification challenges: first identifying plausibly exogenous variation in monetary policy and second endogeneity in the measurement of financial constraints. A valid test examining the role of financial frictions in monetary transmission requires separating firms operating on different marginal cost curves using variation that is independent of firms' investment opportunities or the marginal benefit curve. Measuring financial constraints using firm size, leverage, liquid assets, dividend payments, and other textbook measures greatly hinders the identification of the investment response to monetary policy shocks for firms facing varying levels of financial constraints as these measures are correlated with factors that determine the marginal cost curve and investment opportunities.[2] Moreover, the discussion of conditions under which financial constraints can increase

[1] A large empirical literature has used proxies for financial frictions such as size (Gertler and Gilchrist, 1994), liquidity (Jeenas, 2018), distance to default (Ottonello and Winberry, 2020), bank debt (Ippolito, Ozdagli, and Perez-Orive, 2018) and age (Cloyne, Ferreira, Froemel, and Surico, 2018) to examine the response of constrained firms to monetary policy shocks relative to unconstrained firms.

[2] Firm size has often been used as a proxy for financial constraints. While firm size is correlated with financial factors such as informational frictions, poor collateral, and low liquidity, it is also related to non-financial factors. For example, large firms smooth variation in demand by contracting out to small firms and they have a diversified customer base whereas small firms are concentrated in cyclical industries and have a non-diversified customer base (Crouzet and Mehrotra, 2020). Apart from the omitted variable concern

or decrease the responsiveness of firms to monetary policy shocks is largely absent in the empirical literature.

The objective of this paper is twofold. First, I attempt to address these endogeneity issues. I provide identification using a plausibly exogenous natural experiment which provides variation in a key financial friction: the strength of creditor rights or collateral constraints. This natural experiment allows me to identify plausibly exogenous variation in the marginal cost curve that is independent of firm's investment opportunities. My strategy to identify financial constraints, combined with the high-frequency measurement of monetary policy shocks, permits a direct comparison of the investment responses to monetary policy of firms operating under different levels of financial constraints. Second, I formalize the mechanism using a quantitative heterogeneous-firm-New-Keynesian model with collateral constraint. I exploit the empirical estimates to discipline the model and decompose the different channels through which monetary policy affects firm investment in the presence of financial frictions. My results show that financial frictions may dampen monetary transmission. Specifically, the results suggest that unconstrained firms – facing a flatter marginal cost curve of investment due to relaxation of collateral constraints – are more responsive to monetary policy shocks, as they exhibit a greater response to movements in the marginal benefit curve.

I employ the staggered enactment of anti-recharacterization legislation across different states in the US, from 1997 to 2002, as a source of exogenous variation in creditor rights. These statutes strengthened creditors' ability to seize collateral from borrowing firms in bankruptcy by legitimizing asset transfers to special purpose vehicles (SPV). The enactment of anti-recharacterization laws improved creditor rights, which in turn reduced financial constraints – by relaxing collateral constraints – for firms headquartered or incorporated in states where anti-recharacterization statutes were enacted. Firms transfer collateral to an SPV while engaging in secured borrowing. Assets transferred to an SPV are excluded from Chapter 11 proceedings, making it easier for creditors to seize these assets. However, before anti-recharacterization statutes, courts could adjudicate on the legality of the Chapter 11 remoteness of assets transferred to SPVs on a case-by-case basis. The enactment of anti-recharacterization legislation provided legitimacy to these bankruptcy-remote transfers. Hence, the legislation facilitated secured creditors' ability to seize assets in the event of bankruptcy by reducing the uncertainty related to the seizure of collateralized assets by lenders. However, the 2003 Fifth

due to non-financial factors, there is also a concern of reverse causality if the firm size determines financial constraint or vice versa. Similarly, more advanced measures of financial constraints – such as Kaplan-Zingales, Hadlock-Pierce and Whited-Wu – based on a linear combination of accounting numbers are also correlated with factors that determine the firms' marginal cost and investment opportunities.

Circuit Court ruling in *Reaves v. Sunbelt* came as a huge blow to anti-recharacterization laws making these statutes ineffective for non-financial firms.

I use an on-and-off approach to study the effect of monetary policy shocks on the investment of firms headquartered or incorporated in states where anti-recharacterization laws were enacted relative to firms in states where anti-recharacterization laws were not applicable. This approach is similar to the traditional differences-in-differences (DID) approach and has previously been employed in Li, Whited, and Wu (2016) and Ersahin (2020). In this approach the indicator variable turns on, taking a value of one, for the treated group when the treatment is active and turns off, taking a value of zero, otherwise. This specific approach is adopted as the law was active in a state after its enactment, but was rendered ineffective for non-financial firms after the 2003 Fifth Circuit Court ruling. Firms headquartered or incorporated in states where the laws were enacted (treated group) are less financially constrained during the period when the law was active relative to firms headquartered or incorporated in states where the laws were not enacted (control group). I include firm and industry $\times$ quarter $\times$ year fixed effects. Hence, the estimate is identified using the variation among treated and control firms within the same four-digit SIC industry group that are likely to face similar investment opportunities, while controlling for time-invariant firm fixed effects. Thus, the setting allows me to infer the monetary policy elasticity of the treated firms (less constrained) relative to the control (more constrained) firms using cross-sectional and temporal variation.

I find that the investment of treated firms is more sensitive to monetary policy shocks relative to the control firms. Treated firms exhibit a semi-elasticity of investment to monetary policy that is 1.65 percentage points (pp) higher than control group firms during the law's active period relative to the non-active period. Specifically, a 25 basis point (bps) expansionary monetary policy shock results in 2.03 pp higher investment growth among treated firms relative to control firms. This result is both statistically and economically significant given the average investment growth for the firms in the sample is 2.6%.

I interpret the greater sensitivity of treated firms to monetary policy shocks relative to the control firms as evidence that financially unconstrained firms are more responsive to monetary policy shocks relative to financially constrained firms. This interpretation assumes that the strengthening of creditor rights increases the borrowing capacity of firms, which makes them less financially constrained. This is a reasonable assumption as stronger creditor rights increase the ability of creditors to recover collateral in the event of bankruptcy (Hart and Moore, 1994; Rampini and Viswanathan, 2013) which reduces firm financial constraints through a variety of channels such as increasing its access to credit, decreasing the cost of credit, increasing its borrowing capacity, expanding the menu of collateralizable assets, and increasing its flexibility. Using a structural model, Li, Whited, and Wu (2016) provides evidence consistent with this assumption that the collateral parameter increased for the treated firms after the enactment of anti-recharacterization laws. I verify this assumption independently using the heterogeneous-firm-new-Keynesian model and find that the collateral parameter increased by 14% after the enactment of these laws.

Next, I argue that my empirical results are indeed driven by monetary policy shocks and the enactment of anti-recharacterization laws. First, my results are driven by firms in sectors that possess either tangible or intangible assets available for pledging. Second, I document that the effect is dominant among firms with a greater likelihood of SPV usage. Third, I show that the effect is driven by changes in interest rates and not by the resolution of uncertainty following Fed monetary policy announcements or the Fed information effect. Fourth, I show that the treated firms finance new investments following expansionary monetary policy shocks through debt. I document an increase in debt for treated firms relative to the control firms following expansionary monetary policy shocks. Furthermore, this effect on debt growth is more significant for firms with a higher likelihood of SPV usage, which are likely to benefit the most from the anti-recharacterization laws.

Next, I examine the monetary policy responsiveness of constrained and unconstrained firms during the economic downturn of 2001. Constrained firms are expected to respond more to monetary policy shocks during periods of economic downturn. During normal times, firms with a flatter marginal cost curve of investment (unconstrained firms) are more responsive to movements in the marginal benefit curve of investment relative to firms with a steeper marginal cost curve of investment (constrained firms). However, movements in the marginal benefit curve are attenuated during periods of economic downturns when investment opportunities are scarce or when aggregate demand is low. The economic downturn of 2001 provides for such an episode. Constrained firms are expected to respond more to monetary policy shocks during periods of economic downturns, as the flattening of the marginal cost curve of investment is likely to be dominant during such episodes. My results indicate that while unconstrained firms are more responsive to monetary policy shocks during normal times, constrained firms become more responsive to monetary policy shocks during periods of economic downturn.

While the analysis of the economic downturn of 2001 is informative about the mechanism, it is suggestive at best as several other factors also vary between recessions and normal times. To better decompose the quantitative importance of the marginal benefit (MB) and the marginal cost

(MC) channels in driving the cross-sectional result, I estimate a heterogeneous-firm-New-Keynesian model. This model builds on Khan, Senga, and Thomas (2016) and Ottonello and Winberry (2020) by introducing a collateral constraint to capture the effect of financial frictions arising due to constraints on firms' collateralized debt capacity. The model has three key ingredients. The first ingredient captures the heterogeneous response to monetary policy. This ingredient incorporates sticky prices and aggregate adjustment costs, which generate temporal variation in the relative price of capital. The second ingredient in the model defines the role of the central bank that sets the nominal risk-free interest rate according to the Taylor rule. Additionally, this model section generates a New Keynesian Philips curve that allows relating nominal variables to the real economy. The third ingredient models a representative household that allows me to derive the stochastic discount factor and close the model.

Three key results emerge from the model. First, the model allows for an examination of the effect due to the presence of the collateral constraint. This component distinguishes financial frictions arising due to the firm distress risk as in Ottonello and Winberry (2020) from the one being examined in this paper, i.e., financial frictions arising due to constraints on firms' collateralized debt capacity. The presence of collateral constraint increases the marginal cost of capital. Specifically, an increase in the collateral constraint parameter flattens the firms' marginal cost curve. Additionally, the presence of dividend non-negativity constraint captures the shadow value of future resources. As a result, the presence of collateral constraint adds two forces when examining the effect of monetary policy shocks. On the one hand, firms with more relaxed collateral constraints tend to have flatter MC curve. Consequently, the movements in the MB curve due to monetary policy shocks can amplify the effect for such firms. On the other hand, monetary policy shocks can flatten the MC curve for firms facing tighter collateral constraints, amplifying the effect for such firms.

Second, after disciplining the model with the cross-sectional semi-elasticity, I can quantify the effect of the enactment of anti-recharacterization laws on financial constraints faced by firms. Specifically, I estimate that these laws increased the collateral constraint parameter, i.e., the strength of financial frictions associated with collateral constraint decreased by 16%.

Third, I use counterfactual experiments to assess the relative importance of each transmission channel. I start with a model with all channels and then subtract each channel one at a time. Eliminating the MB channel makes firms with tighter collateral constraint more responsive to monetary policy shocks, while firms with relaxed collateral constraint are more responsive when the MC channel is eliminated. Specifically, I find that the relative semi-elasticity becomes positive and decreases by 125.00% when the MB channel is shut, and the relative semi-elasticity increases by 31.25% when the

MC channel is shut.

Related Literature: This paper is related to several strands of literature. First, I contribute to the literature studying the transmission of monetary policy when firms face financial frictions. A large literature has used several accounting and financial proxies such as firm size (Gertler and Gilchrist, 1994; Kashyap, Lamont, and Stein, 1994), liquidity (Jeenas, 2018), distance to default (Ottonello and Winberry, 2020), bank debt (Ippolito, Ozdagli, and Perez-Orive, 2018), and age (Cloyne, Ferreira, Froemel, and Surico, 2018) to examine the response of constrained firms to monetary policy shocks relative to unconstrained firms. Unlike previous studies, I do not rely on endogenous accounting measures to proxy for financial constraints. I provide identification using a natural experiment that varies a key financial friction - the strength of creditor rights. The natural experiment generates variation in the marginal cost curve that is independent of the variation in the marginal benefit curve or the response of the marginal benefit curve to monetary policy shocks. Hence, my empirical methodology is more adept at solving the theoretical and empirical challenges posed in the literature so far. The results show that firms facing a flatter marginal cost curve of investment, unconstrained firms, are more responsive to monetary policy shocks, as they exhibit a greater response to movements in the marginal benefit curve.

This paper is closely related to Ottonello and Winberry (2020), who focus on the effects of financial constraints arising from firms' distress risk. In contrast, this paper focuses on a different channel, i.e., the effects of financial constraints arising due to constraints on firms' collateralized debt capacity. The model incorporates a collateral constraint to effectively capture this friction. The presence of collateral constraint affects the marginal cost curve. As a result, capital and debt accumulation are attenuated in a model with collateral constraint. Disciplining the model using empirical estimates, I show that anti-recharacterization laws increased the collateral constraint parameter by 16%. The increase in the value of the collateral constraint parameter reduces financial frictions due to the expansion of firms' collateralized debt capacity. Moreover, the quantitative exercise allows me to establish that firms tend to preserve their debt capacity. These result resonate with the findings of Li, Whited, and Wu (2016). Another contribution of this paper is to quantitatively decompose the semi-elasticity for firms facing relaxed collateral constraints relative to firms with tighter collateral constraints due to movements in the MC and MB curves. Both of these contributions, alongside the empirical analysis, distinguish the findings of this paper from the existing literature.

To the best of my knowledge, this paper is the first to highlight that an improvement in creditor rights amplifies the effects of monetary policy. Therefore, this paper also contributes to a large literature examining the effects of creditor rights on credit markets and firm behaviour. Prior literature associates stronger creditor rights with liquidation bias (Aghion and Bolton, 1992), conservative financing policy (Vig, 2013), conservative investment policy (Acharya, Amihud, and Litov, 2011), and lower innovation output (Acharya and Subramanian, 2009). These studies stand in contrast to the studies that have documented positive effects of anti-recharacterization laws on leverage (Li, Whited, and Wu, 2016), investment and productivity (Ersahin, 2020), patenting firms access to credit (Mann, 2018), and mitigating exposure to uncertainty shocks (Favara, Gao, and Giannetti, 2021). This paper adds to the literature by focusing on the role that creditor rights play in the transmission of monetary policy by affecting collateral constraint.

Next, I lay out the road-map of the paper. Section 2 presents the institutional details of the anti-recharacterization law. Section 3 describes the data, empirical strategy, and identification at length. Section 4 presents results from my analysis. Section 5 presents the underlying mechanism. Section 6 quantifies the channels using a Heterogeneous-Firm-New-Keynesian model. Section 7 concludes.

2 Institutional Details

In this section, I describe the anti-recharacterization laws that affect the strength of creditor rights. Anti-recharacterization laws operate via the usage of Special Purpose Vehicles (SPVs) to conduct secured borrowing. Firms transfer assets intended to be used as collateral against secured borrowing to an SPV. Feng, Gramlich, and Gupta (2009) show that usage of SPVs is a common practice among US firms. Using data from 10-K filings between 1994 and 2004, Feng, Gramlich, and Gupta (2009) find that 42% of Compustat firms are associated with at least one SPV, and 32% with multiple SPVs. SPVs are bankruptcy remote in case of Chapter 11 filings, allowing lenders to easily seize assets. However, in the pre-law period, this *"true sale"* - transfer of an asset from the firm to an SPV - was not guaranteed. The bankruptcy courts had the authority to re-characterize these transfers as loans to the SPV instead of a true sale. After recharacterization by courts, the lender becomes a secured creditor of the firm instead of the SPV. Hence, following recharacterization, creditors lose the right to seize assets until Chapter 11 proceedings terminate. However, the enactment of anti-recharacterization laws removes the possibility of this re-characterization by courts.

The anti-recharacterization laws require that collateral transfers to an SPV be treated as a true sale, stripping courts of any authority to rule over this matter. Hence, anti-recharacterization laws strengthen creditors' ability to swiftly seize assets without any delay due to Chapter 11 proceedings. Seven states enacted anti-recharacterization laws. Texas and Louisiana passed the anti-recharacterization laws in

1997, followed by Alabama in 2001, Delaware in 2002, South Dakota in 2003, Virginia in 2004, and Nevada in 2005. These laws can be grouped into two categories (Kettering, 2010); while Texas and Louisiana discard the possibility of recharacterization of all sales of receivables, the other states only discard this possibility when sales are explicitly marked as securitization transactions.

However, the Fifth Circuit Court ruling of *Reaves v. Sunbelt* in 2003 came as a huge blow to anti-recharacterization laws.[3] The summary judgement by the Fifth Circuit Court judge re-characterized the firms' sale of assets to an SPV as a lending agreement. This judgement increases the likelihood of challenging anti-recharacterization laws based on federal laws. The 2003 federal court ruling increased the uncertainty around anti-recharacterization laws by creating a precedent where federal courts could overrule state anti-recharacterization laws. Li, Whited, and Wu (2016) notes that this case was cited as a precedent in 62 other bankruptcy cases within seven years of *Reaves v. Sunbelt* decision. Thus, the ruling makes the effect of anti-recharacterization laws limited after 2003.[4] Karpoff and Wittry (2018) argues that important federal court rulings must be taken into account while identifying the incremental effect of a law change. Hence, in this paper I only consider the states of Texas, Louisiana and Alabama as treated states with treatment being active between the year of enactment and its subsequent reversal in 2003.

Finally, the enactment of the anti-recharacterization laws can be argued as being plausibly exogenous for the sample of non-financial firms. Kettering (2008) shows that the lobbying efforts related to anti-recharacterization laws were spearheaded by the banking sector, specifically the securitization industry. Janger (2003) argues that the non-financial firms had little role in the enactment of these laws. Moreover, I address the issue of the endogeneity of the laws via a falsification test. If the results are indeed driven by state-specific conditions which led to the enactment of the law, I should also find significant results even in states that passed anti-recharacterization laws after 2003. However, the estimates in my falsification test are neither statistically nor economically significant for the states that passed the law after 2003. Hence, it is difficult to argue that my identification strategy is contaminated by political economy considerations leading to selection bias in the treatment group among non-financial firms.

The anti-recharacterization laws improved firms' pledgeability by strengthening creditors' rights. Using a structural model, Li, Whited, and Wu (2016) shows that firms' leverage changes significantly

[3]Reaves Brokerage Company, Inc. v. Sunbelt Fruit & Vegetable Company, Inc. case originally filed by the plaintiff citing violation of a federal law, Perishable Agricultural Commodities Act (PACA) of 1930 by the defendant.

[4]It is to be noted that the *Reaves v. Sunbelt* decision only affects non-financial firms. The ruling does not affect the applicability of the law to financial firms such as firms in the securitization industry. States continued to pass anti-recharacterization laws after 2003 following lobbying by the securitization industry in the state. These financial firms, however, are not included in the analysis.

after the implementation of anti-recharacterization laws, originating from movements in the position of the collateral constraint. I present similar analysis documenting the effect of these laws on the collateral constraint parameter in section 6. Using the US Census microdata, Ersahin (2020) shows that the total factor productivity of treated plants increases by 2.6% after the implementation of anti-recharacterization laws. Ersahin (2020) argues that stronger creditor rights, due to anti-recharacterization laws, relax borrowing constraints and help firms adopt more efficient production technologies. Favara, Gao, and Giannetti (2021) shows that these laws enhanced firms' ability to borrow by strengthening creditors' rights to repossess collateral pledged in SPVs. Hence, anti-recharacterization laws relaxed firm financial constraints.

3 Data and Methodology

3.1 Data

Quarterly firm-level data on key financial variables from 1994 to 2007 is extracted from Compustat. All financial firms (SIC Codes 6000-6999), regulated utilities firms (SIC Codes 4900-4949), and firms incorporated outside the United States are dropped from the sample. The sample begins in 1994 as the banking system across states in the US had mostly integrated by then.[5] I end my sample in December 2007, before the financial crisis, studying the period of conventional monetary policy with a fully integrated banking system across states in the US. Data on macroeconomic factors, effective Fed funds rate, GDP, CPI and unemployment rate (UR) is sourced from the website of the Federal Reserve Bank at St. Louis. Data on the economic policy uncertainty index is obtained from the website of the Policy Uncertainty Project.[6]

3.1.1 Monetary Policy Shocks

In this section, I discuss the methodology used for constructing monetary policy shocks. I closely follow the approach used in Gorodnichenko and Weber (2016) to identify the unexpected monetary policy shocks, denoted as $\Delta\varepsilon_t$. These monetary policy shocks are constructed using the high-frequency event study approach pioneered by Cook and Hahn (1989) and employed in Bernanke and Kuttner (2005). The surprise component, $\Delta\varepsilon_t$ is calculated using price changes in the Fed Funds futures within

[5]The formal nation-wide banking integration law, Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994 was signed by the then President Bill Clinton on September of 1994. The nation already had an effective interstate banking system by 1993 as noted by the United States Secretary of the Treasury Lloyd Bentsen (Fed History). My results are however robust to including 1993.

[6]The data on economic policy uncertainty was accessed from https://www.policyuncertainty.com/us_monthly.html.

a narrow window around the Federal Open Market Committee (FOMC) meetings.[7] Fed Funds futures have been trading on the Chicago Board of Trade (CBOT) since 1990. Price changes in the Fed Funds futures within a narrow window around FOMC announcements reflect the surprise component in the path of the Fed Funds rates, the main policy instrument of the Fed during my sample period. The unexpected component is calculated as

$$\Delta\varepsilon_t = \frac{D}{D-d}(\nu_{t+\Delta^+} - \nu_{t-\Delta^-}) \tag{1}$$

where t is the time of FOMC announcement on date d. D is the number of days in the month. ν_t is the implied Fed Funds rate from the current-month Fed Funds futures contract at time t. $\nu_{t+\Delta^+}$ and $\nu_{t-\Delta^-}$ reflect the Fed Funds rate implied by the futures contract at time Δ^+ after and Δ^- before the FOMC announcement. The term $\frac{D}{D-d}$ adjusts for the fact that the Fed Funds futures settle on the average effective overnight Fed Funds rate. These shocks affect interest rates. Using high-frequency monetary policy shocks, Nakamura and Steinsson (2018a) show that nominal and real interest rates increase roughly one-for-one several years out into the term structure in response to an interest rate hike. Next, I aggregate these high-frequency shocks at the quarterly level to merge with the firm-level data. I aggregate the data at the quarterly level by taking an average of all high-frequency shocks in that quarter, $\Delta\varepsilon_t^q$. For robustness, I employ several other measures of monetary policy shocks – as in Jarociński and Karadi (2020), Nakamura and Steinsson (2018a), and Bu, Rogers, and Wu (2020) – discussed in detail in appendix B.

3.1.2 Data Description

Table 1 reports the summary statistics for firm-level and macroeconomic variables employed in the analysis. Panel A (B) report the number of observations, the first, second and third quartile values, the mean, and the standard deviation for firm-level (macroeconomic) variables. All variables are defined in Appendix A. The natural logarithm of capital expenditure has a mean (standard deviation) value of 1.12 (2.38) and its growth rate has a mean value of 0.03 (1.06), showing a great degree of heterogeneity in my sample. The median firm in the sample has a size of $133 million measured using the book value of assets, a leverage ratio of 16.3%, sales growth rate of 2.3%, EBITDA to equity ratio of 9%, and the cash to assets ratio of 5.8%. The median value of the ratio of market to book value of assets

[7] I use the terms monetary policy surprise and monetary policy shock interchangeably.

is 1.58 in the sample.[8] The change in the effective Fed Funds rate (Δr_t^q) has a mean value of 2.84 bps during the sample period. The policy surprise shocks (ε_t^q-Tight) have a mean value of -1.20 bps over a tight window of 30 minutes around the FOMC announcements during the sample period. The variation in the monetary policy surprise shocks ranges from -14.31 bps to 13.03 bps.

3.1.3 Treatment and Control Firms

In this section, I discuss the definition of treated firms and the on-off variable – $1(Law_{st} = 1)$. Treatment assignment based on the state-wise passage of anti-recharacterization laws. Texas and Louisiana enacted the law in 1997, Alabama in 2001, Delaware in 2002, South Dakota in 2003, Virginia in 2004, and Nevada in 2005 (see table A.1). However, the 2003 ruling on the Reaves v Sunbelt case nullified the law. I follow Ersahin (2020) to define the treated and the control firms, as firms headquartered or incorporated in states that passed anti-recharacterization laws before 2002. Treated firms are firms headquartered or incorporated in Texas, Louisiana, or Alabama. The sample has a total of 8,224 unique firms, of which 11.3% are treated. Using this definition of treatment, I define an indicator variable, on-off variable - $1(Law_{st} = 1)$, that takes a value of 1 when the law is active for the treated firms and zero otherwise. As an example, for firms headquartered or incorporated in Texas the variable $1(Law_{st} = 1)$ will take a value of 1 (turn on) for all time periods from 1997 to 2003, and will take a value of 0 (turn-off) otherwise. This variable is always 0 for the control firms. The variable $1(Law_{st} = 1)$ takes a value of 1 for 5.5% of all observations in the sample.

3.2 Empirical Strategy

In this paper, I study the joint impact of the enactment of the law and aggregate monetary policy shocks. My baseline empirical specification is as follows:

$$\Delta log I_{it} = \beta_0 \cdot 1(Law_{st} = 1) \times \Delta\varepsilon_t^q + \beta_1 \cdot 1(Law_{st} = 1) + \gamma_i + \theta_{jt} + \Gamma Z_{it} + \nu_{it} \tag{2}$$

where i denotes a firm in state s, operating in industry j at time t. Industry is defined using the four-digit SIC code. The dependent variable is $\Delta log I_{it}$, measured as the change in log capital expenditure between t and t+1. $\Delta\varepsilon_t^q$ is the contemporaneous monetary policy surprises aggregated at quarterly level, γ_i and θ_{jt} denotes firm and industry-time fixed effects respectively. In robustness analysis, I also include Z_{it}, a vector of firm-specific characteristics: natural logarithm of the book value of assets,

[8]The sample runs from 1994 to 2007 which includes the period from 1997 to 2000 when the market valuation relative to the book valuation was at an historical all time high. See FRED.

leverage ratio, sales growth, average Q, cash to assets ratio and EBITDA to equity ratio. $1(Law_{st} = 1)$ is an on-off indicator variable discussed in section 3.1.3. The empirical strategy is similar to a difference-in-differences (DID) methodology but follows an on-off approach as in Li, Whited, and Wu (2016) and Ersahin (2020).

3.2.1 Identification

The objective of this paper is to identify the investment response of firms operating on different marginal cost curves to an aggregate unexpected shock. A valid test requires separating firms that operate on different marginal cost curves using variation that is independent of firms' investment opportunities. By comparing across firms within the same industry, I can control for firms' investment opportunities and identify the effect of financial constraints on the sensitivity of investment to monetary policy. I refer to this approach as "within-industry" estimation. Alternatively, one can also interpret β_0 as a within-firm estimator for the treatment group relative to the control group. Under this interpretation, the identifying assumption is that industry-time fixed effects fully control for aggregate industry-specific business-cycle fluctuations.

The key identifying assumption is that firms face identical investment opportunities within an industry. This is a reasonable assumption relying on the existence of a spatial equilibrium in investment opportunities as firms located in any state are free to engage in investment opportunities elsewhere. The latter follows from the fact that firms in my sample are listed firms with access to nationwide equity and debt markets, and operate under an open economy system. A weaker version of the identifying assumption is that any friction that prevents otherwise identical firms within an industry located in different states from having access to identical investment opportunities is unrelated to the financial frictions associated with creditor rights that these firms face.

4 Baseline Results

In this section, I discuss the baseline results evaluating the effect of monetary policy shocks on investment for the treated firms relative to the control firms.[9] The baseline results indicate that the investment of treated firms is more responsive to monetary policy shocks relative to the control firms indicating that financially unconstrained firms are more responsive to monetary policy shocks relative to financially constrained firms.

Table 2 reports the results from the estimation of equation 2 with change in the natural logarithm

[9] Appendix C discusses the aggregate effect of monetary policy shocks on firm investment and the impact of strengthening creditor rights on firm investment.

of capital expenditure as the dependent variable. Column (1) presents the results from the estimation of equation 2 with state and time fixed effects. The estimated coefficient of interest, the interaction term of $1(Law_{st} = 1)$ and $\Delta\varepsilon_t^q$, is -0.02. The estimate is significant at 1% confidence level and negative. Columns (2) and (3) re-estimate equation 2 with industry and industry-time fixed effects respectively. Finally, in column (4), equation 2 is estimated with firm and industry-time fixed effects. The point estimate of the interaction term in column (4) can be interpreted as a within-industry estimator while controlling for all time-invariant firm-specific observable and unobservable characteristics. The point estimates reported in columns (1) through (4) are all negative and statistically significant at the 1% level.[10] Moreover, the point estimate is extremely stable despite the increase in model R^2 from 22% to 32%. The point estimate suggests that the semi-elasticity of firm investment to monetary policy rate is ≈ 0.016 higher for the treated firms relative to the control firms. To put this in economic terms, a 25 bps expansionary monetary policy shock results in ≈ 2.03 pp higher investment growth among treated firms relative to the control firms.[11] The estimated differential impact between treated and control firms is economically significant given the average value of 2.6% investment growth for the sample.

Furthermore, to investigate the dynamics of the differential response of treated and control firms to monetary policy shocks over a long horizon, I estimate a Jordà (2005) local projection:

$$LogI_{i,t+h} - LogI_{i,t-1} = \beta_h^0 \cdot 1(Law_{st} = 1) * \Delta\varepsilon_t^q + \beta_h^1 \cdot 1(Law_{st} = 1) + \alpha_i + \theta_{jt} + \nu_{it} \tag{3}$$

where $h \geq 0$ indexes quarters in the future. The point estimate β_h^0 measures the cumulative response of investment in quarter $t + h$ to a monetary policy surprise in quarter t for treated firms relative to control firms. Christiano, Eichenbaum, and Evans (2005) and Gertler and Karadi (2015) find that the effects of monetary policy shocks on real activity appear slowly over time. Ottonello and Winberry (2020) find that the heterogeneous response of monetary policy appears immediately and disappears approximately six quarters after the shock. Figure 1 shows the heterogeneous impact of monetary policy surprises on treated firms relative to control firms over time. The β_h^0 appears immediately after the shock, increases for the next two quarters, starts reverting after 3 quarters, and disappears completely after 6 quarters from the initial policy surprise. The short-lived dynamics of β_h^0 are consistent with the results presented in Ottonello and Winberry (2020).

[10] The significance level is determined based on the standard errors computed using two-way clustering at the state (51 clusters) and quarter-year (54 clusters) level.

[11] One standard deviation of monetary policy surprise (4.75 bps) is associated with a 1.6 pp difference. The coefficient of the monetary policy surprise change from the the regression of effective Fed Funds rate on monetary policy surprise is 4.15. Hence, a 25 bps change in effective Fed Funds rate is associated with a $1.6 \times \frac{25}{4.75 \times 4.15} = 2.03$ pp difference.

4.1 Heterogeneous Treatment Effects

Recent advances in the differences-in-differences literature have documented that the standard DID estimator does not provide a valid estimand in a staggered treatment design in the presence of heterogeneous treatment effects. Specifically, Sun and Abraham (2021) note that standard staggered DID estimator is biased due to the “bad comparisons" problem when different treated cohorts likely experience different paths of treatment effect.

Baker, Larcker, and Wang (2022) provides a comprehensive overview of the challenges associated with the standard Difference-in-Differences (DID) estimator, discusses potential remedies, and offers practical guidance on how to tackle these challenges. They note that the bias due to heterogeneous treatment effects becomes more pronounced when there is significant variation in the timing of treatments or when the proportion of units that never receive treatment is small. The impact of these two sources of bias is expected to be minimal for this paper as the variation in treatment timing is limited and a substantial fraction of units never undergo treatment. Nevertheless, in line with the recommendation put forth by Baker, Larcker, and Wang (2022), we employ a “stacked regression” approach à la Gormley and Matsa (2011) to address the issue of treatment effects heterogeneity.[12]

Table 3 presents the results from the stacked regression. There are two treatment cohorts in the stacked regression. The first cohort consists of firms that underwent treatment in 1997, while the second cohort comprises firms that were treated in 2001. Furthermore, we use two sets of control firms. In Columns 1 and 2, the control group consists of firms that were either never treated or were treated after 2002. Columns 3 and 4 include only the subset of firms that were never treated as the control group. All regression models incorporate interactions between the baseline fixed effects and the cohort indicator variable. This inclusion ensures that our estimates represent weighted averages of differences between treatment and control groups within each cohort, mitigating the potential issue of “bad comparisons.” Columns 2 and 4 further refine the analysis by restricting the sample until the Reaves v. Sunblet decision in 2003. This adjustment makes the treatment variable similar to a conventional one-time treatment rather than an on-and-off indicator. The results indicate that our baseline finding is robust to issues arising due to treatment effect heterogeneity across treated cohorts.

[12]Using alternative estimators like those discussed in Borusyak, Jaravel, and Spiess (2021), Callaway and Sant'Anna (2021) and Sun and Abraham (2021) present a challenge due to the unique nature of the setting. First, the treatment is not a one-off treatment but it switches on and then off. All these estimators, except De Chaisemartin and d'Haultfoeuille (2020), assume that the treatment is permanent. Second, the primary focus of interest lies not in the coefficient related to the treatment itself, but rather in the interaction term between the treatment and the monetary policy shocks. The extension of these estimators to include the interaction term is non-trivial and beyond the scope of this paper.

4.2 Assessment of Pre-Trends

A key identifying assumption of the analysis is that the treatment and the control group would have evolved similarly absent the treatment. A suggestive way to test this assumption is to examine if the response of investment to monetary policy shocks for treated and control firms have common trends before the passage of the anti-recharacterization laws.

I evaluate this assumption following the recommendations presented in Baker, Larcker, and Wang (2022), i.e., I estimate a dynamic version of the stacked regression discussed in section 4.1. The control group consists of firms that were either never treated or treated after 2002. Furthermore, I restrict the analysis until the Reaves v. Sunbelt decision in 2003 as the empirical design is an on-off strategy. This sample cut allows me to do a standard pre-trends assessment.

Figure 2 provides a visual presentation of the trend in the impact of monetary policy surprises on firm investment across treated and control firms in the years before and after the enactment of anti-recharacterization laws. I do not observe substantial differences in investment response to monetary policy shocks for the treated and control firms in periods preceding the adoption of laws.

4.3 Robustness Checks

In this section, I conduct a battery of robustness tests to ensure the stability and validity of the baseline results.

Identifying Assumption: Industry leaders may have access to better investment opportunities. Moreover, industry leaders could be more responsive to monetary policy shocks (Kroen, Liu, Mian, and Sufi, 2021; Liu, Mian, and Sufi, 2021). This concern poses a threat to my identification assumption that all firms within a four-digit SIC industry code face identical investment opportunities. I address this concern directly by comparing treated and control firms within the same four-digit SIC industry and the same sales; assets; property, plant, and equipment decile by including $Industry \times Size - Decile \times PP\&E - Decile \times Sale - Decile \times Qtr - Year$ fixed effect. Appendix table D.1 reports these results for different combinations of the interaction fixed effects of industry-time and sales; assets; and property, plant, and equipment decile. Across all columns, the results are qualitatively similar to our baseline results reported in table 2.

Addressing Endogeneity of Law – Falsification Test: The identification strategy relies on the quasi-randomness of the enactment of anti-recharacterization laws. The enactment could be contaminated by state-specific conditions if the enactment of the law in a state can be attributed to the firms in that state.

This is unlikely to be true, especially for my sample of non-financial firms as noted by Kettering (2008) and Janger (2003). To further assess the validity of this argument, I conduct a falsification test using a group of treated firms that should not exhibit treatment effect. The *Reaves v. Sunbelt* court decision of 2003 came as a huge blow to the relevance of anti-recharacterization laws for non-financial firms. However, some states continued to pass these laws after 2003 to aid the securitization industry. South Dakota, Virginia and Nevada (late states) enacted these laws in 2003, 2004 and 2005 respectively. The indicator variable for firms in this treatment group is identified as $1(Post - 2003_{st} = 1)$, switching to one indefinitely since the enactment of the law for firms headquartered or incorporated in the late states. If the setting is truly quasi-random, the firms headquartered or incorporated in these states are treated but should not exhibit the treatment effect. Appendix table D.2 reports the results of the falsification test and find results similar to the ones reported in column 4 of table 2.

Other Robustness Tests: Additionally, I conduct a battery of robustness tests that examine the robustness of the estimate to – (1) alternative measures of monetary policy shocks, (2) sensitivity of the estimate in the context of Oster (2019) framework, (3) the robustness of the estimate to controlling for firm-specific covariates and their interaction term with monetary policy shocks, (4) the robustness of the estimate to controlling for the interaction term of the treatment variable with other macroeconomic shocks, (5) the robustness to using alternative samples that refine the control group to better match the treatment group, and (5) a placebo test to address the issue that the point estimate of the interaction term may capture a spurious relationship. Appendix section D.1 discusses these results. Overall, the baseline results are robust to these tests.

5 Mechanism

In this section, I examine the underlying forces that drive the baseline results. First, I show that the results are driven by conventional policymaking, referred to as the pure monetary policy effect, and not driven by unconventional forms of policymaking such as forward guidance, referred to as the Fed (central bank) information effect. Second, the baseline results appear to be concentrated among firms operating in sectors with fixed or intangible assets available for secured lending. Third, the effect is stronger for firms with greater ex-ante likelihood of using an SPV. Lastly, I discuss the differences in the channel highlighted in this paper with the one discussed in Ottonello and Winberry (2020).

5.1 Pure Monetary Policy Effect & Fed Information Effect

The usage of narrow windows around the FOMC announcement enables identification of pure monetary policy shocks under the assumption that no other news is systematically released. However, Romer and Romer (2000), Nakamura and Steinsson (2018a), and Jarociński and Karadi (2020) among others, have called this assumption into question. The literature on the Fed information effect posits that the Federal Reserve systematically reveals new information in its meeting announcements, in addition to the pure monetary policy news. The new information may contain private information on the economy, Feds' preferences, or the model it uses to analyze the economy. Hence, the monetary policy shocks measured in the narrow window may be correlated with changes in non-monetary policy economic fundamentals such as changes in uncertainty. Therefore, to identify the effect of loosening of financing costs due to monetary policy shocks, it is important to differentiate between the two effects.

The narrow window shocks used thus far are likely to capture the effect of monetary policy rather than the Fed information effect for three reasons. First, the Fed information effect does not seem to be dominant during my sample period. Faust, Swanson, and Wright (2004) argue that the Fed information effect is concentrated among intermeeting announcements. However, there were barely any intermeeting decisions pre-financial crisis (Gorodnichenko and Weber, 2016). Second, Jarociński and Karadi (2020) argue that the stock market and interest rates would negatively co-move under the pure monetary policy effect, and positively co-move under the Fed information effect. The correlation between the stock returns (measured by S&P 500 Index returns) and interest rates (measured by monetary policy surprises) was -62% during the sample period from 1994 till 2007. The same correlation for the period between 2008 and 2016 was -25%, indicating that the Fed information effect became dominant only after 2007 with the adoption of unconventional monetary policy. Third, if the narrow window shocks reflect the Fed information effect, then the aggregate uncertainty in the economy should decrease following FOMC announcements. Alfaro, Bloom, and Lin (2018) and Favara, Gao, and Giannetti (2021) argue that constrained firms are more responsive to the resolution of uncertainty relative to unconstrained firms. Hence, the contamination of my baseline shocks due to the presence of Fed information effect is likely to understate the true effect as constrained firms are likely to be more responsive to the resolution of uncertainty.

I further address this issue by employing the monetary shock series constructed in Jarociński and Karadi (2020) and Bu, Rogers, and Wu (2020).[13] These alternative shock series measure the pure

[13] I refer the reader to appendix B for details on the construction and properties of these measures.

monetary policy effect. Bu, Rogers, and Wu (2020) filter out the pure monetary policy component from the Fed information component using the methodology of Rigobon and Sack (2003) under the assumption that the variance of the Fed information component exhibits homoscedasticity. Jarociński and Karadi (2020) exploit the negative and positive co-movement between interest rates and stock prices to disentangle the pure monetary policy effect from the Fed information effect. Appendix table E.1 compares the estimate on the interaction term for pure monetary policy effects of Bu, Rogers, and Wu (2020) and Jarociński and Karadi (2020) in columns (2) and (3), respectively, with the baseline monetary policy surprise measure in column (1). The coefficient of the interaction term associated with the Bu, Rogers, and Wu (2020) shocks is higher in magnitude than the coefficient of the interaction term associated with the baseline shocks. The coefficient of the interaction term associated with Jarociński and Karadi (2020) shocks is smaller but the standard deviation for these shocks is small, almost half the standard deviation of baseline shocks, rendering them with little predictive power (Nakamura and Steinsson (2018a)). Overall, the results indicate that the baseline estimates reported in table 2 are unlikely to be driven by the Fed information effect.

5.2 Within-Sector Results

This section discusses the cross-sectional response of firms to monetary policy surprises given the treatment shock within sectors.[14] This analysis fosters a better understanding of the underlying mechanism. The enactment of these laws improved the protection of creditor rights in the case of secured lending. Some sectors such as construction, mining and manufacturing due to the nature of their operation have a greater stock of tangible and fixed assets on their balance sheets, and are more likely to finance their operations via secured borrowing (Lian and Ma, 2021). Other sectors such as services have a higher stock of patents which also benefit from greater creditor rights protection (Mann, 2018). Hence, if the results are driven by the change in the level of financial constraints because of the enactment of anti-recharacterization laws then the baseline results should be driven by such sectors which posses tangible and intangible assets that can be pledged.

Figure 3 and appendix table E.2 report the results for sector-specific point estimates of the interaction term of law and monetary policy surprise.[15] The baseline result seems to be driven by the mining, manufacturing, and the services sector. Among these sectors, mining has the highest

[14] I refer to the 4-digit SIC as industry and 2-digit SIC as sector throughout.

[15] The cross-sectional splits for this test are based on the broader 2-digit SIC industry classification. The broader industry classification still allows me to control for narrow 4-digit SIC industry-time fixed effects within each 2-digit SIC industry.

magnitude, followed by services and manufacturing, respectively. However, the estimates for the three sectors are statistically indistinguishable from each other.

The enactment of anti-recharacterization laws improved creditor rights for all forms of secured lending. Prior research has shown that in addition to impacting investments, such as new equipment, machinery, and IT (Ersahin, 2020), the enactment of anti-recharacterization laws also has an effect on intangible investments such as research and development (Favara, Gao, and Giannetti, 2021). I complement the extant literature by investigating the effect of anti-recharacterization laws on investment for research and development.[16] These results are reported in Appendix table E.3. The results indicate an increase in research and development spending for both the manufacturing and services sectors. Results reported in Panel A of Appendix table D.3 (column 3) provide further support to the argument that investment in intangibles increases after the enactment of anti-recharacterization laws. This result is consistent with the findings of Favara, Gao, and Giannetti (2021).

5.3 SPV Usage and the Effect

Anti-recharacterization laws improve access to debt markets for firms with access to SPVs. This section explores whether the response of firm investment growth to monetary policy shocks after the passage of anti-recharacterization laws is related to the likelihood of SPV usage. I predict the likelihood that a firm employs an SPV using firm-level characteristics such as market-to-book ratio, cash flow ratio, liquidity ratio, acquisitions to assets ratio and research and development expenses.[17] The likelihood of SPV usage of firms is a time-invariant estimate. I use the estimate before the law was enacted to avoid concerns of endogeneity, i.e., one year before the passage of the law for the treated firms, and 1996 for the control firms. A firm is defined to have a high likelihood of having an SPV if its predicted probability is greater than the sample median. Table 4 tests whether firms with a high likelihood of having an SPV have a greater sensitivity of firm investment growth to monetary policy shocks after the passage of anti-recharacterization laws. The coefficient of the triple interaction term, $High - SPV \times 1(Law_{st} = 1) \times \Delta\varepsilon_t^q$, is negative and statistically significant. An added advantage of this test is that it allows me to use state × industry × quarter × year fixed effects effectively comparing firms, with ex-ante high and low likelihood of SPV usage, in the same four-digit SIC industry within a state (see columns 4 and 5). The inclusion of state-industry-time fixed effects helps alleviate a myriad

[16] I restrict this analysis to the manufacturing and services sectors because the data on research and development expenses is unavailable for most firms in other sectors. For example, in the construction sector, when using the baseline specification with firm and industry × time fixed effects, I am left with just 243 observations in my sample.

[17] I am grateful to Laura Xiaolei Liu and Mike Mao for sharing their data on firms' usage of SPVs employed in Lemmon, Liu, Mao, and Nini (2014).

of concerns related to the endogeneity of the enactment of anti-recharacterization laws. This test implies that the effect of monetary policy shocks on investment growth is largest for the treated firms with higher ex-ante likelihood of SPV usage. This implication is consistent with the conjecture that anti-recharacterization laws improve access to debt markets for firms with access to SPVs.

5.4 How Do Firms Finance their Investment?

The results so far indicate that the investment of unconstrained firms is more responsive to monetary policy shocks. This section discusses how unconstrained firms finance their increased investment relative to similar but more constrained firms following a relaxation of monetary policy. Specifically, table 5 documents an increase in debt growth for unconstrained firms, relative to constrained firms, following a relaxation of monetary policy. Columns 1-4 show an increase in debt growth among treated firms relative to control firms following expansionary monetary policy shocks. This increase is statistically significant and indicates that the semi-elasticity of debt to monetary policy for the treated firms is 1 percentage point (pp) higher than control firms during the law's active period relative to the non-active period. Moreover, this semi-elasticity is higher for firms with a higher likelihood of SPV usage. This test implies an increase in debt for treated firms relative to the control firms following expansionary monetary policy shocks. Furthermore, the effect on debt growth is higher for firms with a higher likelihood of SPV usage, which are likely to benefit more from the anti-recharacterization laws.

5.5 Effect during the 2001 Recession

The baseline results show that unconstrained firms are more responsive to monetary policy shocks relative to constrained firms. I argue that this effect is driven by firms with a flatter marginal cost (MC) curve of investment (unconstrained firms) being more responsive to movements in the marginal benefit (MB) curve of investment relative to firms with a steeper MC curve of investment (constrained firms). While this is a difficult proposition to test empirically, periods of recessions may provide a potential setting to provide some suggestive empirical evidence. The movement in the MB curve of investment due to monetary policy shocks is attenuated during periods of economic downturn, when investment opportunities are scarce, or the aggregate demand is low. Hence, monetary policy shocks are likely to leave the MB curve largely unchanged. Hence, constrained firms could potentially be more responsive than unconstrained firms as the flattening of the MC curve is the dominant force during such periods. Moreover, Kashyap, Lamont, and Stein (1994) argue that the financial conditions are more binding during recessionary periods. Hence, periods of recession are ideal to test for the presence of a financial accelerator effect.[18]

The 2001 recession was an eight month long economic downturn starting in March of 2001 and ending in December of 2001. The stock prices and the valuation of many dot-com businesses declined while several went bankrupt. This economic downturn was worsened by the 9/11 attacks. The Fed had previously raised the Fed Funds rate three times reaching 6.5% in May of 2000. However, following the downturn, the Fed reduced interest rates drastically during 2001 resulting in the Fed Funds rate dropping to 1.75% by January of 2002. This episode is similar in conditions and context to the historical episodes of Romer and Romer (1990) used in Gertler and Gilchrist (1994) and Kashyap, Lamont, and Stein (1994). I use the period from the second quarter of 2001 until the end of the year to evaluate the cross-sectional response to monetary policy shock during this period of economic downturn.

Table 6 reports the estimation results showing that constrained firms are more responsive to monetary policy shocks, relative to unconstrained firms, during periods of economic downturn. The point estimate of the triple interaction term of the law, monetary policy surprises and the recession is positive and statistically significant at 1% level. The interaction term of the law with monetary policy surprises remains negative and statistically significant as in the baseline results. As expected the interaction term of the law with the recession is positive and statistically significant indicating that constrained firms are more hit by the recession relative to the unconstrained firms. The Wald F-statistic for the null $1(Law_{st} = 1) \times \Delta\varepsilon_t^q \times Recession + 1(Law_{st} = 1) \times \Delta\varepsilon_t^q + 1(Law_{st} = 1) \times Recession + 1(Law_{st} = 1) = 0$ is 13.21, significant at 1% level. The Wald F-statistic for the null $1(Law_{st} = 1) \times \Delta\varepsilon_t^q \times Recession + 1(Law_{st} = 1) \times Recession = 0$ is 12.49, significant at 1% level. Therefore, constrained firms seem to be more responsive to monetary policy shocks during periods of economic downturn relative to unconstrained firms.

5.6 Alternative Explanation: Distress Risk

This paper documents the effect of financial constraints arising from the enactment of anti-recharacterization laws which is a shock to firms' collateralized debt capacity. Ottonello and Winberry (2020) focus on

[18] I want to acknowledge that a caveat of this analysis is that it only offers suggestive evidence supporting the MC/MB mechanism. During such episodes, numerous other factors change, and it is challenging, if not impossible, to address all of these concerns completely. However, a key point to discuss is if this change in the result during the 2001 economic downturn is really driven by a lack of investment opportunities. The National Federation of Independent Businesses (NFIB) surveys indicate that there was a substantial increase in the fraction of small businesses citing poor sales as the biggest worry during the 2001 downturn. Meanwhile, there was little change in the fraction of small businesses (most credit-dependent businesses), citing financing and interest rates as a cause of worry both during the 2001 economic crisis (see, appendix figure E.1).

a different channel arising from a firm's distress risk. However, distress risk may act as a confounding channel and better debt access could also influence default risk.

I start by examining the effect of the enactment of anti-recharacterization laws on firms' distress risk. I estimate firm-level distance to default based on the methodology outlined in Gilchrist and Zakrajšek (2012). Appendix table E.4 reports the results. The estimate associated with the interaction term is statistically significant and negative, indicating a decline in financial constraint in the context of Ottonello and Winberry (2020). However, the economic magnitude is small and is equivalent to 0.30% of the standard deviation and 0.26% of the mean value of the distance to default. Moreover, moving from column (1) to (4), the magnitude of the estimate decreases from 0.01 to 0.003, while the model R^2 increases from 15% to 71%. This comparison of the relative changes in estimates with model R^2 under the Oster (2019) framework indicates that the Oster set includes zero, suggesting that the estimate of interest may not be economically significant. Overall, this analysis suggests that the effect of the enactment of these laws may have been economically small on firms' distress risk.

Next, I directly control for the distance to default and the associated interaction terms to run a horse race. Table 7 reports the results. Column 1 controls for contemporaneous distance to default. Column 2 controls for the interaction terms associated with the contemporaneous distance to default. Column 3 controls for the interaction terms associated with the static distance to default. The static distance to default is measured based on the average value in the year before the enactment of the law for the treated group, and in 1996 for the control group. Across all columns, the estimate of interest associated with the interaction term $1(Law_{st} = 1)$ and $\Delta\varepsilon_t^q$ is statistically significant and qualitatively similar to the baseline estimates. These results suggest that the channel presented in this paper is robust to controlling for confounding factors such as firm default risk.

6 Model

This section presents a heterogeneous firm New Keynesian model. The model adds to the analysis by allowing me to study the relative quantitative importance of the marginal benefit and the marginal cost channels in driving the cross-sectional result. Moreover, the model also allows me to examine the effect of the enactment of anti-recharacterization laws on collateral constraint. This analysis is important for two reasons. First, it adds texture to the reduced-form analysis, by using the model to measure the change in collateral constraint parameter. Second, it allows me to provide evidence supporting the assumption that the strengthening of creditor rights reduces the marginal cost of firms, which makes them less financially constrained. Finally, it is worth noting that the reduced-form analysis alone would not have been able to quantify the effect of the laws on collateral constraint and the relative quantitative importance of the marginal benefit and the marginal cost channels.

Model Overview: The model has three key ingredients. The first ingredient captures the heterogeneous response to monetary policy. This ingredient builds on the flexible price model presented in Khan, Senga, and Thomas (2016) by incorporating sticky prices and aggregate adjustment costs, which generate temporal variation in the relative price of capital à la Bernanke, Gertler, and Gilchrist (1999). The second ingredient borrows heavily from Ottonello and Winberry (2020) and introduces three important forces in the model. First, the retailers set prices and face price adjustment costs. Second, the central bank sets the nominal risk-free interest rate according to the Taylor rule. Third, a New Keynesian Philips curve that allows relating nominal variables to the real economy. Finally, the third ingredient models a representative household to derive the stochastic discount factor and close the model. Time is discrete and infinite, and there is no aggregate uncertainty in the model. Next, we discuss all players in detail.

6.1 Firms

Each firm produces an undifferentiated good y_{jt} using the capital stock k_{jt} and by hiring labor l_{jt} from a competitive labor market at real wage w_t. The firm's production function is

$$y_{jt} = z_{jt} k_{jt}^{\alpha} l_{jt}^{\eta}; \quad \alpha + \eta < 1$$

where z_{jt} is an idiosyncratic total factor productivity (TFP) shock which follows a log-AR(1) process $\log z_{jt+1} = \rho \log z_{jt} + \varepsilon_{jt+1}$, with $\varepsilon_{it+1} \sim N\left(0, \sigma^2\right)$.

Firms sell their output to retailers in a competitive market at a relative price p_t expressed in terms of the final good (numeraire). The firm's profit before taking decisions on the next period capital and debt is output minus the labor cost given by the following expression, where p_t is the relative price of output.

$$\pi_{jt}\left(z_{jt}, k_{jt}\right) = \max_{l_{jt}} \left\{ p_t z_{jt} k_{jt}^{\alpha} l_{jt}^{\eta} - w_t l_{jt} \right\}$$

Timeline: The idiosyncratic shocks to TFP are realized at the beginning of each period. Firms must pay back the face value of their outstanding debt (b_{jt}). Firms purchase new capital at a relative price q_t. Firms have two sources of investment finance, both of which are subject to a friction. First, firms can issue new one-period nominal debt with real face value $b_{jt+1} = \frac{B_{jt+1}}{P_t}$ subject to an exogenous collateral constraint, where B_{jt+1} is the nominal face value and P_t is the nominal price of the final good. Second, firms can use internal finance by lowering dividend payments d_{jt} but cannot issue new equity, which bounds dividend payments $d_{jt} \geq 0$. The second constraint captures the direct flotation costs and indirect costs that firms face in issuing new equity. This assumption is supported by the fact that firms rarely issue external equity. The three state variables of a firm are its idiosyncratic productivity z, capital k, and debt b.

There is no default in the model. Specifically, firms cannot renege on the debt contract and must pay back the outstanding debt by selling their capital stock. The price of the debt issued by firms is equal to the inverse of the equilibrium interest rate (nominal) R_t. All the firms face the same debt pricing schedule because firms are risk-free. This feature of debt being risk-free can be attributed to the presence of collateral constraint and the absence of significant aggregate shocks or idiosyncratic capital quality shocks. This characteristic is common across a wide range of dynamic investment models, from the seminal work of Kiyotaki and Moore (1997) to more recent studies like Li, Whited, and Wu (2016).

6.1.1 Solution to the Firm Problem

Let $v_t(z, k, b)$ be the value of the firm. The firm decides on the optimal investment $k'(z, k, b)$ and borrowing $b'(z, k, b)$ decisions by solving the following Bellman equation.

$$v_t(z,k,b) = \max_{k',b'} \left\{ \underbrace{\pi_t(z,k) + q_t(1-\delta)k - q_t k' - \frac{b}{\Pi_t} + \frac{1}{R_t}b'}_{\text{dividend } (d)} + \mathbb{E}_t\left[\Lambda_{t+1} v_{t+1}(z',k',b')\right] \right\} \tag{4}$$

subject to:

$$\theta(1-\delta)q_t k' \geq \frac{1}{R_t}b' \tag{5}$$

$$d \equiv \pi(z,k) + q_t(1-\delta)k - q_t k' - \frac{b}{\Pi_t} + \frac{1}{R_t}b' \geq 0 \tag{6}$$

where Λ_{t+1} is the stochastic discount factor, $\Pi_t = \frac{P_t}{P_{t-1}}$ is realized gross inflation, δ is the depreciation, and θ is the collateral constraint parameter. The collateral constraint as in 5 indicates that the firm can borrow up to a fraction θ of the expected value of physical capital. Li, Whited, and Wu (2016) note that such a formulation of collateral constraint reflects common borrowing practices and aligns with the types of financial contracts we typically see in the real world.[19]

Firms' problem can be simplified by defining the net wealth or net worth of the firm as $n(z,k,b)$, i.e., $n_t(z,k,b) = \pi_t(z,k) + q_t(1-\delta)k - \frac{b}{\Pi_t}$. This transformation reduces the number of state variables from three (z,k,b) to two (z,n) i.e., the solution to the firms' problem depends only on their net worth and idiosyncratic productivity. See Appendix F.1 for details.

Lemma 1: Consider a firm at time t, with idiosyncratic productivity z and net worth n. The firm's optimal decision is characterized by one of the following three cases, see Appendix F.2 for details:
(i) **Unconstrained Firms**: A firm is financially unconstrained if $n > \bar{n}_t(z)$. Unconstrained firms solve $q_t = \mathbb{E}_t\left[\Lambda_{t+1} MRPK_{t+1}\left(z', k_t^*(z)\right) \mid z\right]$ and follow the *frictionless* capital accumulation policy $k_t'(z,k,b) = k_t^*(z)$, where $MRPK_{t+1}(z',k') = \frac{\partial}{\partial k'}\left(\pi_{t+1}(z',k') + q_{t+1}(1-\delta)k'\right)$ is the return on capital to the firm. Unconstrained firms are indifferent over any combination of b' and d such that they remain unconstrained for every period with probability one. Unconstrained firms can implement both the optimal amount of capital and the minimum savings policy that guarantees these firms remain unconstrained in the future (Khan, Senga, and Thomas, 2016; Ottonello and Winberry, 2020).
(ii) **Less Financially Constrained Firms**: A firm with $n \in \left[\underline{n}_t(z), \bar{n}_t(z)\right]$ is less financially constrained. Less financially constrained firms with optimal investment $k_t'(z,k,b)$ and borrowing $b_t'(z,k,b)$ decisions solve the Bellman equation with binding non-negativity dividend constraint but are not subject to a binding collateral constraint. These firms can implement the optimal amount of capital, $k_t^*(z)$, but not the minimum savings policy and are therefore less financially constrained. These firms prioritize retaining resources over distributing dividends to households, leading them to choose zero dividends, to avoid facing constraints in the next period. Their debt decision is: $\frac{1}{R_t}b' = qk_t^*(z) - n$.
(iii) **More Financially Constrained Firms**: A firm with $n < \underline{n}_t(z)$ is more financially constrained. More financially constrained firms with optimal investment $k_t'(z,k,b)$ and borrowing $b_t'(z,k,b)$ decisions solve the Bellman equation with binding collateral and dividend non-negativity constraints. These firms can not implement the optimal amount of capital and utilize all their borrowing capacity. Their capital decision is $k' = \frac{1}{(1-\theta+\theta\delta)q}n$, which is strictly smaller than their optimal level of capital $k_t^*(z)$, and their debt decision is $\frac{1}{R_t}b' = \frac{\theta(1-\delta)}{(1-\theta+\theta\delta)}n$.

[19]For example, most loans are taken out with a clear intention to use the funds to purchase an asset, and some are secured by that asset. Additionally, credit lines and term loans typically have a maximum limit determined by the borrowing base, comprising of pledgeable assets.

6.2 Aggregation and Monetary Policy

This section introduces three important forces in the model and borrows from the setup presented in Ottonello and Winberry (2020). First, the retailers set prices and face price adjustment costs. Second, the central bank sets the nominal risk-free interest rate according to the Taylor rule. Third, a New Keynesian Philips curve that allows me to relate nominal variables to the real economy.

6.2.1 Retailers

There is a fixed mass of retailers $i \in [0, 1]$ producing differentiated variety $\widetilde{y}_{it}$. Retailers use the heterogeneous production firms' good as their only input: $\widetilde{y}_{it} = y_{it}$. y_{it} is the amount of the undifferentiated good demanded by retailer i. Retailers set a relative price for their variety $\widetilde{p}_{it}$ but must pay a quadratic price adjustment cost $\frac{\varphi}{2}\left(\frac{\tilde{p}_{it}}{\tilde{p}_{it-1}} - 1\right)^2 Y_t$, where Y_t is the final good.

6.2.2 Final Good Producer

The retailers' demand curve is generated by the representative final good producer, which has production function $Y_t = \left(\int \widetilde{y}_{it}^{\frac{\gamma-1}{\gamma}} \mathrm{d}i\right)^{\frac{\gamma}{\gamma-1}}$, where γ is the elasticity of substitution over intermediate goods. This final good is the numeraire.

6.2.3 New Keynesian Phillips Curve

The retailers and final good producers aggregate into the New Keynesian Phillips Curve:

$$\log \Pi_t = \frac{\gamma - 1}{\varphi} \log \frac{p_t}{p^*} + \beta \mathbb{E}_t \log \Pi_{t+1},$$

where $p^* = \frac{\gamma-1}{\gamma}$ is the steady state relative price of the heterogeneous production firm output. The Phillips Curve links this section of the model to the investment block through relative prices – p_t. Retailers increase production of their differentiated goods when aggregate demand for the final good increases. Nominal rigidities increase the demand for the heterogeneous firms' goods, which increases their relative price and generates inflation.

6.2.4 Capital Good Producer

There is a representative capital good producer who produces new aggregate capital using the technology $\Phi\left(\frac{I_t}{K_t}\right) K_t$, where I_t are units of the final good used to produce capital, $K_t = \int k_{jt}\, \mathrm{d}j$ is the aggregate capital stock at the beginning of the period, $\Phi\left(\frac{I_t}{K_t}\right) = \frac{\delta^{1/\phi}}{1-1/\phi}\left(\frac{I_t}{K_t}\right)^{1-1/\phi} - \frac{\delta}{\phi-1}$, and δ

is the steady-state investment rate. Profit maximization pins down the relative price of capital as $q_t = \left(\frac{I_t/K_t}{\delta}\right)^{1/\phi}$.

6.2.5 Monetary Policy Authority

The central bank or the monetary policy authority sets the nominal risk-free rate in the economy. The central bank follows the Taylor rule $\log R_t = \log \frac{1}{\beta} + \varphi_\pi \log \Pi_t + \varepsilon_t^m$, where R_t is the nominal risk-free rate, φ_π is the weight on inflation in the reaction function, and $\varepsilon_t^m \sim N\left(0, \sigma_m^2\right)$, is the unexpected monetary policy shock.

6.3 Household

Finally, I introduce the household block that allows me to derive the stochastic discount factor and close the model. There is a representative household with preferences over consumption C_t and labor supply L_t, and has the following utility function, $U = E_0 \sum_{t=0}^{\infty} \beta^t \left(\log C_t - \Psi L_t\right)$, where β is the discount factor and Ψ controls the disutility of labor supply. The utility function is subject to the following budget constraint:

$$P_t C_t + \frac{1}{R_t} B_t \leq B_{t-1} + W_t L_t + \text{Profits}$$

where P_t is the price index, R_t is the nominal interest rate, and B_t is one period bond. The stochastic discount factor is linked to the firms' problem through the Euler equation for bonds which is as follows:

$$\Lambda_{t,t+1} = \frac{1}{R_t} \frac{P_{t+1}}{P_t} = \frac{\Pi_{t+1}}{R_t}$$

An equilibrium in this economy is defined as a set of value functions $v_t(z,n)$; optimal firm policies $\left\{k_t'(z,n), b_t'(z,n), l_t(z,n)\right\}$; prices $\{w_t, q_t, p_t, \Pi_t, \Lambda_{t+1}\}$; and the distribution of firms $\mu_t(z,n)$ that solves the firms' problem, the household's optimization problem, retailers' optimization problem, and labor market and goods market clear. See Appendix F.3 for details.

6.4 Channels

The objective of this exercise is to quantitatively analyze the relative effects of monetary policy surprises – given by the innovations (ε_t^m) to the Taylor rule – on constrained and unconstrained firms, and characterize the channels through which monetary policy affects firm investment. Specifically, movements in the marginal cost curve and the marginal benefits curve are the two channels through which monetary policy affects firm investment. We focus on the more constrained firms for this analysis. These firms face a binding collateral and a binding dividend non-negativity constraint. The optimal capital and debt decisions are therefore given by the following first order conditions (see Appendix F.1):

$$q_t k' = n + \frac{1}{R_t} b' \tag{7}$$

$$\frac{1}{R_t} b' = \theta(1-\delta) q_t k' \tag{8}$$

$$\begin{aligned} &\mathbb{E}_t \left[1 + \lambda^D_{t+1} \left(z', n_{t+1} \left(z', k', b' \right) \right) \right] q_t + \lambda^C_t (1 - \theta(1-\delta)) q_t \\ &\qquad = \frac{\Pi_{t+1}}{R_t} \mathbb{E}_t \left[\mathrm{MRPK}_{t+1} \left(z', k' \right) \left(1 + \lambda^D_{t+1} \left(z', n_{t+1} \left(z', k', b' \right) \right) \right) \right] \end{aligned} \tag{9}$$

6.4.1 Marginal Cost Curve

Equation 9 indicates that the marginal cost (MC) is given by the following expression:

$$MC = q_t \left(1 + \mathbb{E}_t \left[\lambda^D_{t+1} \right] + \lambda^C_t (1 - \theta(1-\delta)) \right)$$

The MC is the sum of three components. The first component is the relative price of capital. This term represents the MC curve for unconstrained firms. The second and third terms represent the marginal costs related to the tightening of the dividend non-negativity constraint and the collateral constraint, respectively. These terms indicate that the marginal cost of capital is always higher for constrained firms than for unconstrained firms. Moreover, capital and debt accumulation are attenuated in a model with collateral constraint. Lastly, marginal cost decreases with an increase in the collateral constraint parameter θ, i.e., firms with higher θ have a flatter MC curve.

Monetary policy shocks affect the MC curve through two forces. First, these shocks affect the aggregate investment demand changing the relative price of capital. The change in the relative price of capital further affects the MC curve due to the presence of dividend non-negativity and collateral constraints. Second, monetary policy shocks affect firms' net worth, which changes the amount the firm needs to borrow to finance any level of investment. This further affects the expected shadow value of firms' resources. The flattening of the MC curve following a monetary policy shock – and its subsequent impact on investment – is more pronounced for constrained firms and is similar in spirit to the financial accelerator effect presented in Bernanke, Gertler, and Gilchrist (1999). Particularly, an increase in the collateral constraint parameter, θ, attenuates the impact of monetary policy shocks on firms' marginal cost.

6.4.2 Marginal Benefit Curve

The marginal benefit (MB) curve is given by the following expression:

$$MB = \mathbb{E}_t \left[\frac{\Pi_{t+1}}{R_t} \cdot \mathrm{MRPK}_{t+1}(z', k') \cdot \left(1 + \lambda_{t+1}^D\right) \right]$$

where R_t is the nominal risk-free rate between t and $t+1$, λ_{t+1}^D is the Lagrange multiplier on the dividend non-negativity constraint. Therefore, the MB curve is the sum of two terms. The first term is the expected return on capital discounted by the real interest rate. The second term captures the covariance of the return on capital with the firm's shadow value of resources. The MB curve is downward sloping due to diminishing returns to capital. Monetary policy shocks affect the MB curve through three channels. First, monetary policy shocks change the real interest rate, affecting the firm's discount rate and the discounted return on capital. Second, monetary policy shocks affect the relative price of output, real wages, and the relative price of capital. Third, monetary policy shocks affect the covariance term. Finally, the effect of the monetary policy shocks on investment due to movements in the MB curve is more pronounced for firms with a flatter MC curve of investment and is similar in spirit to the effect presented in Ottonello and Winberry (2020).

The key difference between this model and the model presented in Ottonello and Winberry (2020) is the source of financial frictions arising due to constraints on firms' collateralized debt capacity. On the one hand, firms with more relaxed collateral constraints tend to have flatter MC curve. Consequently, the movements in the MB curve due to monetary policy shocks can amplify the effect for such firms. On the other hand, monetary policy shocks can flatten the MC curve for firms facing tighter collateral constraints, amplifying the effect for such firms.

6.5 Calibration

Next, I discuss model calibration. Table 8 presents the values for the fixed parameters. The capital and labor coefficients are set to $\alpha = 0.21$ and $\nu = 0.64$, which together imply a total returns to scale of 85%. The depreciation rate is fixed at $\delta = 0.025$ per quarter, corresponding to the model's quarterly period. Following Bernanke, Gertler, and Gilchrist (1999), the curvature of aggregate adjustment costs ϕ is set to 4. The elasticity of substitution in final goods production γ is assigned a value of 10, resulting in a steady-state markup of 11%. Following Kaplan, Moll, and Violante (2018), the coefficient on inflation in the Taylor rule φ_π is set at 1.25, and the price adjustment cost parameter φ

is set at 90, which produces a Phillips Curve with a slope of 0.1. Lastly, the discount factor β is set at 0.99. Appendix F.4 presents an overview of the calibration procedure.

6.5.1 Identification

The remaining parameters are the persistence of the TFP shock ρ, the standard deviation of the innovations to the TFP shock process σ, and the collateral constraint parameter θ. The first two parameters (ρ, σ) govern the firm's idiosyncratic shock process and the last parameter θ governs the frictions associated with the firm's financing decisions.

I calibrate these parameters by targeting the empirical moments in table 9. Specifically, I focus on three moments – the standard deviation of the investment rate, the average of the gross leverage ratio, and the fraction of firms with positive debt – that are calculated using the data to identify the fitted parameters. The standard deviation of investment rate is sensitive to the standard deviation of the TFP shock process. The fraction of firms with positive debt is more sensitive to the collateral constraint parameter governing the firm's financial frictions. Moreover, I find that all the parameters are sensitive to the standard deviation of the investment rate and the collateral constraint parameter is highly sensitive to average gross leverage.

I follow the methodology outlined in Andrews, Gentzkow, and Shapiro (2017) for the identification of fitted parameters. Specifically, I calculate the local elasticities of moments with respect to model parameters, as well as the elasticities of the calibrated parameters with the targeted moments. This exercise helps to understand the parameter identification in the calibration exercise. Panel A of table 11 presents the local elasticities of the moments that are targeted with respect to the calibrated parameters (σ, θ). The findings indicate that the standard deviation of the TFP shock process significantly impacts the targeted moments. Specifically, it increases the standard deviation of investment rates while reducing the average gross leverage ratio and the fraction of firms with positive debt. The fraction of firms with positive debt shows high sensitivity to the collateral constraint parameter, suggesting its crucial role in identifying the collateral constraint parameter θ.

Panel B of table 11 shifts focus to the elasticities of the calibrated parameters (σ, θ) with the targeted moments. The exercise reveals that both parameters exhibit high sensitivity to the standard deviation of the investment rate. The collateral constraint parameter θ is highly responsive to the fraction of firms with positive debt, average gross leverage ratio, and the standard deviation of the investment rate. Interestingly, while the gross leverage ratio appears relatively insensitive to the collateral constraint parameter in Panel A, the inverse elasticity in Panel B reveals a high sensitivity.

This contrast is indicative of the importance of considering inverse elasticities in understanding parameter sensitivity. Overall, this exercise sheds light on the informativeness of the moments used in the calibration to fit the parameters (σ, θ).

6.5.2 Discussion on Fitted Parameter Values

Table 10 presents the calibrated values of these fitted parameters. The standard deviation of innovations to the TFP shock process is 0.04, and the persistence of TFP shock is 0.90. Finally, the collateral constraint parameter θ is fitted to 0.381.

A persistence value of 0.90 for TFP indicates that shocks—whether positive or negative—have a long-lasting impact on a firm. This means that a boost in productivity will influence the firm for many future periods. The standard deviation of innovations to TFP, measuring the variability of unexpected productivity changes, is 0.042. This relatively low value suggests that firms face less economic uncertainty within the model. Together, the high persistence and low standard deviation imply that firms operate in a stable environment, facilitating easier long-term planning.

A key point to note is that the estimate of θ, presented in table 10, suggests a significant preservation of debt capacity when compared to the model-implied leverage. Model simulations indicate an average (median) leverage of 0.223 (0.189), with the 25th and 75th percentile values at 0.079 and 0.287, respectively. The gap between the estimated parameter $\theta = 0.381$ and the model-implied leverage highlights this preservation of debt capacity. This finding is crucial because it suggests that firms do not always fully operate right at the limit of the collateral constraint. This inference is consistent with the findings of Li, Whited, and Wu (2016).

Lastly, I use the calibrated model and match the semi-elasticity of investment with respect to the monetary policy shock with the semi-elasticity obtained from the reduced form analysis. Specifically, I answer the following question: By how much should the value of θ increase such that the differential semi-elasticity is -0.016 as obtained in the empirical analysis? In other words, I quantify the relaxation in collateral constraint, such that the difference between the new semi-elasticity with the relaxed collateral constraint and the semi-elasticity implied by the collateral constraint in table 10 is -0.016. I estimate that the parameter, θ, increases by 0.061, i.e., the strength of financial frictions associated with collateral constraint reduces by 16.01%. This increase in the collateral constraint is consistent with the findings of Li, Whited, and Wu (2016), who show that the enactment of anti-recharacterization laws leads to an increase in the collateral constraint parameter.

6.5.3 External Validation

I provide three demonstrations of external validity of the model. First, I compare untargeted moments of key firm balance sheet variables between the model and the real-world data. Second, I analyze how firms respond to monetary shocks in the model compared to the data. Third, I assess firms' response to the anti-recharacterization law in the model versus the data.

I start by comparing key firm metrics, such as debt-to-assets, investment-to-assets, sales-to-assets, profits-to-assets, and net worth-to-assets, between the model and the data. Specifically, I compare the median, mean, standard deviation, and serial correlation of these metrics. Panel A of table 12 presents the comparison. Overall the model fits the data reasonably well, especially in terms of key moments associated with debt, sales, and net worth. The model underperforms in capturing certain moments. For instance, although it successfully targets the standard deviation of the investment-to-assets ratio, it overestimates the average level of this ratio. This discrepancy may be due to the omission of firm-level adjustment costs. Similarly, the model struggles to match the serial correlation of sales and net worth ratios and the average profits.

Next, I compare the semi-elasticity of investment in response to monetary policy shocks between the model and the data. It's important to note that while I target the relative semi-elasticity of investment to monetary policy shocks for firms with different levels of the collateral constraint parameter, I do not target the absolute semi-elasticity. Thus, comparing the semi-elasticity for firms with the initial value of θ in the model to that observed in the data provides a reliable benchmark for assessing the model's external validity. Panel B of table 12 presents this comparison, suggesting that the model corresponds fairly well with the data in terms of how firm investment reacts to monetary policy shocks.

Lastly, I compare how the firms in the model respond to the natural experiment of anti-recharacterization laws with the actual data on their responses. First, I observe that the significant changes in firms' investment responses to monetary policy shocks during this period are indeed driven by shifts in the collateral constraint as discussed in section 6.5.2. Second, I assess the impact of the increased collateral constraint parameter on leverage and investment, and compare it to findings documented in the literature by Li, Whited, and Wu (2016) and Ersahin (2020). Panel C of table 12 presents the comparison. The results indicate that the model aligns reasonably well with the data in terms of how firms' leverage and investment react to a relaxation of the collateral constraint surrounding the natural experiment.

6.6 Decomposing the Channels of Monetary Policy Transmission

This exercise aims to quantitatively decompose the semi-elasticity for firms facing relaxed collateral constraints relative to firms with tighter collateral constraints due to movements in the MC and MB curves. I proceed by eliminating movements in the MC curve and the MB curve from the model, one at a time. This counterfactual exercise analyzes how the absence of each of these channels affects the relative semi-elasticity. Row 2 of table 13 presents the estimate of relative semi-elasticity without the movement in the MC curve. I find that the magnitude of the relative semi-elasticity increases by 31.25% when the monetary policy shocks are not allowed to affect the MC curve. This result indicates that firms with relaxed collateral constraints face a flatter MC curve. As a result, these firms are more responsive to movements in the MB curve due to monetary policy shocks. Row 3 of table 13 presents the estimate of relative semi-elasticity without the movement in the MB curve. I find that the sign of the relative semi-elasticity flips and becomes positive in this counterfactual. This result indicates that firms with tighter collateral constraints are more responsive to monetary policy shocks if we ignore the effects of monetary policy shocks on the MB curve. Lastly, note that the two semi-elasticities do not sum to the semi-elasticity in row 1 because there is a small effect caused by the simultaneous movement of the MB and MC curves.

The two results taken together indicate that the movement in the MB curve due to monetary policy shocks amplifies the response when the collateral constraint is relaxed, and the movement in the MC curve amplifies the response when the collateral constraint is tightened. Overall, the movement in the MB curve due to monetary policy shocks dominates the financial accelerator effect. Hence, the response of firms facing relaxed collateral constraints is greater than that of firms facing tighter collateral constraints.

7 Conclusion

Expansionary monetary policy shocks flatten the MC curve of investment and shifts the MB curve outwards. Hence, the cross-sectional response of monetary policy shocks varies depending on whether the flattening of the MC curve or the outward shift of the MB curve is dominant. In this paper, I focus on financial frictions due to the presence of collateral constraints, and show that financial frictions dampen firms' response to monetary policy surprises. Hence, I argue that the effect is driven by firms with a flatter MC curve of investment being more responsive to movements in the MB curve of investment relative to firms with a steeper MC curve of investment.

My argument has two components. First, using an exogenous increase in creditor rights to identify a decrease in financial constraints, I show that the investment growth of treated (relaxed collateral constraint) firms is more sensitive to monetary policy shocks relative to the control (tight collateral constraint) firms. Second, I exploit these empirical estimates to estimate a quantitative heterogeneous-firm-New-Keynesian model with collateral constraint that allows me to – (1) quantify the effect of changes in creditor rights on collateral constraint, and (2) decompose the different channels through which monetary policy affects firm investment in the presence of financial frictions. Specifically, I show that the relaxation of collateral constraint flattens the marginal cost curve. Consequently, the movements in the marginal benefit curve due to monetary policy shocks can amplify the effect of monetary policy shocks on such firms.

The results improve our understanding of the monetary transmission mechanism and carry potential implications for policymakers, shedding light on the differential impact of monetary policy across firms. While conventional wisdom suggests that monetary policy has a greater impact on constrained firms, my results challenge this notion, indicating that unconstrained firms may exhibit a relatively stronger response, at least during normal times. The cross-sectional elasticity identified in this paper can potentially be useful in disciplining other quantitative macroeconomic models with competing mechanisms – in the spirit of Nakamura and Steinsson (2018b) – which I leave for future work.

References

Acharya, Viral V, Yakov Amihud, and Lubomir Litov, 2011, Creditor rights and corporate risk-taking, *The Journal of Financial Economics* 102, 150–166.

Acharya, Viral V, and Krishnamurthy V Subramanian, 2009, Bankruptcy codes and innovation, *The Review of Financial Studies* 22, 4949–4988.

Aghion, Philippe, and Patrick Bolton, 1992, An incomplete contracts approach to financial contracting, *The Review of Economic Studies* 59, 473–494.

Alfaro, Ivan, Nicholas Bloom, and Xiaoji Lin, 2018, The finance uncertainty multiplier, Discussion paper National Bureau of Economic Research.

Andrews, Isaiah, Matthew Gentzkow, and Jesse M Shapiro, 2017, Measuring the sensitivity of parameter estimates to estimation moments, *The Quarterly Journal of Economics* 132, 1553–1592.

Baker, Andrew C, David F Larcker, and Charles CY Wang, 2022, How much should we trust staggered difference-in-differences estimates?, *Journal of Financial Economics* 144, 370–395.

Bernanke, Ben S, Mark Gertler, and Simon Gilchrist, 1999, The financial accelerator in a quantitative business cycle framework, *The Handbook of Macroeconomics* 1, 1341–1393.

Bernanke, Ben S, and Kenneth N Kuttner, 2005, What explains the stock market's reaction to federal reserve policy?, *The Journal of Finance* 60, 1221–1257.

Borusyak, Kirill, Xavier Jaravel, and Jann Spiess, 2021, Revisiting event study designs: Robust and efficient estimation, *arXiv preprint arXiv:2108.12419*.

Bu, Chunya, John Rogers, and Wenbin Wu, 2020, A unified measure of fed monetary policy shocks, *The Journal of Monetary Economics*.

Callaway, Brantly, and Pedro HC Sant'Anna, 2021, Difference-in-differences with multiple time periods, *Journal of econometrics* 225, 200–230.

Christiano, Lawrence J, Martin Eichenbaum, and Charles L Evans, 2005, Nominal rigidities and the dynamic effects of a shock to monetary policy, *The Journal of Political Economy* 113, 1–45.

Cloyne, James, Clodomiro Ferreira, Maren Froemel, and Paolo Surico, 2018, Monetary policy, corporate finance and investment, Discussion paper National Bureau of Economic Research.

Cook, Timothy, and Thomas Hahn, 1989, The effect of changes in the federal funds rate target on market interest rates in the 1970s, *The Journal of Monetary Economics* 24, 331–351.

Crouzet, Nicolas, and Neil R Mehrotra, 2020, Small and large firms over the business cycle, *The American Economic Review* 110, 3549–3601.

De Chaisemartin, Clément, and Xavier d'Haultfoeuille, 2020, Two-way fixed effects estimators with heterogeneous treatment effects, *American Economic Review* 110, 2964–2996.

Ersahin, Nuri, 2020, Creditor rights, technology adoption, and productivity: Plant-level evidence, *The Review of Financial Studies* 33, 5784–5820.

Faust, Jon, Eric T Swanson, and Jonathan H Wright, 2004, Do federal reserve policy surprises reveal superior information about the economy?, *The Contributions in Macroeconomics* 4.

Favara, Giovanni, Janet Gao, and Mariassunta Giannetti, 2021, Uncertainty, access to external finance, and firm precautionary behavior, *The Journal of Financial Economics* 141, 436–453.

Feng, Mei, Jeffrey D Gramlich, and Sanjay Gupta, 2009, Special purpose vehicles: Empirical evidence on determinants and earnings management, *The Accounting Review* 84, 1833–1876.

Gertler, Mark, and Simon Gilchrist, 1994, Monetary policy, business cycles, and the behavior of small manufacturing firms, *The Quarterly Journal of Economics* 109, 309–340.

Gertler, Mark, and Peter Karadi, 2015, Monetary policy surprises, credit costs, and economic activity, *The American Economic Journal: Macroeconomics* 7, 44–76.

Gilchrist, Simon, and Egon Zakrajšek, 2012, Credit spreads and business cycle fluctuations, *American economic review* 102, 1692–1720.

Gormley, Todd A, and David A Matsa, 2011, Growing out of trouble? corporate responses to liability risk, *The Review of Financial Studies* 24, 2781–2821.

Gorodnichenko, Yuriy, and Michael Weber, 2016, Are sticky prices costly? evidence from the stock market, *The American Economic Review* 106, 165–99.

Hadlock, Charles J, and Joshua R Pierce, 2010, New evidence on measuring financial constraints: Moving beyond the kz index, *The Review of Financial Studies* 23, 1909–1940.

Hart, Oliver, and John Moore, 1994, A theory of debt based on the inalienability of human capital, *The Quarterly Journal of Economics* 109, 841–879.

Hayashi, Fumio, 1982, Tobin's marginal q and average q: A neoclassical interpretation, *Econometrica* pp. 213–224.

Ippolito, Filippo, Ali K Ozdagli, and Ander Perez-Orive, 2018, The transmission of monetary policy through bank lending: The floating rate channel, *The Journal of Monetary Economics* 95, 49–71.

Janger, Edward J, 2003, The death of secured lending, *The Cardozo Law Review* 25, 1759.

Jarociński, Marek, and Peter Karadi, 2020, Deconstructing monetary policy surprises—the role of information shocks, *The American Economic Journal: Macroeconomics* 12, 1–43.

Jeenas, Priit, 2018, Monetary policy shocks, financial structure, and firm activity: A panel approach, *Unpublished Working Paper*.

Jordà, Òscar, 2005, Estimation and inference of impulse responses by local projections, *The American Economic Review* 95, 161–182.

Kaplan, Greg, Benjamin Moll, and Giovanni L Violante, 2018, Monetary policy according to hank, *American Economic Review* 108, 697–743.

Kaplan, Steven N, and Luigi Zingales, 1997, Do investment-cash flow sensitivities provide useful measures of financing constraints?, *The Quarterly Journal of Economics* 112, 169–215.

Karpoff, Jonathan M, and Michael D Wittry, 2018, Institutional and legal context in natural experiments: The case of state antitakeover laws, *The Journal of Finance* 73, 657–714.

Kashyap, Anil K, Owen A Lamont, and Jeremy C Stein, 1994, Credit conditions and the cyclical behavior of inventories, *The Quarterly Journal of Economics* 109, 565–592.

Kettering, Kenneth C, 2008, True sales of receivables: A purpose analysis, *The American Bankruptcy Institute Law Review* 16, 511.

——— , 2010, Harmonizing choice of law in article 9 with emerging international norms, *The Gonzaga Law Review* 46, 235.

Khan, Aubhik, Tatsuro Senga, and Julia K Thomas, 2016, Default risk and aggregate fluctuations in an economy with production heterogeneity, *Unpublished Manuscript*.

Kiyotaki, Nobuhiro, and John Moore, 1997, Credit cycles, *Journal of Political Economy* 105, 211–248.

Kroen, Thomas, Ernest Liu, Atif Mian, and Amir Sufi, 2021, Falling rates and rising superstars, Discussion paper Working paper.[3, 26].

Lamont, Owen, Christopher Polk, and Jesús Saaá-Requejo, 2001, Financial constraints and stock returns, *The Review of Financial Studies* 14, 529–554.

Lemmon, Michael, Laura Xiaolei Liu, Mike Qinghao Mao, and Greg Nini, 2014, Securitization and capital structure in nonfinancial firms: An empirical investigation, *The Journal of Finance* 69, 1787–1825.

Li, Shaojin, Toni M Whited, and Yufeng Wu, 2016, Collateral, taxes, and leverage, *The Review of Financial Studies* 29, 1453–1500.

Lian, Chen, and Yueran Ma, 2021, Anatomy of corporate borrowing constraints, *The Quarterly Journal of Economics* 136, 229–291.

Liu, Ernest, Atif Mian, and Amir Sufi, 2021, Low interest rates, market power, and productivity growth, *Econometrica*.

Mann, William, 2018, Creditor rights and innovation: Evidence from patent collateral, *The Journal of Financial Economics* 130, 25–47.

Merton, Robert C, 1974, On the pricing of corporate debt: The risk structure of interest rates, *The Journal of finance* 29, 449–470.

Nakamura, Emi, and Jón Steinsson, 2018a, High-frequency identification of monetary non-neutrality: the information effect, *The Quarterly Journal of Economics* 133, 1283–1330.

———, 2018b, Identification in macroeconomics, *The Journal of Economic Perspectives* 32, 59–86.

Oster, Emily, 2019, Unobservable selection and coefficient stability: Theory and evidence, *The Journal of Business & Economic Statistics* 37, 187–204.

Ottonello, Pablo, and Thomas Winberry, 2020, Financial heterogeneity and the investment channel of monetary policy, *Econometrica* 88, 2473–2502.

Rampini, Adriano A, and S Viswanathan, 2013, Collateral and capital structure, *The Journal of Financial Economics* 109, 466–492.

Rigobon, Roberto, and Brian Sack, 2003, Measuring the reaction of monetary policy to the stock market, *The Quarterly Journal of Economics* 118, 639–669.

Romer, Christina D, and David H Romer, 1990, New evidence on the monetary transmission mechanism, *The Brookings Papers on Economic Activity* 1990, 149–213.

———, 2000, Federal reserve information and the behavior of interest rates, *The American Economic Review* 90, 429–457.

Sun, Liyang, and Sarah Abraham, 2021, Estimating dynamic treatment effects in event studies with heterogeneous treatment effects, *Journal of Econometrics* 225, 175–199.

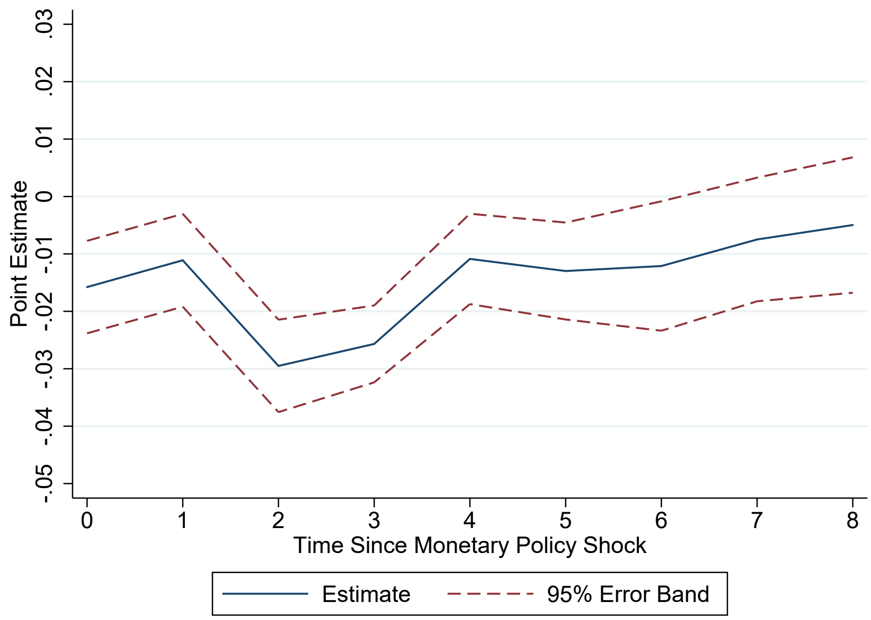
Vig, Vikrant, 2013, Access to collateral and corporate debt structure: Evidence from a natural experiment, *The Journal of Finance* 68, 881–928.

Whited, Toni M, and Guojun Wu, 2006, Financial constraints risk, *The Review of Financial Studies* 19, 531–559.

Wong, Arlene, 2019, Refinancing and the transmission of monetary policy to consumption, *The American Economic Review*.

Young, Eric R, 2010, Solving the incomplete markets model with aggregate uncertainty using the krusell–smith algorithm and non-stochastic simulations, *Journal of Economic Dynamics and Control* 34, 36–41.

Figure 1: Dynamics of Differential Response to Monetary Shocks: Jordà (2005) projection

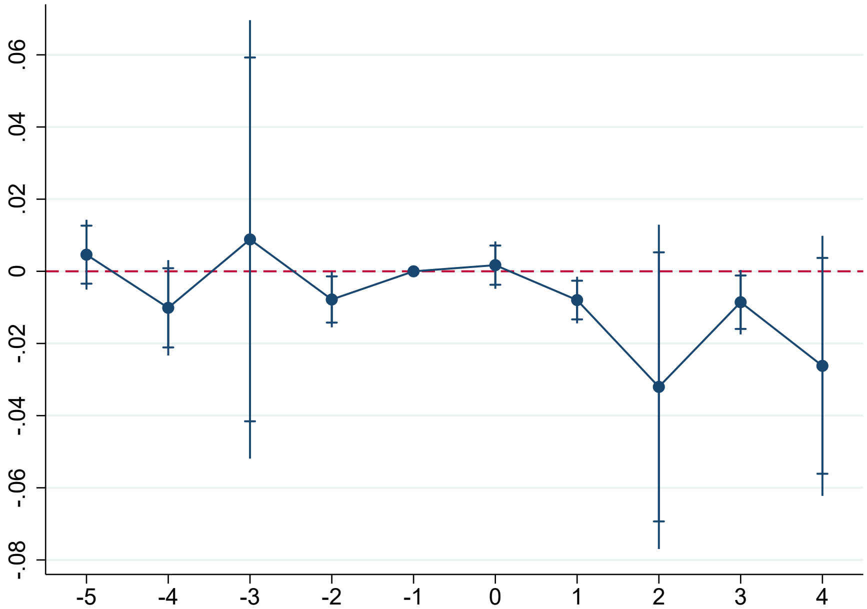


This figure plots the dynamics of the interaction coefficient of anti-recharacterization laws and monetary policy surprise over time. I estimate Jordà (2005) style projection regression until 8 steps. The specification is as follows and h takes an integer value between 0 and 8, where h = 0 and h=3 give the q-o-q and y-o-y response respectively.

$$log(I_{i,t+h}) - log(I_{i,t-1}) = \beta_h^0 \cdot 1(Law_{st} = 1) \times \Delta\varepsilon_t^q + \beta_h^1 \cdot 1(Law_{st} = 1) + \alpha_i + \theta_{jt} + \nu_{it}$$

where i denotes firm, j is industry, s is the state of headquarter or incorporation of the firm i and t is the quarter year. α_i denotes firm fixed effects, and θ_{jt} denotes industry-quarter-year fixed effects. The main independent variable is the interaction term of $1(Law_{st} = 1)$ and $\Delta\varepsilon_t^q$. $1(Law_{st} = 1)$ is an on-off indicator variable that takes a value of 1 when the law is active for the treated firms and zero otherwise. Firms headquartered or incorporated in the states of TX, LA and AL are defined as treated firms. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. The 95% error bands are estimated by clustering of the standard errors at the state level.

Figure 2: Parallel Trends Assumption: Assessment of Pre-Trends

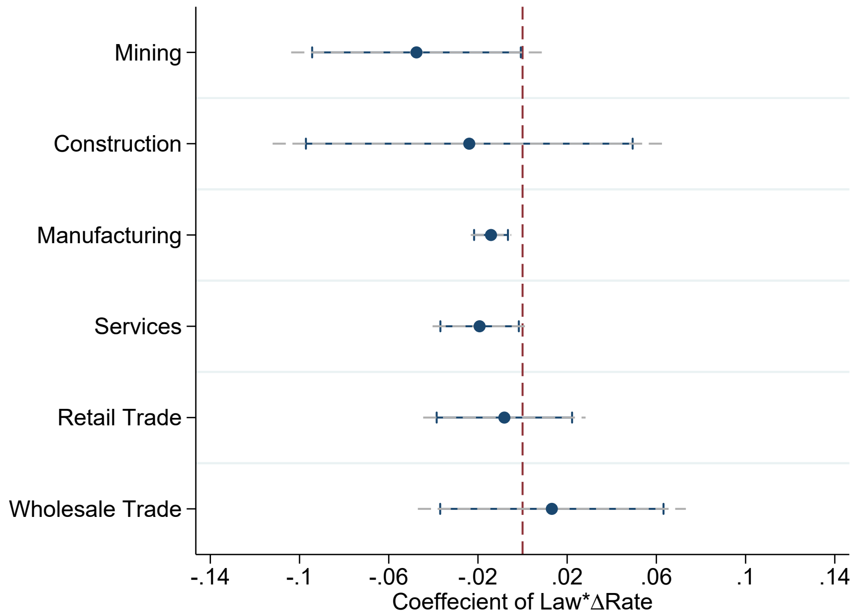


The figure plots the estimates of β_0^k and the 90% and 95% confidence intervals from the following regression equation:

$$\Delta log(I_{i,c,t}) = \sum_{k=-5,k\neq-1}^{k=+4} \beta_0^k \cdot 1(Treatment_{i,c} = 1) \times \Delta\varepsilon_t^q \times Time_{t,c}^k + \alpha_{i,c} + \theta_{j,c,t} + \nu_{i,c,t}$$

where i denotes firm, j is industry, s is the state of headquarters or incorporation of the firm i, t is the quarter year, and c refers to the cohort. There are two cohorts in the stacked regression. The first cohort is the set of firms that got treated in 1997 and the second set that were treated in 2001. The control group for the two cohorts include firms that were never treated and firms that were treated after 2002. $\alpha_{i,c}$ denotes firm × cohort fixed effects, $\theta_{j,c,t}$ denotes industry-cohort-quarter-year fixed effects. $1(Treatment_{i,c} = 1)$ is an indicator function that takes a value of 1 for the firm if the state of headquarter or incorporation (TX, or LA, or AL) had passed the anti-recharacterization law before 2002. $Time_{t,c}^k$ takes a value of 1 if the year is k years before/after the passage of the law for treatment and control firms belonging to each cohort. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2003. We drop the quarter-year observation associated with the height of crisis, i.e., 2003 quarter 3. We present the analysis associated with this observation separately. We restrict the time dimension until the Reaves v Sunblet decision in 2003. This sample restriction allows us to conduct a standard event study analysis. All variables are standardized to mean zero and standard deviation of one. The 90% and 95% error bands are estimated by two-way clustering of the standard errors at state and quarter-year level.

Figure 3: Sector Specific Point Estimates



The figure plots the point estimates, β_k^1, for the six sectors from the following regression:

$$\Delta log(I_{i(i\in k),t}) = \beta_k^1 \cdot 1(Law_{st} = 1) \times \Delta\varepsilon_t^q + \beta_k^0 \cdot 1(Law_{st} = 1) + \alpha_{i(i\in k)} + \theta_{(j\in k)t} + \nu_{it}$$

where i denotes firm, j is 4 digit SIC industry, s is the state of headquarter or incorporation of the firm i and t is the quarter year. α_i denotes firm fixed effects, $\theta_{(j\in k)t}$ denotes four-digit industry quarter-year fixed effects such that the four-digit SIC industry, j is in the 2-digit industry k. I estimate the regression separately for each 2-digit sector k. Table E.2 reports the estimates of the interaction term for each sector. The six sectors include Mining, Construction, Manufacturing, Services, Retail Trade, and Wholesale Trade. $1(Law_{st} = 1)$ is an on-off indicator variable that takes a value of 1 when the law is active for the treated firms and zero otherwise. Firms headquartered or incorporated in the states of TX, LA and AL are defined as treated firms. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. The 90% (navy) 95% (grey dashed) error bands are estimated by two-way clustering of the standard errors at state and quarter-year level.

Table 1: Summary Statistics

Panel A: Firm Characteristics						
	# Obs	p25	p50	p75	Mean	St Dev
$Log(I_{it})$	203,091	-0.5125	1.1240	2.7658	1.1191	2.3753
$\Delta log(I_{it})$	203,091	-0.0518	0.3402	0.6107	0.0256	1.0623
$1(Law_{st} = 1)$	203,091	0.0000	0.0000	0.0000	0.0555	0.2290
Ln(Assets)	203,091	3.6506	4.8937	6.3376	5.0454	1.9177
Debt/Asset	203,091	0.0152	0.1626	0.3350	0.2085	0.2089
Average Q	203,091	1.1422	1.5803	2.4798	2.2350	2.0543
g(Sales)	203,091	-0.0706	0.0231	0.1183	0.0226	0.2891
EBITDA/Equity	203,091	0.0220	0.0900	0.2956	0.1936	0.2291
Cash/Assets	203,091	-0.0013	0.0577	0.1078	0.5222	3.8303
Distance to Default	156,385	1.9975	4.3899	7.6221	5.3434	4.6180

Panel B: Macroeconomic Characteristics						
	# Obs	p25	p50	p75	Mean	St Dev
Δr_t^q	56	-0.0500	0.0100	0.2400	0.0284	0.3255
$\Delta \varepsilon_t^q$ (Tight)	56	-0.0231	-0.0034	0.0035	-0.0120	0.0475
$\Delta \varepsilon_t^q$ (Wide)	56	-0.0222	-0.0025	0.0055	-0.0106	0.0484
JK_t^q	56	-0.0073	0.0045	0.0116	-0.0022	0.0286
BRW_t^q	56	-0.0346	-0.0044	0.0165	-0.0036	0.0376
Δgdp_t^q	56	0.5385	0.8099	1.0727	0.8007	0.4851
ΔUR_t^q	56	-0.1500	-0.0667	0.0667	-0.0304	0.1833
ΔCPI_t^q	56	0.8167	1.2333	1.4333	1.1522	0.6492
ΔEPU_t^q	56	-12.6276	-0.7964	12.1544	-0.2754	25.5458

This table reports the descriptive statistics for the key variables used in the analysis. Panel A reports the summary statistics for firm-level variables, and panel B reports the summary statistics for macroeconomic variables. Panel A includes a sample of non-financial and non-utilities firms from 1994 through 2007. The data on firm-specific variables comes from Compustat. Panel B includes data on macroeconomic variables from 1994 through 2007. The data on macroeconomic variables is sourced from the Federal Reserve at St. Louis. The data on economic policy uncertainty index comes from the website of the policy uncertainty project. All variables are defined in appendix A.

Table 2: Anti-Recharacterization Laws, Firm Investment and Monetary Policy Surprise

$\Delta log(I_{it})$	(1) All	(2) All	(3) All	(4) All
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q$	-0.0189**	-0.0189**	-0.0165***	-0.0158***
	(0.0073)	(0.0072)	(0.0034)	(0.0036)
$1(Law_{st} = 1)$	-0.0027	-0.0027	0.0043	0.0008
	(0.0115)	(0.0114)	(0.0061)	(0.0101)
Qtr × Year FE	Yes	Yes		
State FE	Yes	Yes	Yes	
Industry FE		Yes		
Industry × Qtr × Year FE			Yes	Yes
Firm FE				Yes
# Obs	203,091	203,091	203,091	203,091
R^2	0.2231	0.2235	0.3059	0.3151

This table presents the estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on change in firm investment. The dependent variable is the change in the natural logarithm of capital expenditure, $\Delta log I_{it}$. The main independent variable is the interaction term of $1(Law_{st} = 1)$ and $\Delta\varepsilon_t^q$. $1(Law_{st} = 1)$ is an on-off indicator variable that takes a value of 1 when the law is active for the treated firms and zero otherwise. Firms headquartered or incorporated in the states of TX, LA and AL are defined as treated firms. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are two-way clustered at state and quarter-year level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Stacked Regression: Anti-Recharacterization Laws, Firm Investment and Monetary Policy Surprise

$\Delta log(I_{it})$	(1)	(2)	(3)	(4)
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q$	-0.0161***	-0.0157***	-0.0177***	-0.0172***
	(0.0034)	(0.0035)	(0.0050)	(0.0050)
$1(Law_{st} = 1)$	0.0003	-0.0013	-0.0021	-0.0017
	(0.0098)	(0.0032)	(0.0156)	(0.0088)
Industry X Qtr X Year X Cohort FE	Yes	Yes	Yes	Yes
Firm X Cohort FE	Yes	Yes	Yes	Yes
Control Group	Never Treated + Treated After 2002		Never Treated Only	
Time Sample	Full	Until 2003	Full	Until 2003
# Obs	382,570	288,215	137,996	107,743
R^2	0.3138	0.3035	0.3446	0.3383

This table presents the estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on change in firm investment in a stacked regression framework. The dependent variable is the change in the natural logarithm of capital expenditure, $\Delta log I_{it}$. The main independent variable is the interaction term of $1(Law_{st} = 1)$ and $\Delta\varepsilon_t^q$. $1(Law_{st} = 1)$ is an on-off indicator variable that takes a value of 1 when the law is active for the treated firms and zero otherwise. Firms headquartered or incorporated in the states of TX, LA and AL are defined as treated firms. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. The unit of observation in each regression is a firm-quarter-year-cohort pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. There are two cohorts in the stacked regression. The first cohort is the set of firms that got treated in 1997 and the second set that were treated in 2001. The control group for the two cohorts in columns 1 and 2 include firms that were never treated and firms that were treated after 2002. The control group for the two cohorts in columns 3 and 4 include firms that were never treated. Columns 1 and 3 use the full time sample and the $1(Law_{st} = 1)$ variable acts as an on-off indicator variable. Columns 2 and 4 restrict the time dimension until the Reaves v Sunblet decision in 2003 and the $1(Law_{st} = 1)$ variable behaves like a standard post-treatment indicator. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are two-way clustered at state and quarter-year level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: SPV Usage and the Effect of Monetary Policy Shocks

$\Delta log(I_{it})$	(1)	(2)	(3)	(4)	(5)
$1(Law_{st}=1)\times\Delta\varepsilon_t^q\times High-SPV$		-0.0272***	-0.0271***	-0.0326***	-0.0294***
		(0.0052)	(0.0046)	(0.0072)	(0.0087)
$1(Law_{st}=1)\times High-SPV$		0.0234***	0.0225**	0.0043	0.0043
		(0.0070)	(0.0103)	(0.0141)	(0.0241)
$\Delta\varepsilon_t^q\times High-SPV$		0.0082**	0.0084***	0.0086***	0.0085
		(0.0034)	(0.0023)	(0.0024)	(0.0058)
$1(Law_{st}=1)\times\Delta\varepsilon_t^q$	-0.0172***	-0.0056	-0.0058		
	(0.0053)	(0.0054)	(0.0057)		
$1(Law_{st}=1)$	-0.0000	-0.0095	-0.0082		
	(0.0107)	(0.0084)	(0.0093)		
Firm Controls			Yes		Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes	Yes		
State Incorp × Industry × Qtr × Year FE				Yes	Yes
State HQ × Industry × Qtr × Year FE				Yes	Yes
# Obs	153,482	153,482	153,482	86,338	86,338
R^2	0.3040	0.3040	0.3147	0.4488	0.4559

This table presents the estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on change in firm investment by firms' usage of SPV. The dependent variable is the change in the natural logarithm of capital expenditure, $\Delta logI_{it}$. The main independent variable is the interaction term of $1(Law_{st}=1)$, $\Delta\varepsilon_t^q$ and and a dummy variable High SPV. $1(Law_{st}=1)$ is an on-off indicator variable that takes a value of 1 when the law is active for the treated firms and zero otherwise. Firms headquartered or incorporated in the states of TX, LA and AL are defined as treated firms. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. High SPV is a dummy variable taking a value of 1 if the likelihood of the firm using an SPV is greater than the sample median and 0 otherwise. The likelihood that a firm employs an SPV is predicted using firm-level characteristics such as market-to-book ratio, cash flow ratio, liquidity ratio, acquisitions to assets ratio and research and development expenses using a probit model and firm-characteristics. We use the predicted measure from one year before the passage of the law for the treated firms and for the year 1996 for the control firms. The firm specific covariates (firm controls) include natural logarithm of the book value of assets, debt to assets ratio, average Tobin's Q, growth in sales, EBITDA to equity ratio and cash to assets ratio. The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are two-way clustered at state and quarter-year level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Debt Growth, Anti-Recharacterization Laws, Monetary Policy and SPV Usage

$\Delta log(D_{it})$	(1)	(2)	(3)	(4)	(5)
$1(Law_{st}=1)\times\Delta\varepsilon_t^q$	-0.0099***	-0.0101***	-0.0101***	-0.0099***	
	(0.0037)	(0.0035)	(0.0005)	(0.0025)	
$1(Law_{st}=1)$	-0.0068	-0.0083	-0.0146	-0.0208	
	(0.0082)	(0.0080)	(0.0120)	(0.0176)	
$1(Law_{st}=1)\times\Delta\varepsilon_t^q\times High-SPV$					-0.0599***
					(0.0203)
$1(Law_{st}=1)\times High-SPV$					-0.0243
					(0.0186)
$\Delta\varepsilon_t^q\times High-SPV$					0.0113
					(0.0193)
Qtr X Year FE	Yes	Yes			
State FE	Yes	Yes	Yes	Yes	
Industry FE		Yes			
Firm FE				Yes	Yes
Industry X Qtr X Year FE			Yes	Yes	
State Incorp × Industry × Qtr × Year FE					Yes
State HQ × Industry × Qtr × Year FE					Yes
# Obs	141,787	141,787	141,787	141,787	56,555
R^2	0.0065	0.0110	0.1462	0.1912	0.3443

This table presents the estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on change in firm debt. The dependent variable is the change in the natural logarithm of total debt, $\Delta logD_{it}$. The main independent variable is the interaction term of $1(Law_{st}=1)$, $\Delta\varepsilon_t^q$. $1(Law_{st}=1)$ is an on-off indicator variable that takes a value of 1 when the law is active for the treated firms and zero otherwise. Firms headquartered or incorporated in the states of TX, LA and AL are defined as treated firms. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. High SPV is a dummy variable taking a value of 1 if the likelihood of the firm using an SPV is greater than the sample median and 0 otherwise. The likelihood that a firm employs an SPV is predicted using firm-level characteristics such as market-to-book ratio, cash flow ratio, liquidity ratio, acquisitions to assets ratio and research and development expenses using a probit model and firm-characteristics one year before the passage of the law for the treated firms and characteristics on 1996 for the control firms. The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are two-way clustered at state and quarter-year level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table 6: Effect During the 2001 Recession

$\Delta log(I_{it})$	(1)	(2)
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q \times Recession$	0.1228***	0.1524***
	(0.0404)	(0.0415)
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q$	-0.0122***	-0.0128**
	(0.0042)	(0.0053)
$1(Law_{st} = 1) \times Recession$	0.3355***	0.4017***
	(0.0820)	(0.0882)
$1(Law_{st} = 1)$	-0.0069	-0.0069
	(0.0104)	(0.0106)
Firm FE	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes
Firm Controls		Yes
# Obs	203,091	203,091
R^2	0.3151	0.3246

This table presents the estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on change in firm investment. The dependent variable is the change in the natural logarithm of capital expenditure, $\Delta log I_{it}$. The main independent variable is the interaction term of $1(Law_{st} = 1)$, $\Delta\varepsilon_t^q$ and and the recession of 2001. $1(Law_{st} = 1)$ is an indicator variable that equals one if a firm is headquartered or incorporated in TX or LA between 1997 and 2003, or AL between 2001 and 2003. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. Recession takes a value of 1 for the period 2001:Q2 - 2001:Q4 and zero otherwise. The firm specific covariates (firm controls) include natural logarithm of the book value of assets, debt to assets ratio, average Tobin's Q, growth in sales, EBITDA to equity ratio and cash to assets ratio. The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are two-way clustered at state and quarter-year level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Alternative Explanation: Distress Risk

$\Delta log(I_{it})$	(1)	(2)	(3)
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q$	-0.0145***	-0.0155***	-0.0208***
	(0.0047)	(0.0049)	(0.0038)
$1(Law_{st} = 1)$	0.0065	0.0138***	-0.0009
	(0.0040)	(0.0050)	(0.0078)
Distance to Default	0.0524***	0.0520***	
	(0.0060)	(0.0061)	
Distance to Default $\times 1(Law_{st} = 1)$		0.0288***	-0.0108
		(0.0106)	(0.0091)
Distance to Default $\times \Delta\varepsilon_t^q$		-0.0053	-0.0048*
		(0.0049)	(0.0028)
Industry X Qtr-Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Measurement of Distance to Default	Contemporaneous	Contemporaneous	Static
# Obs	155,524	155,524	124,091
R^2	0.3425	0.3425	0.3224

This table presents the estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on change in firm investment. The dependent variable is the change in the natural logarithm of capital expenditure, $\Delta log I_{it}$. The main independent variable is the interaction term of $1(Law_{st} = 1)$, $\Delta\varepsilon_t^q$ and and the recession of 2001. $1(Law_{st} = 1)$ is an indicator variable that equals one if a firm is headquartered or incorporated in TX or LA between 1997 and 2003, or AL between 2001 and 2003. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. I estimate firm-level measure of distance to default based on the methodology outlined in Gilchrist and Zakrajšek (2012). Column 1 controls for contemporaneous distance to default. Column 2 controls for the interaction terms associated with the contemporaneous distance to default. Column 3 controls for the interaction terms associated with the static distance to default. The static distance distance to default is measured based on the average value in the year before the enactment of the law for the treated group and in 1996 for the control group. The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are two-way clustered at state and quarter-year level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Fixed Parameters

Parameter	Description	Value
Firms		
ν	Labor coefficient	0.64
α	Capital coefficient	0.21
δ	Depreciation	0.025
New Keynesian Block		
ϕ	Aggregate capital AC	4
γ	Demand elasticity	10
φ_π	Taylor rule coefficient	1.25
φ	Price adjustment cost	90
Household		
β	Discount factor	0.99

Table 9: Targeted Moments

Description of the Moment	Data	Model
Std. Dev. Investment Rate: $\sigma(i/k)$	0.044	0.053
Average gross leverage ratio: $\mathrm{E}(b/k)$	0.209	0.223
Firms w/ positive debt: Frac$(b > 0)$	0.828	0.841

Table 10: Fitted parameters

Parameter	Description	Value
ρ	Persistence of TFP	0.900
σ	SD of innovations to TFP	0.042
θ	Collateral Constraint	0.381

Table 11: Identification in calibration exercise

Panel A: Elasticities of moments w.r.t. parameters		
	σ	θ
$\sigma(i/k)$	3.15	0.49
E(b/k)	-2.17	1.09
Frac($b > 0$)	-6.77	-3.12
Panel B: Elasticities of parameters w.r.t. moments		
	σ	θ
$\sigma(i/k)$	2.22	-1.89
E(b/k)	0.89	3.41
Frac($b > 0$)	0.61	-3.23

Table 12: Comparing Model Simulated Data and Real Data

Panel A: Firm-level Moments

	Model	Data
Median debt to assets	0.189	0.156
Average debt to assets*	0.223	0.209
Standard deviation of debt to assets	0.111	0.217
Serial correlation of debt to assets	0.461	0.650
Median investment to assets	0.095	0.021
Average investment to assets	0.085	0.036
Standard deviation of investment to assets*	0.053	0.044
Serial correlation of investment to assets	0.395	0.305
Median sales to assets	0.462	0.280
Average sales to assets	0.488	0.320
Standard deviation of sales to assets	0.231	0.218
Serial correlation of sales to assets	0.771	0.573
Median profit to assets	0.119	0.028
Average profit to assets	0.171	0.015
Standard deviation of profit to assets	0.063	0.064
Serial correlaton of profit to assets	0.465	0.477
Median net worth to assets	0.616	0.562
Average net worth to assets	0.708	0.552
Standard deviation of net worth to assets	0.393	0.272
Serial correlation of net worth to assets	0.857	0.634

Panel B: Response to Monetary Policy Shocks

	Model	Data
Semi-elasticity of investment to monetary policy shock	-0.113	-0.095

Panel C: Response to Anti-Recharacterization Law

	Model	Data
Change in debt to assets	0.029	0.037-0.072
Change in investment to assets	0.009	0.007

This table presents the key firm-level moments using model simulated data and real data using a sample of quarterly Compustat non-financial and non-utilities firms from 1994 through 2007. The sample firms only include non-treated firms. Firms headquartered or incorporated in the states of TX, LA and AL are defined as treated firms. Panel A reports the comparison of key firm moments in the model and the data. The moments marked with * denote moments that were targetted and all other moments are untargeted. Panel B reports the semi-elasticity of firm investment associated with a monetary policy shock of 25 bps. The model elasticity is estimated for the initial value of θ and the data semi-elasticity is computed by regressing change in the natural logarith of capital expenditure on changes in fed funds rate with firm and year fixed effects. Panel C reports the changes in the firm debt to assets ratio and investment-to-assets ratio associated with the change in θ. The data comparison for changes in debt to asset are sourced from Table 2 of Li, Whited, and Wu (2016) and the data comparison for changes in investment to assets is sourced from column 1 of Panel A in Table 7 of Ersahin (2020).

Table 13: Estimates of Semi-Elasticity and Counterfactual Estimates

	Description	Relative Semi-Elasticity		Change relative to Baseline (%)
		Model	Data	
(1)	Both MC & MB Channels Present	-0.016	-0.016	
(2)	No MC Channel	-0.021		31.25%
(3)	No MB Channel	0.004		-125.00%

This table presents the semi-elasticity of investment to monetary policy for firms with relaxed collateral constraint relative to firms with tighter collateral constraint. Row 1 reports the baseline semi-elasticity estimated from the model and compares it to the baseline semi-elasticity from the empirical exercise. Row 2 reports the semi-elasticity estimated from the model without movements in the MC curve. The last column of row 2 reports the contribution of the MC channel. Row 3 reports the semi-elasticity estimated from the model without movements in the MB curve. The last column of row 3 reports the contribution of the MB channel.

Online Appendix for: "Financial Constraints and the Transmission of Monetary Policy: Evidence from Relaxation of Collateral Constraints"

Appendix A Empirical Appendix

This appendix describes the sample selection and the firm-level variables used in the empirical analysis of the paper, based on quarterly Compustat data.

A.1 Sample Selection

The sample comprises of all publically listed firms between January 1993 and December 2007. I exclude all firms not incorporated in the United States. The sample excludes all financial firms with SIC codes between 6000 and 6799 and all utilities firms with SIC codes between 4000 and 4999. I drop these firms because they are heavily regulated. I drop all firms with acquisitions larger than 5% of assets.

A.2 Variable Definition

- $Ln(I_{it})$: Investment, defined as the natural logarithm of capital expenditure
- $\Delta Ln(I_{it})$: Change in investment, defined as the log differences in capital expenditure between t and $t+1$
- $Ln(A_{it})$: Firm Size is defined as the natural logarithm of the total book value of assets
- $Debt/Assets$: Leverage, defined as the ratio of total debt to total assets
- Avg Q: Average Q, defined as the ratio of market to the book value of assets.
- $g(Sales)$: Sales growth, defined as the difference in the natural logarithm of sales
- $EBITDA/Equity$: Cash flow is measured as the ratio of EBITDA to the book value of equity
- $Cash/Asset$: Liquidity is defined as the ratio of cash and cash equivalents to the book value of assets
- $\frac{I_{it}}{A_{i,t-1}}$: Investment to assets ratio is defined as the period t capital expenditure scaled by period $t-1$ book value of assets

- $\frac{I_{it}}{K_{i,t-1}}$: Investment to capital ratio is defined as the period t capital expenditure scaled by period $t-1$ property, plant and equipment

- $\Delta log(R\&D_{it})$: defined as the log difference in the research and development expenditure

- $\Delta log(PP\&E_{it})$ defined as the log difference in the property, plant and equipment

- KZ Index: KZ Index denotes the synthetic KZ Index employed in Lamont, Polk, and Saaá-Requejo (2001) based on estimates from Kaplan and Zingales (1997). It is computed as follows where K is PPE_{t-1}:

$$KZ - Index = -1.001909 * \frac{EBITDA}{K} + 0.2826389 * Q + 3.139193 * \frac{Debt}{K} - 39.3678 * \frac{Div}{K} - 1.314759 * \frac{Cash}{K}$$

- SA Index: SA Index denotes the Size-Age Index of Hadlock and Pierce (2010) and is calculated as follows:

$$SA - Index = -0.737 * Size + 0.043 * Size^2 - 0.040 * Age$$

- WW Index: WW Index denotes the structural index of Whited and Wu (2006) and is calculated as follows:

$$WW - Index = -0.091 * \frac{CF}{A} - 0.062 * DIV + 0.021 * \frac{LTDebt}{Asset} - 0.044 * Size + 0.102 * Ind - g(Sales) - 0.035 * g(Sales)$$

- Distance to Default: Distance to default is defined as in Merton (1974) and estimated using the iterative process outlined in Gilchrist and Zakrajšek (2012). Distance to Default = $\frac{log(V/D)+\mu_v-0.5\cdot\sigma_v^2}{\sigma_v}$, where, V denotes the total value of the firm, μ_v the annual expected returns on V, σ_v the annual volatility of the firm's value, and D denotes firm's debt. I direct readers to Ottonello and Winberry (2020) for the discussion of the details of the iterative process used for estimation.

Table A.1: Changes in the Law

State	Year
Texas	1997
Louisiana	1997
Alabama	2001
Delaware	2002
South Dakota	2003
Virginia	2004
Nevada	2005
Reaves v. Sunbelt	2003

A.3 Timeline of the enactment of the Law

Appendix B Measures of Monetary Policy

B.1 Variable Definition

- Q-o-Q change in FFR (FFR): FFR is calculated as the difference in effective Federal Funds rate at the end and the start of the quarter.

- Bernanke-Kuttner Shock (Tight) (HF-Tight): See section 3.1.1.

- Bernanke-Kuttner Shock (Tight) (HF-Wide): See section 3.1.1.

- Nakamura-Steinsson Shock (NS): I directly use the data provided by Nakamura and Steinsson (2018a). Here, I describe the construction of policy news shock or the Nakamura-Steinsson Shock (NS). NS is the first principal component of the unanticipated change over the 30-minute window in the following five interest rates: the Fed Funds rate immediately following the FOMC meeting, the expected Fed Funds rate immediately following the next FOMC meeting, and the expected three-month Euro-Dollar interest rates at horizons of two, three, and four quarters. Data on Fed Funds futures and Euro-Dollar futures measures changes in market expectations about future interest rates at the time of FOMC announcements. The variable is scaled such that its effect on the one-year nominal Treasury yield is equal to one. I direct the readers to the online appendix A of Nakamura and Steinsson (2018a) for details of the construction of this measure.

- Jarocinski and Karadi Shock (JK): Jarociński and Karadi (2020) exploit the negative and positive co-movement between interest rates and stock prices to disentangle the monetary policy component from the information effect component.

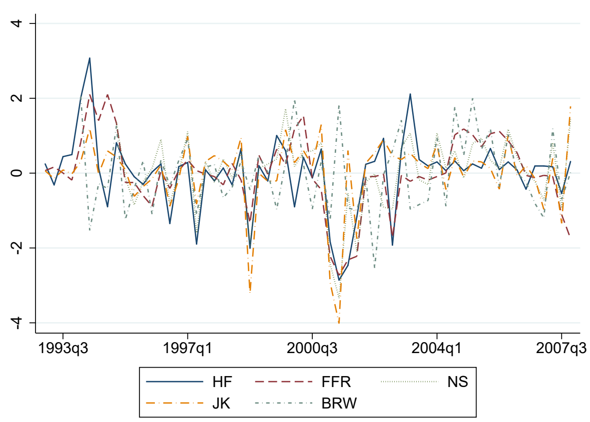
- Bu, Rogers and Wu Shock (BRW): Bu, Rogers, and Wu (2020) employ a heteroscedasticity based partial least squares approach combined with Fama-MacBeth regressions to extract pure monetary policy component devoid of Fed information effect from monetary policy shocks. Their approach is based on the identification assumption similar to Rigobon and Sack (2003) that the institutional component of monetary shocks (information effect) is homoskedastic.

Table B.1: Correlation between different measures of Monetary Policy Shocks

	HF	FFR	NS	JK	BRW
HF	1.000				
FFR	0.600	1.000			
NS	0.761	0.624	1.000		
JK	0.623	0.492	0.847	1.000	
BRW	0.036	0.220	0.288	0.127	1.000

The table reports the correlation coefficient between the five quarterly measures of monetary policy shocks employed in the study between 1993 and 2007. HF denotes the tight window shocks computed as in Bernanke and Kuttner (2005). FFR denotes quarter on quarter change in Federal Funds rate. NS denotes monetary policy path computed as in Nakamura and Steinsson (2018a). JK and BRW denote pure monetary policy shocks after removing fed information effect as in Jarociński and Karadi (2020) and Bu, Rogers, and Wu (2020) respectively.

Figure B.1: Time-series plot of Monetary Policy Shocks



The figure plots the quarterly time-series variation in monetary policy shocks between 1993 and 2007. HF denotes the tight window shocks respectively computed as in Bernanke and Kuttner (2005). FFR denotes quarter on quarter change in Federal Funds rate. NS denotes monetary policy path computed as in Nakamura and Steinsson (2018a). JK and BRW denote pure monetary policy shocks after removing fed information effect as in Jarociński and Karadi (2020) and Bu, Rogers, and Wu (2020) respectively.

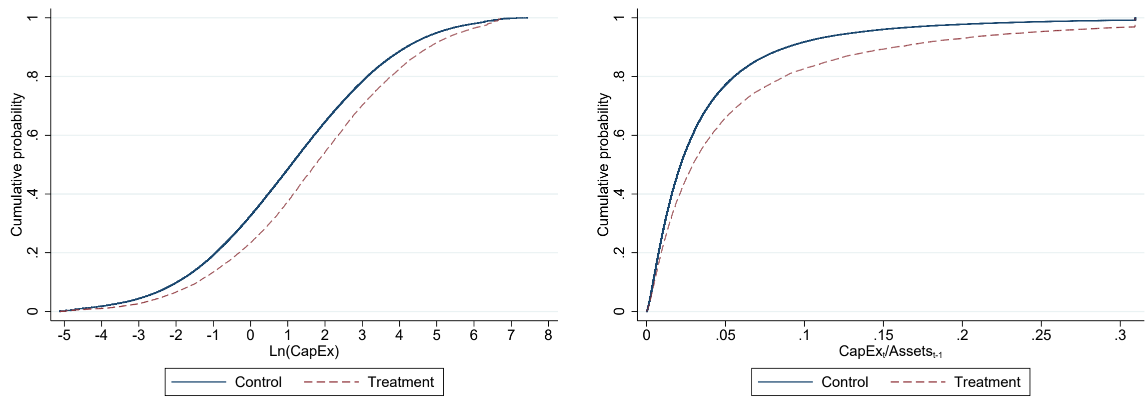
Appendix C Pre-Baseline Tests

This section documents the aggregate effect of monetary policy shocks on firm investment and the impact of strengthening creditor rights on firm investment.

Table C.1 reports the results for the regression of the change in log investment on monetary policy surprises. These results imply that investment responds negatively to monetary policy changes and that this relationship is robust, statistically significant, and economically relevant. The point estimate of $\Delta\varepsilon_t^q$ is negative for all specifications in columns (1)-(4). The point estimate is statistically significant at the 1% level. The estimated semi-elasticity of investment is between -0.02 and -0.07. In columns (5) and (6), the change in log investment is regressed on the change in effective Fed Funds rate during the quarter. Consistent with the findings in columns (1)-(4), the point estimate of Δr_t^q is negative and statistically significant at the 1% level. In columns (7) and (8), monetary policy surprise is used as an instrument for changes in the effective Fed Funds rate in a 2SLS specification. The R^2 for the regression of the change in the effective Fed Funds rate on policy surprises is 36%, implying relevance. The 2SLS estimates of Δr_t^q in columns (7) and (8) are negative and statistically significant.

As a next step, I examine the response of firm investment to the strengthening of creditor rights. Figure C.1 plots the cumulative distribution function (CDF) of $Ln(I_t)$ and $I_t/Assets_{t-1}$ in Panels A and B, respectively, for the control (solid blue line) and the treatment (dashed red line) firms during the period while the law was active in the treated state. The CDF of the treatment firms' first-order stochastically dominates the CDF of the control firms, signifying an increase in investment following the enactment of anti-recharacterization laws. This rightward shift in the distribution of treated firms is significant at 1% level for the mean, first, second, and third quartile values. This is consistent with prior work of Ersahin (2020) that uses US Census plant-level data to find an increase in productivity and investment among treated firms relative to the controls firms following the enactment of anti-recharacterization laws.

Figure C.1: Response of Investment to the Change in Law



(a) $Ln(I_t)$ (b) $I_t/Assets_{t-1}$

	$Ln(I_t)$			$I_t/Assets_{t-1}$		
	Treatment	Control	Difference	Treatment	Control	Difference
Mean	1.7015	1.0849	0.6166***	0.0580	0.0381	0.0198***
p25	0.1337	-0.5447	0.6784***	0.0118	0.0093	0.0025***
Median	1.7378	1.0865	0.6513***	0.0293	0.0215	0.0078***
p75	3.3505	2.7295	0.6210***	0.0701	0.0462	0.0239***

The figure plots the cumulative distribution function (CDF) for the natural logarithm of investment in panel A and capital expenditure to lagged assets ratio in panel B for the control (solid blue line) and the treated (dashed red line) firms. A firm is defined as treated if the firm is headquartered or incorporated in TX or LA and the period of observation is between 1997 and 2003, or AL and the period of observation is between 2001 and 2003. The table below the figure shows the mean, first, second and third quartile of $Ln(I_t)$ and $I_t/Assets_{t-1}$ for the treatment and the control group. The significance for the difference in the mean is based on a standard t-statistic, whereas the significance level for the first, second and the third quartiles are based on the significance level obtained by a quantile regression of the investment on the variable $1(Law_{st} = 1)$ for q = 0.25, 0.50 and 0.75.

Table C.1: Monetary Policy Response to Investment

$\Delta log(I_{it})$	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) IV-2SLS	(8) IV-2SLS
$\Delta\varepsilon_t^q$	-0.0211***	-0.0647***	-0.0646***	-0.0723***				
	(0.0034)	(0.0025)	(0.0025)	(0.0029)				
Δr_t^q					-0.1151***	-0.1668***	-0.3160***	-0.2965***
					(0.0040)	(0.0047)	(0.0140)	(0.0128)
ΔGDP_t^q				0.1636***		0.1754***		0.1898***
				(0.0063)		(0.0061)		(0.0065)
ΔUR_t^q				0.0536***		0.0063**		-0.0173***
				(0.0036)		(0.0027)		(0.0029)
ΔCPI_t^q				0.0162***		0.0310***		0.0378***
				(0.0028)		(0.0028)		(0.0028)
ΔEPU_t^q				-0.0266***		-0.0378***		-0.0384***
				(0.0037)		(0.0036)		(0.0036)
Firm FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes
State × Year FE			Yes	Yes	Yes	Yes	Yes	Yes
# Obs	203,091	203,091	203,091	203,091	203,091	203,091	203,091	203,091
R^2	0.0004	0.0224	0.0234	0.0386	0.0244	0.0422		
First Stage F-stat							11311.37	17128.79

This table presents the estimates of firm-level impact of monetary policy surprises on change in firm investment. The dependent variable is the change in the natural logarithm of capital expenditure, $\Delta log I_{it}$. The main independent variable is $\Delta\varepsilon_t^q$ which denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. Column (1)-(4) report results from a simple OLS regression of $\Delta log I_{it}$ on $\Delta\varepsilon_t^q$. Column (5) and (6) report results from a simple OLS regression of $\Delta log I_{it}$ on Δr_t^q. Column (7) and (8) report the results from IV-2SLS regression where the change in the Fed Fund rate (Δr_t^q) during the quarter is instrumented using the monetary policy surprise during the quarter ($\Delta\varepsilon_t^q$). Column (4), (6) and (8) include other macroeconomic covariates - GDP growth rate during the quarter (ΔGDP_t^q), change in unemployment rate during the quarter (ΔUR_t^q), change in consumer price index during the quarter (ΔCPI_t^q), and the change in economic policy uncertainty (ΔEPU_t^q) during the quarter. The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are clustered at state level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Appendix D Robustness of Baseline Results

Table D.1: Comparing Firms within Size, Sales and PP&E Deciles

$\Delta log(I_{it})$	(1)	(2)	(3)	(4)	(5)
$1(Law_{st}=1)\times\Delta\varepsilon_t^q$	-0.0671***	-0.0605**	-0.0590**	-0.0525*	-0.0524**
	(0.0237)	(0.0272)	(0.0289)	(0.0293)	(0.0254)
$1(Law_{st}=1)$	-0.0348	-0.0385	-0.0333	-0.0274	-0.0366
	(0.0355)	(0.0364)	(0.0386)	(0.0353)	(0.0363)
Firm FE	Yes	Yes	Yes	Yes	Yes
Industry × Qtr-Year FE	Yes				
Industry × Qtr-Year × Asset Decile FE		Yes			
Industry × Qtr-Year × PP&E Decile FE			Yes		
Industry × Qtr-Year × Sales Decile FE				Yes	
Industry × Qtr-Year × Asset Decile × PP&E Decile × Sales Decile FE					Yes
# Obs	27,416	27,416	27,416	27,416	27,416
R^2	0.3315	0.4811	0.4799	0.4805	0.5408

This table presents the estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on change in firm investment while controlling for the interaction fixed effects of industry-time with asset; sales and PP&E deciles. The dependent variable is the change in the natural logarithm of capital expenditure, $\Delta logI_{it}$. The main independent variable is the interaction term of $1(Law_{st}=1)$ and $\Delta\varepsilon_t^q$. $1(Law_{st}=1)$ is an on-off indicator variable that takes a value of 1 when the law is active for the treated firms and zero otherwise. Firms headquartered or incorporated in the states of TX, LA and AL are defined as treated firms. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are two-way clustered at state and quarter-year level. The decile values are based on cutting the sample into ten equal parts based on average assets, sales and PP&E before 1997.* $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Falsification Test: Appendix table D.2 reports the results of the falsification test. Appendix table D.2 compares the treatment effect of firms headquartered or incorporated in states that enacted the law before 2003 and the firms in late states. The former is captured by the interaction term of $1(Pre-2003_{st}=1)$ with monetary policy surprise and the latter is captured by the interaction term of $1(Post-2003_{st}=1)$ with monetary policy surprise. The point estimate of $1(Post-2003_{st}=1)\times\Delta\varepsilon_t^q$ is statistically indistinguishable from zero and the magnitude of the point estimate is small. Whereas, the point estimate of $1(Pre-2003_{st}=1)\times\Delta\varepsilon_t^q$ remains statistically significant and similar in magnitude to the ones reported in column 4 of table 2. Hence, I can rule out issues related to the endogeneity of the law as I do not observe significant treatment effects among firms headquartered or incorporated in the late-treated states.

Table D.2: Falsification Test

$\Delta log(I_{it})$	(1)	(2)
$1(Pre-2003_{st}=1)\times\Delta\varepsilon_t^q$	-0.0158***	-0.0157***
	(0.0036)	(0.0042)
$1(Post-2003_{st}=1)\times\Delta\varepsilon_t^q$	-0.0012	-0.0009
	(0.0957)	(0.0969)
$1(Pre-2003_{st}=1)$	0.0008	0.0009
	(0.0101)	(0.0107)
$1(Post-2003_{st}=1)$	0.0020	-0.0027
	(0.0265)	(0.0268)
Firm FE	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes
Firm Controls		Yes
# Obs	203,091	203,091
R^2	0.3151	0.3246

This table presents the falsification test estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on change in firm investment. The dependent variable is the change in the natural logarithm of capital expenditure, $\Delta logI_{it}$. The main independent variable is the interaction term of $1(Pre-2003_{st}=1)$ and $\Delta\varepsilon_t^q$. $1(Pre-2003_{st}=1)$ is an on-off indicator variable that takes a value of 1 when the law is active for the early treated firms and zero otherwise. Firms headquartered or incorporated in the states of TX, LA and AL are defined as early treated firms. $1(Post-2003_{st}=1)$ is a binary indicator variable that takes a value of 1 after the law is passed for late treated firms and zero otherwise. Firms headquartered or incorporated in the states of SD, VA and NV are defined as late treated firms. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. The firm specific covariates (firm controls) include natural logarithm of the book value of assets, debt to assets ratio, average Tobin's Q, growth in sales, EBITDA to equity ratio and cash to assets ratio. The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are two-way clustered at state and quarter-year level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

D.1 Other Robustness Tests

Alternative Measures of Investment: First, I validate robustness to alternative measures of firm investment. Alternative measures of firm investment include the ratio of capital expenditure to lagged book value of assets as in Hayashi (1982), the ratio of capital expenditure to lagged book value of capital measured using gross property, plant and equipment, and change in the natural logarithm of property, plant and equipment. Additionally, to capture investment in intangible assets, change in the natural logarithm of research and development expenditure is used. The estimation results using alternative measures of firm investment reported in Panel A of appendix table D.3 indicate that the results are qualitatively similar to the baseline estimates.

Alternative Measures of Monetary Policy Shocks: Second, I employ alternative measures of monetary policy shocks to verify the robustness of the baseline results. The alternative measures of monetary policy used are wide window shocks, actual change in effective Fed Funds rate over the quarter and the Nakamura and Steinsson (2018a) monetary policy shocks.[20] Additionally, I verify that the results are robust to alternative aggregation methodologies for monetary policy shocks. Gorodnichenko and Weber (2016) and Wong (2019) use the addition of all shocks during the quarter to construct quarterly shocks. Ottonello and Winberry (2020) construct quarterly shocks using the moving average of the raw shocks weighted by the number of days in the quarter after the shock occurs. This time aggregation strategy ensures that the shocks are weighted by the amount of time firms have had to react to them. The estimation of baseline equation using alternative measures of monetary policy shocks and alternative aggregation methodologies of shocks in Panel B of appendix table D.3 indicate that the results are qualitatively similar to the results in table 2.

Omitted Variable Bias: The results in table 2 show that the estimate of interest does not change drastically, even though the R^2 increases by 10 pp from column (1) through (4), indicating that the omitted variable bias maybe of little concern. We formally test for this issue using the framework presented in Oster (2019). The estimates of Oster (2019) lower bound for columns (3) and (4) are -0.006 and -0.003 respectively. The estimates of lower bound are smaller than zero. Thus, under the Oster (2019) framework, I reject that the effect of monetary policy shock and anti-recharacterization laws on firm investment is driven by omitted variables.

Despite the stability of the point estimate and the rejection of the null under Oster (2019), the point estimate of the interaction term could still be plagued by omitted variable bias via firm-specific or macroeconomic covariates as the test relies heavily on the assumption regarding maximum R^2 attainable with a given dependent variable. I address this concern in three ways. First, I control for the interaction term of monetary policy shocks and firm-specific covariates. Firm-specific covariates include firm size measured as the natural logarithm of the book value of assets, book leverage ratio, Tobin's Q, growth in sales, EBITDA-to-Equity ratio and cash to assets ratio. The firm specific static covariates are measured as the average value in the year before the enactment of the law for the treated firms, and the values during 1996 for the control firms. Second, I control for the interaction term of monetary policy shocks with the contemporaneous time-varying firm characteristics. Third, I control

[20] I refer the reader to appendix B for a discussion on measurement and other properties of these shocks.

for the interaction term of the treatment variable with other macroeconomic shocks including the gross domestic product, unemployment rate, consumer price index, and economic policy uncertainty index. Panel C of appendix table D.3 indicate that the estimate of interest is robust to controlling for these covariates.

Alternative Sample: Fourth, a concern pertaining to the sample of control firms is how good of a counterfactual the control group represents relative to the treatment group. Systematic ex-ante differences between the two groups could bias the estimates. I address this issue in Panel D of appendix table D.3 by constructing alternative samples. Column (1) uses the firms headquartered or incorporated in the following states: states of Texas, Louisiana and Alabama along with their neighbouring states of New Mexico, Oklahoma, Arkansas, Mississippi, Georgia, Florida, and Tennessee. The underlying assumption of this test is that systematic differences in firms due to their geography are likely to be smooth across state boundaries and hence, firms in neighboring states are likely to be a better control set for the experiment. Column (2) uses a propensity score matched sample where each treated firm is matched with one control firm. The firms are matched using the pre-1997 average of investment growth, investment level, size, leverage, cash-flow ratio, liquidity ratio and the ratio of market to book value of assets. This matched sample of control firms have a very similar sensitivity to monetary policy shocks before 1997 indicating that the control firms are reasonably well-suited to act as a counterfactual to the treated firms.[21] Column (3) drops all the oil and gas firms associated with SIC codes 1311, 1381, 1382, and 1389. This is done to argue that the results are not driven by the oil and gas industry as the treated sample of firms is in the Deep South region of the United States, which tends to be tilted towards the oil and gas sector. Column (4) uses a balanced sample of firms during our sample period to address issue of the baseline estimate being contaminated by the entry and exit of firms. Panel D of appendix table D.3 indicate that the estimate of interest is robust to these alternative samples.

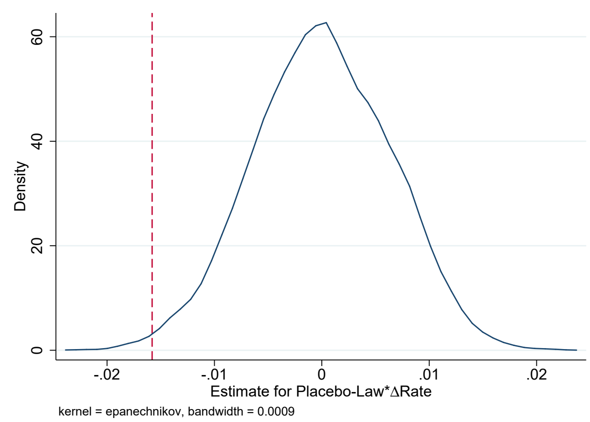
Addressing Spuriousness by Placebo Test: A concern about the validity of the empirical results is that the point estimate of the interaction term may capture a spurious relationship, unrelated to the enactment of anti-recharacterization law. I address this concern by conducting a placebo test. A year is randomly drawn to mark the enactmentment of anti-recharacterization law for each state from a uniform distribution between 1994 and 2003. The random year thus generated is used to define the

[21] Appendix figure D.2 compares key financial variables for the firms in the matched treatment and the control sample and shows that the two samples are close to each other along the matched dimensions. Appendix figure D.3 compares the investment growth sensitivity of firms to monetary policy shocks before 1997 and finds that the control and the treatment firms are reasonably close matches to each other before the law was active.

placebo on-off variable - $Placebo-Year$. $Placebo-Year$ switches to one after the random year and switches back to zero after 2002. I estimate the coefficient of $Placebo-Year \times \Delta\varepsilon_t^q$ in the baseline specification. This exercise is repeated 10,000 times. To negate the validity of the baseline results, the null hypothesis that the point estimate associated with $Placebo-Year \times \Delta\varepsilon_t^q$ is zero must be rejected.

Appendix figure D.1 presents a visual assessment of the kernel density of β, coefficient of the interaction term $Placebo-Year \times \Delta\varepsilon_t^q$, estimated using 10,000 simulations. The distribution of β is centered around 0, varying from -0.023 to 0.023 with a standard deviation of 0.006. I fail to reject the null hypothesis that the average point estimate from the placebo analysis is equal to zero. The red dashed line denotes the location of the coefficient of interaction term from column 4 of table 2 with 0.61% of estimates, among the 10,000 simulated placebo β, lie to the left of the red dashed line. The results of the placebo test add confidence to the argument that the baseline results are neither spurious nor unrelated to the enactment of anti-recharacterization laws.

Figure D.1: Placebo Test



Min	p1	p5	p25	p50	p75	p95	p99	Max	Mean	St Dev
-0.0230	-0.0147	-0.0104	-0.0043	0.0000	0.0045	0.0104	0.0142	0.0228	0.0000	0.0064

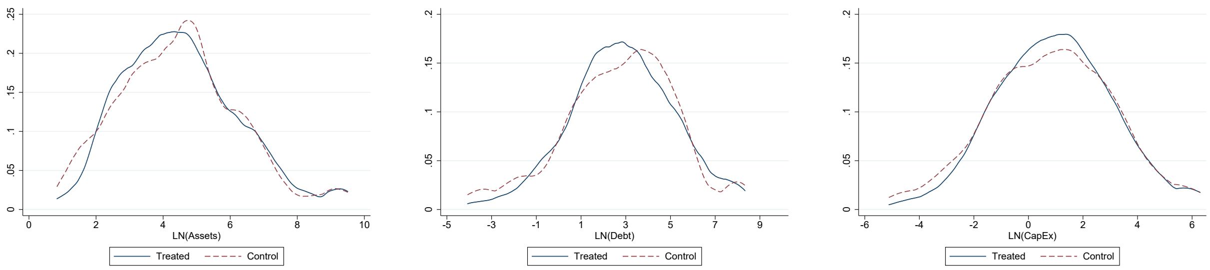
The figure plots the kernel density of the point estimates of the $1(Placebo-Law_{st}=1) * \Delta\varepsilon_t^q$ obtained from the 10,000 Monte Carlo simulations. A placebo law variable is generated for each state in every simulation by drawing a value from a uniform distribution between 1993 and 2003. $1(Placebo-Law_{st}=1)$ is an on-off indicator variable that takes a value of 1 when the law is active for the treated firms and zero otherwise. Firms headquartered or incorporated in the states where the randomly generated placebo year is prior to 2003 are defined as treated firms. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2003. The red dotted line marks the baseline estimate of -0.0158 in column (4) of table 2. Less than 0.61% of the point estimates among the 10,000 simulations lie to the left of the red dashed line.

Table D.3: Robustness to Alternatives

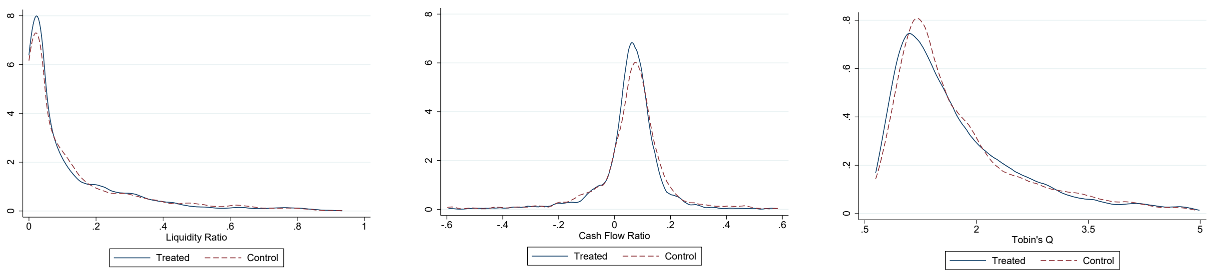
	(1)	(2)	(3)	(4)	(5)
Panel A: Alternative Measures of Firm Investment					
	$\frac{I_{i,t}}{A_{i,t-1}}$	$\frac{I_{i,t}}{K_{i,t-1}}$	$\Delta log(R\&D_{it})$	$\Delta log(PP\&E_{it})$	
Estimate	-0.0201**	-0.0071***	-0.0380***	-0.0108*	
SE	(0.0084)	(0.0019)	(0.0082)	(0.0073)	
# Obs	203,081	146,368	77,240	202,790	
R^2	0.5243	0.2217	0.1003	0.2198	
Panel B: Alternative Measures of Monetary Policy Shocks					
	$Wide$	ΔFFR_t^q	NS	Sum	$Wt - Avg$
Estimate	-0.0162***	-0.0282***	-0.0156***	-0.0135***	-0.0111***
SE	(0.0036)	(0.0048)	(0.0007)	(0.0014)	(0.0010)
# Obs	203,091	203,091	187,891	203,091	203091
R^2	0.3151	0.3151	0.3204	0.3151	0.3151
Panel C: Controlling for Covariates					
	Static Firm Covariates	Contemporaneous Firm Covariates	Macroeconomic Covariates		
Estimate	-0.0177***	-0.0158***	-0.0154***		
SE	(0.0064)	(0.0047)	(0.0038)		
# Obs	153,158	203,091	203,091		
R^2	0.3045	0.3246	0.3151		
Panel D: Alternative Samples					
	Neighbouring States	Matched Sample	No O&G Firms	Balanced Panel	
Estimate	-0.0089*	-0.0254***	-0.0113***	-0.0378***	
SE	(0.0045)	(0.0054)	(0.0038)	(0.0107)	
# Obs	39,367	15,522	194,701	23,800	
R^2	0.444	0.4424	0.3091	0.422	

This table provides robustness around the main specification (Table 2). The test are organised around five dimensions: alternative measures of firm investment (Panel A), alternative measures of monetary policy shocks (Panel B), controlling for covariates (Panel C), and alternative samples (Panel D). For each robustness exercise we report the estimate of interest associated with the interaction term of $1(Law_{st} = 1)$ and the monetary policy shock. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are two-way clustered at state and quarter-year. We also report the number of observations and the model R^2 for each specification. All specifications include firm fixed effects and four digit SIC code × quarter-year fixed effects. In Panel the dependent variable is $\frac{I_{i,t}}{A_{i,t-1}}$ in column 1, $\frac{I_{i,t}}{K_{i,t-1}}$ in column 2, $\Delta log(R\&D_{it})$ in column 3 and $\Delta log(PP\&E_{it})$ in column 4. Panel B uses different measures of mnetary policy shocks. Column 1 uses Wide which is defined as the quarterly average of monetary policy surprise measures in the wide window of 45 minutes. Column 2 uses ΔFFR_t^q which is defined as the quarterly change in effective fed funds rate. Column 3 uses NS which is defined as the quarterly monetary policy shocks as calculated in Nakamura and Steinsson (2018a) and are available only since 1995. The shocks used in column (4) are simple sum of all tight window shocks during the quarter, and the shocks used in column (5) are a weighted average of tight window shocks during the quarter. Panel C controls for additional covariates interacted with $1(Law_{st} = 1)$. Column 1 uses firm specific static covariates which include natural logarithm of the book value of assets, debt to assets ratio, average Tobin's Q, growth in sales, EBITDA to equity ratio and cash to assets ratio, measured in the quarter prior to the enactment of the law for the treated firms and the values as on the fourth quarter of 1996 for the control firms. Column 2 controls for the interaction term of time-varying firm characteristics with $1(Law_{st} = 1)$. Column 3 controls for the interaction term of macroeconomic covariates and $1(Law_{st} = 1)$. The vector of macroeconomic variables include change in gross domestic product, unemployment rate, consumer price index, and economic policy uncertainty index. Panel D uses alternative samples. Column 1 uses the firms headquartered or incorporated in the states of Texas, Louisiana and Alabama along with the firms headquartered or incorporated in neighbouring states of New Mexico, Oklahoma, Arkansas, Mississippi, Georgia, Florida, and Tennessee. Column 2 uses a propensity score matched sample where each treated firm is matched with one control firm. The firms are matched using the pre-1997 average of investment growth, investment level, size, leverage, cash-flow ratio, liquidity ratio and the ratio of market to book value of assets. Column 3 drops all the oil and gas firms associated with SIC codes 1311, 1381, 1382, and 1389. Column 4 uses a balanced sample of firms during our sample period to address issue of the baseline estimate being contaminated by the entry and exit of firms. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure D.2: Comparing the Control and the Treated Firms in the Matched Sample



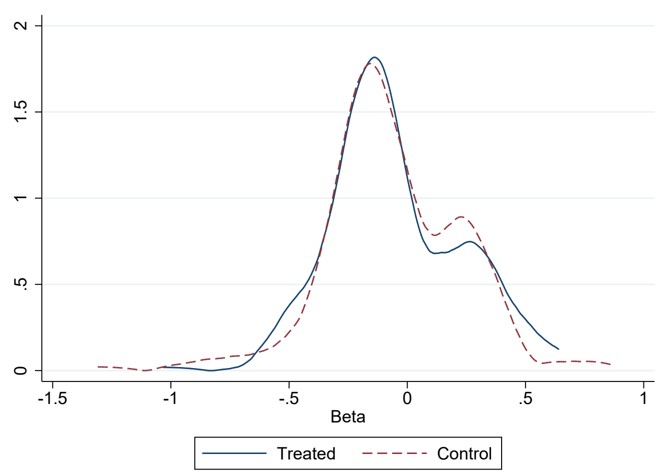
(a) $Ln(Assets)$ (b) $Ln(Debt)$ (c) $Ln(CapEx)$



(d) $\frac{Cash}{Assets}$ (e) $\frac{EBITDA}{Equity}$ (f) Tobin's Q

The figure compares the kernel density of key financial variables - size, debt, investment, cash-flow ratio, liquidity ratio and Tobin's Q for the control and the treated firms before 1997. A firm is defined to be treated if it is headquartered or incorporated in the states of TX, LA and AL. The sample is created by matching each treated firm with exactly one control firm using pre-1997 average of investment growth, investment, size, debt, liquidity ratio, cash-flow ratio and Tobin's Q.

Figure D.3: Comparing the Sensitivity of Investment Growth to Monetary Policy Shocks for the Control and Treated Firms (Pre 1997)



The figure plots the kernel density of the estimated coefficients, β_i, for the treated and the control firms from the following equation: $\Delta log I_{i,t} = \alpha_i + \beta_i \Delta\varepsilon_t^q + \mu_{i,t}$. A firm is defined to be treated if it is headquartered or incorporated in the states of TX, LA and AL. The sample of control firms is created by matching each treated firm with exactly one control firm using pre-1997 average of investment growth, investment, size, debt, liquidity ratio, cash-flow ratio and Tobin's Q. For each firm i, the growth in capital expenditure is regressed on monetary policy shock for the period before 1997 and β_i is computed for each firm. The β_i represents the sensitivity of a firms' investment growth to monetary policy shocks. All variables used in regressions were standardized to mean 0 and variance 1. I also conduct a two-sample Kolmogorov-Smirnov test to compare the equality of the distribution of β_i for the treated and control firms. The adjusted p-value is 0.574 indicating that the distributions of the β_i for the treat and control firms are likely to be identical.

Appendix E Mechanism

Table E.1: Using pure Monetary Policy Shocks

$\Delta log(I_{it})$	(1)	(2)	(3)
$1(Law_{st}=1) \times \Delta\varepsilon_t^q$	-0.0158***		
	(0.0036)		
$1(Law_{st}=1) \times BRW_t^q$		-0.0230**	
		(0.0095)	
$1(Law_{st}=1) \times JK_t^q$			-0.0073***
			(0.0008)
$1(Law_{st}=1)$	0.0008	0.0019	0.0040
	(0.0102)	(0.0107)	(0.0108)
Firm FE	Yes	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes	Yes
# Obs	203,091	203,091	203,091
R^2	0.3151	0.3151	0.3151

This table presents the estimates of firm-level impact of anti-recharacterization laws and pure monetary policy surprises on change in firm investment. The dependent variable is the change in the natural logarithm of capital expenditure, $\Delta log I_{it}$. The main independent variable is the interaction term of $1(Law_{st}=1)$ and monetary policy shock. $1(Law_{st}=1)$ is an on-off indicator variable that takes a value of 1 when the law is active for the treated firms and zero otherwise. Firms headquartered or incorporated in the states of TX, LA and AL are defined as treated firms. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. BRW denotes pure monetary policy shocks as calculated in Bu, Rogers, and Wu (2020). JK denotes pure monetary policy shocks as in Jarociński and Karadi (2020). The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are two-way clustered at state and quarter-year level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table E.2: Sector Specific Results

$\Delta log(I_{i,t})$	(1)	(2)	(3)	(4)	(5)	(6)
$1(Law_{st}=1)\times\Delta\varepsilon_t^q$	-0.0476*	-0.0141***	-0.0239	-0.0193*	-0.0082	0.0131
	(0.0277)	(0.0045)	(0.0431)	(0.0110)	(0.0181)	(0.0297)
$1(Law_{st}=1)$	-0.0419	0.0136**	0.0948	-0.0007	-0.0231	0.0211
	(0.0554)	(0.0056)	(0.0694)	(0.0045)	(0.0371)	(0.0202)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Mining	Manufacturing	Construction	Services	Retail Trade	Wholesale Trade
# Obs	9,622	110,160	2,243	49,441	18,672	9,646
R^2	0.4746	0.2942	0.3611	0.3076	0.3802	0.2929

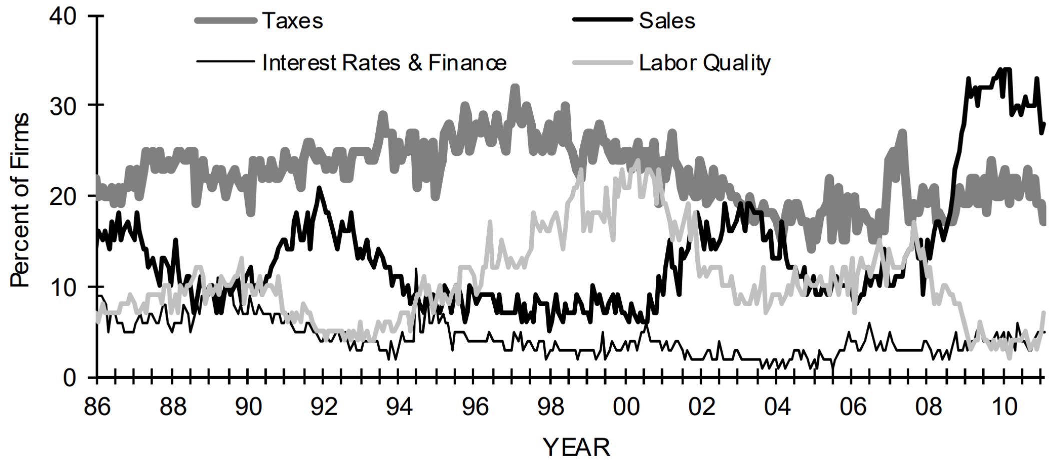
This table presents the estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on change in firm investment for six sectors. The sectors refer to the two digit SIC code. There are six sectors mining, manufacturing, construction, services, retail trade, and wholesale trade. The dependent variable is the change in the natural logarithm of capital expenditure, $\Delta log I_{it}$. The main independent variable is the interaction term of $1(Law_{st}=1)$ and $\Delta\varepsilon_t^q$. $1(Law_{st}=1)$ is an on-off indicator variable that takes a value of 1 when the law is active for the treated firms and zero otherwise. Firms headquartered or incorporated in the states of TX, LA and AL are defined as treated firms. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. Industry-Quarter-Year fixed effect refer to 4 digit SIC-Quarter-Year fixed effects. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are two-way clustered at state and quarter-year level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table E.3: Sector Specific Results – R&D Expenses

$\Delta log(R\&D_{it})$	(1)	(2)
$1(Law_{st}=1)\times\Delta\varepsilon_t^q$	-0.0530*	-0.0185***
	(0.0280)	(0.0108)
$1(Law_{st}=1)$	0.0141	-0.0269
	(0.0335)	(0.0205)
Firm FE	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes
Sector	Services	Manufacturing
# Obs	18,166	52,013
R^2	0.0919	0.1070

This table presents the estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on change in firm investment in research and development for the two sectors. The sectors refer to the two digit SIC code. There are two sectors manufacturing and services. The dependent variable is the change in the natural logarithm of research and development expenses, $\Delta log(R\&D_{it})$. The rest of the notes are same as Appendix table E.2.

Figure E.1: What are Small Businesses Worried About?



Source: National Federation of Independent Businesses (NFIB) Small Business Economic Trends, March 2011. The report can be accessed at this link. The figure shows the percentage of firms that claim taxes, poor sales, interest rates and finance, and labor quality as their biggest concern from January 1986 till February 2011.

Table E.4: Anti-Recharacterization Laws, Distance to Default and Monetary Policy Surprise

Distance to Default	(1)	(2)	(3)	(4)
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q$	-0.0116*	-0.0117**	-0.0076***	-0.0030***
	(0.0060)	(0.0052)	(0.0002)	(0.0003)
$1(Law_{st} = 1)$	0.0110	0.0266	0.0060	0.0085
	(0.0166)	(0.0175)	(0.0292)	(0.0217)
Qtr X year FE	Yes	Yes		
State FE	Yes	Yes	Yes	
Industry FE		Yes		
Industry X Qtr X Year FE			Yes	Yes
Firm FE				Yes
# Obs	155,524	155,524	155,524	155,524
R^2	0.154	0.2183	0.3	0.7074

This table presents the estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on the firm-specifci estimates of distance to default. The dependent variable is distance to default, constructed based on the methodology outlined in Gilchrist and Zakrajšek (2012). The main independent variable is the interaction term of $1(Law_{st} = 1)$ and $\Delta\varepsilon_t^q$. $1(Law_{st} = 1)$ is an on-off indicator variable that takes a value of 1 when the law is active for the treated firms and zero otherwise. Firms headquartered or incorporated in the states of TX, LA and AL are defined as treated firms. $\Delta\varepsilon_t^q$ denotes the monetary policy surprise during the quarter. $\Delta\varepsilon_t^q$ is measured using the price changes in the Fed Funds futures in a narrow window of 30 minutes around the FOMC meetings. The unit of observation in each regression is a firm-quarter-year pair. The sample includes all Compustat non-financial and non-utilities firms from 1994 through 2007. Industry-Quarter-Year fixed effect refer to 4 digit SIC-Quarter-Year fixed effects. All variables are standardized to mean zero and standard deviation of one. All firm-level variables are winsorized at 1% on both ends. Standard errors reported in parentheses are two-way clustered at state and quarter-year level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Appendix F Model

F.1 Firm's Problem and First Order Conditions

The solution to the firm's problem given in equation (4)-(6) can be written in terms of two state variables: idiosyncratic productivity z and net worth n. Given the value of the firm $v_t(z,n)$, the firm decides on the optimal investment $k'(z,n)$ and borrowing $b'(z,n)$ decisions by solving the following Bellman equation.

$$v_t(z,n) = \max_{k',b'} \left\{ \underbrace{n_t\left(z,k,b\right) - q_t k' + \frac{1}{R_t} b'}_{\text{dividend } (d)} + \mathbb{E}_t\left[\Lambda_{t+1} v_{t+1}\left(z', n_{t+1}\left(z',k',b'\right)\right)\right] \right\} \tag{F.1}$$

subject to:

$$\theta(1-\delta)q_t k' \geq \frac{1}{R_t} b' \tag{F.2}$$

$$d \equiv n - q_t k' + \frac{1}{R_t} b' \geq 0 \tag{F.3}$$

where Λ_{t+1} is the stochastic discount factor, δ is the depreciation, and θ is the collateral constraint parameter.

I now derive the first order conditions for the firms' problem presented in equation F.1, subject to constraints presented in equations F.2-F.3. We focus on the more constrained firms for this analysis. These firms face a binding collateral and a binding dividend non-negativity constraint. Let λ_t^C and λ_t^D denote the lagrange multipliers associated with the collateral constraint and dividend non-negativity constraint, respectively. The optimal capital and debt decisions are therefore given by the following first-order conditions:

Optimality condition w.r.t. λ_t^C:

$$\frac{1}{R_t} b' = \theta(1-\delta)q_t k' \tag{F.4}$$

Optimality condition w.r.t. λ_t^D:

$$q_t k' = n + \frac{1}{R_t} b' \tag{F.5}$$

Optimality condition w.r.t. b':

$$(1 + \lambda_t{}^D - \lambda_t^C)\frac{1}{R_t} = -\frac{\partial}{\partial b'}\mathbb{E}_t\left[\Lambda_{t+1} v_{t+1}\left(z', n_{t+1}\left(z', k', b'\right)\right)\right] \tag{F.6}$$

$$(1 + \lambda_t^D - \lambda_t^C) = \mathbb{E}_t\left[1 + \lambda_{t+1}^D\left(z', n_{t+1}\left(z', k', b'\right)\right)\right] \tag{F.7}$$

Optimality condition w.r.t. k':

$$(1 + \lambda_t^D - \lambda_t^C) q_t + \lambda_t^C (1 - \theta(1-\delta)) q_t = \frac{\partial}{\partial k'}\mathbb{E}_t\left[\Lambda_{t+1} v_{t+1}\left(z', n_{t+1}\left(z', k', b'\right)\right)\right] \tag{F.8}$$

$$= \frac{\Pi_{t+1}}{R_t}\mathbb{E}_t\left[\mathrm{MRPK}_{t+1}\left(z', k'\right)\left(1 + \lambda_{t+1}^D\left(z', n_{t+1}\left(z', k', b'\right)\right)\right)\right] \tag{F.9}$$

Combining equation F.7 and F.9 gives us the following condition:

$$\begin{aligned}\mathbb{E}_t&\left[1 + \lambda_{t+1}^D\left(z', n_{t+1}\left(z', k', b'\right)\right)\right] q_t + \lambda_t^C (1 - \theta(1-\delta)) q_t \\ &= \frac{\Pi_{t+1}}{R_t}\mathbb{E}_t\left[\mathrm{MRPK}_{t+1}\left(z', k'\right)\left(1 + \lambda_{t+1}^D\left(z', n_{t+1}\left(z', k', b'\right)\right)\right)\right]\end{aligned} \tag{F.10}$$

F.2 Proof of Lemma 1

Unconstrained firms can implement both the optimal amount of capital and the minimum savings policy that guarantees these firms will never be constrained in the future again. Given the stochastic process for z the optimal amount of capital is the solution to:

$$k^*(z) = \arg\max_{k'}\left\{-qk' + \beta\mathbb{E}_{z'|z}\left[\pi\left(k', z'\right) + q'(1-\delta)k'\right]\right\}$$

So the optimal amount of capital solves the following equation

$$q = \beta\mathbb{E}_{z'|z}\left[\frac{\partial\pi}{\partial k'}\left(k', z'\right) + \frac{\partial}{\partial k'}q'(1-\delta)k'\right]$$

which is when the expected marginal productivity of capital is equal to the marginal cost of an extra unit. The "minimum savings policy" (Khan, Senga, and Thomas, 2016) or the "maximum borrowing policy" (Ottonello and Winberry, 2020) is the optimal debt decision b' in the current period that the firm implements such that the firm will not be constrained in the future states. Let $b^*(z)$ be the optimal debt decision b' and $k^*(z)$ be the optimal capital decision of the firm in the current period. Then the minimum savings is given by

$$\frac{1}{\Pi}b^*(z) = \min_{z'}\left\{\pi\left(z', k^*(z)\right) + q(1-\delta)k^*(z) - qk^*(z') + \min\left\{\frac{1}{R}b^*(z'), \theta q(1-\delta)k^*(z')\right\}\right\}$$

The expression is derived from the dividend non-negativity constraint conditional on the realization of the future shocks and the firm being able to implement the optimal level of capital in the next period $k^*(z')$. For the collateral constraint to not bind, I add the condition that the next period debt has to be less than or equal to fraction θ of the value of the optimal capital level. This results in a set of values for each possible realization of the future shocks. The min operator over z' ensures that the conditions are satisfied even for the worst possible outcome. Hence, $b^*(z)$ is the maximum amount of debt the firm can borrow and be guaranteed to be unconstrained in the future. Given the optimal amount of capital and the minimum savings policy, the dividends distributed by the unconstrained firms are given by

$$d = n - qk^* + \frac{1}{R}b^*$$

From the dividend constraint $d \geq 0$ we can extract the minimum threshold for net worth that guarantees the firm is not constrained

$$\bar{n}(z) = qk^* - \frac{1}{R}b^*$$

and the firms are unconstrained if $n > \bar{n}(z)$.

More financially constrained firms can not implement the optimal amount of capital. These firms utilize all their borrowing capacity to acquire capital. Hence, their optimal debt decision is given by the binding collateral constraint:

$$\frac{1}{R_t}b' = \theta(1-\delta)qk'$$

and their optimal capital decision is given by the binding dividend non-negativity constraint:

$$qk' = n + \theta(1-\delta)qk'$$

Therefore, conditional on the state (z, n), the optimal capital decision of more constrained firms is given by the following expression:

$$k'(z,n) = \frac{1}{(1-\theta+\theta\delta)q} n(z)$$

which is strictly smaller than their optimal level of capital $k^*(z)$.

It is straight forward to see that there exists a threshold net worth $\underline{n}(z)$ such that for all $n \geq \underline{n}(z)$, the firms will be able to implement optimal level of capital $k^*(z)$. Therefore, all the firms with net worth $n < \underline{n}(z)$ are more financially constrained.

Less financially constrained firms can implement the optimal amount of capital, $k^*(z)$, but not the minimum savings policy and are therefore less financially constrained. Intuitively, for these type of firms, the value of internal financing is more than the value of dividends for households and therefore the dividend non-negativity constraint binds $d = 0$. The optimal debt decision is thus given by

$$\frac{1}{R_t} b' = qk' - n$$

From the above arguments for unconstrained firms and more financially constrained firms, the less financially constrained firms are those with their net worth between the two thresholds $\underline{n}(z)$ and $\bar{n}(z)$.

F.3 Equilibrium

This section describes the equilibrium of the model. The equilibrium in this economy is defined as a set of value functions $v_t(z,n)$; optimal firm policies $\left\{k'_t(z,n), b'_t(z,n), l_t(z,n)\right\}$; prices $\{w_t, q_t, p_t, \Pi_t, \Lambda_{t+1}\}$; aggregate quantities $\{L_t, C_t, I_t\}$ and the distribution of firms $\mu_t(z,n)$ such that

- *Firms Optimization:* Given the prices $\{w_t, q_t, p_t, \Pi_t, \Lambda_{t+1}\}$, the value function $v_t(z,n)$ solves the firms' problem given in equations (F.1)-(F.3) with the optimal policies $k'_t(z,n)$, $b'_t(z,n)$, and $l_t(z,n)$.

- *Retailers and Capital Producers Optimization:* The prices q_t and $\{\Pi_t, p_t\}$ solve the capital goods producers' profit maximization problem and satisfy the New Keynesian Phillips curve, respectively.

- *Household's Maximization Problem:* Given the prices $\{w_t, q_t, p_t, \Pi_t\}$, the stochastic discount factor given by $\Lambda_{t+1} = \beta \frac{C_t}{C_{t+1}}$, the aggregate consumption given by $\Psi C_t = w_t$, and the aggregate labor L_t solves the household utility maximization problem. The stochastic discount factor and nominal interest rate are linked through the Euler equation for bonds i.e., $\mathbb{E}_t\left[\Lambda_{t+1}\frac{R_t}{\Pi_{t+1}}\right] = 1$.

- *Market Clearing Conditions:* Labor market clears i.e., labor supply equal labor demand and final goods market is given by $Y_t = C_t + I_t$. Aggregate investment I_t is given by $K_{t+1} = \Phi\left(\frac{I_t}{K_t}\right)K_t + (1-\delta)K_t$, where $K_t = \int k_t \, \mathrm{d}\mu_t(z,n)$.

F.4 Calibration

This section outlines the model calibration, which involves two key steps. First, I solve for the stationary equilibrium, determining the steady-state moments in the absence of monetary shocks. Second, I analyze the transitional equilibrium, capturing the economy's dynamic adjustment back to the steady state after an unexpected monetary shock. This section outlines the procedure for determining the model's stationary equilibrium in the absence of monetary shocks and the calibration strategy employed to identify model parameters to match key empirical targets.

F.4.1 Stationary Equilibrium and Calibration

Equilibrium Conditions and Labor Market Clearing: I define the economy to be in steady state when aggregate variables remain constant over time and there are no monetary policy shocks. I outline the equilibrium conditions that govern the behavior of inflation, prices, and nominal interest rates. I also specify how firms' decisions regarding production, capital, and debt depend on the real wage. I require that the labor market must achieve equilibrium, i.e., the total labor demand from all firms must equal the aggregate labor supply. To apply this condition numerically, I begin by guessing an initial wage rate and solving the model to determine if the resulting aggregate labor demand equals the aggregate labor supply. If there is a mismatch, I modify the wage guess and resolve the model repeatedly until I identify the wage that ensures equilibrium in the labor market.

Value Function Iteration: I solve each firm's optimization problem through Value Function Iteration using the guessed wage that ensures equilibrium in the labor market. Each firm determines the optimal capital and debt to maximize its value subject to the dividend non-negativity constraint and the collateral constraint. Numerically, I begin by initializing a guess for the firm's value function across the relevant state space, i.e., net worth and productivity. I then iterate on the Bellman equation until convergence is achieved. During each iteration, I calculate the firm's optimal policy functions for capital and debt, taking into account the wage and other aggregate prices. I obtain the firm's value function and policy functions once the firm's optimal decisions stabilize. They characterize the optimal choices for capital and debt in the steady state.

Distribution of Firms and Aggregate Variables: The final step in determining the stationary equilibrium involves using the stationary distribution of firms based on their state variables: net worth and productivity. I implement the algorithm presented in Young (2010), which iteratively updates the distribution until it converges to a fixed point. Initially, I start with a guess for the distribution of firms and then apply the firm policy functions derived from the optimization problem to calculate how the distribution evolves. This process is repeated until convergence is achieved. From the resulting stationary distribution, I compute the economy-wide aggregate variables, including investment, output, consumption, labor, and total factor productivity. If the implied aggregate labor demand deviates from the target level, I adjust the wage guess and repeat the process. Once the wage guesses no longer require adjustments, the procedure produces the final stationary equilibrium: a consistent set of aggregate prices, the equilibrium wage, and a distribution of firms along with their policy rules.

Calibration Using Steady-State Moments: Once the stationary equilibrium is established, I utilize its steady-state aggregates to calibrate the model parameters. These parameters include the persistence and standard deviation of the idiosyncratic productivity process, as well as the collateral constraint that governs financial frictions. I target specific empirical moments: the standard deviation of investment rates, the average gross leverage ratio, and the proportion of firms with positive debt. Matching these observed data moments with their model counterparts ensures that the model reflects essential characteristics of the real economy without monetary shocks. After iterating on the parameter set, I determine the final parameter values that minimize the Euclidean distance between the empirical moments and those implied by the model, thus completing the calibration process.

F.4.2 Transitional Equilibrium following a Monetary Policy Shock

Upon identifying the stationary equilibrium through the calibrated parameters, I proceed to incorporate a monetary shock process $\left\{\varepsilon_t^m\right\}$ to examine the economy's adjustment to a new steady state. The objective of this exercise is to capture the dynamic responses of firms and aggregate economic variables to an unanticipated monetary policy shock. To solve for the transitional equilibrium, I employ a backward-forward shooting algorithm to find the solution of the transitional equilibrium.

- The economy is initially in a steady state and unexpectedly encounters an innovation of $\varepsilon_0^m = -0.0025$ to the Taylor rule. Following the framework employed in Ottonello and Winberry (2020), this innovation is permitted to gradually revert to zero according to the relationship $\varepsilon_{t+1}^m = \rho_m \cdot \varepsilon_t^m$ with $\rho_m = 0.5$. We proceed to calculate the perfect foresight transition path of the economy as it moves back toward its steady state. To facilitate this, we consider a sufficiently extended time horizon of 200 periods, ensuring that the transitory effects of the shock can fully manifest without impeding the economy's return to its stationary equilibrium.

- I guess a time path for aggregate prices over the span of 200 periods following the unexpected monetary policy shock. In the final period, I set the prices to match with the steady-state values established during the model's initial period before the shock. This guess facilitates a continuous transition profile that can be updated iteratively.

- I solve the firm's dynamic optimization problem using the guess for aggregate prices. Specifically, starting from the terminal value function, which assumes the economy is in its post-shock steady state, I work backward sequentially through each period. Firms optimize their choices of capital and debt, employing the Bellman equation while considering the future value function at each date, given the aggregate prices for each period. This process allows us to obtain the policy functions, extending from the terminal period back to the initial period.

- Having established the complete set of policy functions, I then conduct a forward simulation from the initial period to the terminal period. The distribution of firms is initialized to reflect their steady-state distribution in the initial period. Utilizing the policy functions, I calculate the capital and debt choices for period 1, which subsequently informs the updated distribution in period 2, and continues iteratively in this manner until the terminal period. This forward simulation generates the trajectory of the firm distribution along with period-by-period aggregates, including capital, debt, output, consumption, and labor.

- I compute aggregate labor demand, output, and other pertinent variables for each period using the results from the forward simulation. I revise the guessed price sequence if these outcomes diverge from the initially guessed path of aggregate prices – indicated by inconsistencies such as mismatches between labor demand and supply, or discrepancies in the implied inflation trajectory. Specifically, I adjust the price levels or inflation rates for each period to reduce the difference between the simulated aggregates and the market-clearing conditions. This iterative process continues until the Euclidean distance between the updated and previous price paths diminishes to an insignificant level, thereby defining the solution to the transitional equilibrium.