What Does Financial Heterogeneity Say about the Transmission of Monetary Policy?*

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Abstract

Do financial constraints determine 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. This reflects their flatter marginal cost curves for financing, which amplifies responses to shifts in the marginal benefit curve. The relationship, however, reverses during economic downturns when investment opportunities are scarce. I rationalize these findings in a static model and quantify the channels using a Heterogeneous-Agent-New-Keynesian model.

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

In this study I attempt to address these endogeneity issues and to identify under which conditions financial constraints increase or decrease the responsiveness of a firm to monetary policy shocks. I provide identification using a plausibly exogenous natural experiment which provides variation in a key financial friction: the strength of creditor rights. This natural experiment allows me to identify plausibly exogenous

[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 et al. (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 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.

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. My results show that financial frictions dampen monetary transmission during normal times and amplify monetary transmission during periods of economic downturn. The results suggest that unconstrained firms – that face a flatter marginal cost curve of investment – are more responsive to monetary policy shocks, as they exhibit a greater response to movements in the marginal benefit curve. Financially constrained firms are more responsive to monetary policy shocks during periods of economic downturn, when investment opportunities are scarce, aggregate demand is low, and credit constraints are binding. Therefore, my results improve our understanding of the role of financial frictions in monetary transmission.

Stronger creditor rights are a key determinant of firm financing as they increase the ability of creditors to recover collateral in the event of bankruptcy (Hart and Moore (1994), Rampini and Viswanathan (2013)). The increased ability of creditors to recover assets effects a firm 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 (Ponticelli and Alencar (2016), Calomiris et al. (2017), Cerqueiro, Ongena and Roszbach (2016), Li, Whited and Wu (2016), Gopalan, Mukherjee and Singh (2016), Haselmann, Pistor and Vig (2010)). Therefore strong creditor rights decrease firm financial constraints.

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 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 Circuit Court ruling in *Reaves v. Sunbelt* came as a huge blow to anti-recharacterization laws making these statues 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 headquartered or incorporated 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 × quarter × 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, that is firms headquartered or incorporated in states where the anti-recharacterization laws were enacted, 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 the one for 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%. The result is robust to a wide array of firm-specific and macroeconomic controls, alternative measures of investment and monetary policy shocks, entry and exit of firms, alternative samples of firms headquartered or incorporated in states geographically bordering the treated states, and a propensity score matched sample of control firms with similar monetary policy elasticity of investment in the pre-treatment period. Parallel-trend analysis rules out that the effect is driven by pre-existing trends. Furthermore, this result cannot be generated in a placebo or a falsification test indicating the effect is unlikely to be spurious or a result of the endogeneity in the passage of the law.

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. One question is whether firms re-optimize after the law is passed and operate at the new optimal leverage. If so are they really less constrained? This does not pose a threat to my interpretation as long as the steady state where treated firms will re-optimize their debt and assets to operate at the new optimal leverage is not reached instantaneously after the enactment of the law. Treated firms are less financially constrained for the time-period between the enactment of the law and the convergence to the new steady state. While the relaxation in financial constraints of treated firms due to the enactment of the law may decrease as these firms approach their new steady state, such an effect would bias my estimates downwards in which case one could interpret my estimates as the lower bound. Moreover, Ersahin (2020) documents an increase in total factor productivity and adoption of more efficient production technologies among treated firms following the enactment of anti-recharacterization laws. This indicates that the additional debt taken by treated firms does not simply exhausts the debt capacity of a firm but also creates value further relaxing constraints. Additionally, I document that financial constraints decline for treated firms relative to control firms after the passage of the law. Overall, the laws reduced financial constraints by increasing debt capacity and value creation.

Next, I argue that my 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 primarily engage in secured asset-based borrowing and have relatively high asset tangibility. Second, I compute the likelihood of SPV usage for all firms using pre-law characteristics and I document that the effect is dominant among firms with a greater likelihood of SPV usage. This result implies that the effect is primarily driven by the change in anti-recharacterization laws involving the usage of SPVs. Additionally, this test allows me to include state $\times$ industry $\times$ time fixed effects which helps alleviate a myriad of concerns related to the endogeneity of the enactment of anti-recharacterization laws. Third, I provide evidence that the results are unlikely to be driven by the Fed information effect. This indicates that the effect is driven by changes in interest rates and not by resolution of uncertainty following Fed monetary policy announcements. Fourth, I exploit the staggering of contractual and wage changes as in Olivei and Tenreyro (2007) over calendar time to show that unconstrained firms are more responsive to monetary policy shocks relative to constrained firms during times of greater contractual and wage rigidity. This test is motivated by prior research showing that firms facing greater nominal rigidity are more responsive to monetary policy shocks (Christiano, Eichenbaum and Evans (2005), Weber (2014)).

I show that the treated firms finance new investment 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.

I next examine the monetary policy responsiveness of constrained and unconstrained firms during the economic downturn of 2001 as 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 low interest rates and 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 downturn, as the flattening of marginal cost curve of investment is dominant during such episodes. Moreover, Kashyap, Lamont and Stein (1994) argue that periods of economic downturn are best suited to test for the presence of a financial accelerator; during a recession, firms are not only operating under constraints, but these constraints become binding. 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. Hence, this paper reconciles the contradicting empirical results obtained in Kashyap, Lamont and Stein (1994) and Gertler and Gilchrist (1994) with Ottonello and Winberry (2020).

I construct a static model similar to Hayashi (1982) and Kaplan and Zingales (1997) to outline the key mechanism operating through the steepness of the marginal cost (MC) curve, movements in the marginal benefit (MB) curve. The model features convex adjustment costs of new investment in the presence of financial frictions. I compare the response of (1) firms with financial frictions that face heterogeneity in the level of MC curves but have the same slope and (2) firms facing heterogeneity in the slope of their MC curve due to financial frictions against (3) a frictionless benchmark in which firms face no financing frictions. I show that when financial frictions result in an MC curve that differs only in level, constrained firms are more responsive to monetary policy shocks. This effect is driven by a greater downward shift in the MC curve for a constrained firm relative to an unconstrained firm. However, when financial frictions result in an MC curve that differs in slope, unconstrained firms could be more responsive to monetary policy shocks due movements in the MB curve. Another key implication of this model is that constrained firms are more responsive to monetary policy shocks when movements in the MB curve are muted or during periods of low interest rates, regardless of the shape of MC curve.

I complement my static model by analyzing the heterogeneous-agent-New-Keynesian (HANK) model of Ottonello and Winberry (2020). This model allows me to interpret the evidence in a dynamic framework. Notably, the HANK model allows me to quantify the relative importance of the marginal benefit and the marginal cost channels in driving the cross-sectional result. This is the key advantage of this model as my empirical tests cannot completely disentangle the contributions of the two channels. 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 (2014) 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 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. 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 marginal benefit channel makes constrained firms more responsive to monetary policy shocks, while unconstrained firms are more responsive when the marginal cost channel is eliminated.

Related Literature: My work identifies the micro-foundations of the transmission of monetary policy shocks to the real economy. My findings are broadly related to five strands of literature.

First, I contribute to the literature studying the transmission of monetary policy when firms face financial frictions. I provide identification using a natural experiment that varies a key financial friction - the strength of creditor rights. The key advantage of using this natural experiment to measure heterogeneity in financial frictions is that it is not endogenous like accounting proxies of financial frictions. Gertler and Gilchrist (1994) and Kashyap, Lamont and Stein (1994) find that smaller, presumably relatively constrained, firms are more responsive to monetary policy shocks than larger, presumably less constrained, firms. Since then a large literature has used several accounting and financial proxies such as liquidity (Jeenas (2018)), distance to default (Ottonello and Winberry (2020)), bank debt (Ippolito, Ozdagli and Perez-Orive (2018)), and age (Cloyne et al. (2018)) to examine the response of constrained firms to monetary policy shocks relative to unconstrained firms. My findings are consistent with the results in Ottonello and Winberry (2020) who show that firms with greater distance to default, presumably less constrained firms, are more responsive to monetary policy shocks. Unlike previous studies, I do not rely on endogenous accounting measures to proxy for financial constraints. 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. Finally, the HANK model allows me to quantify the relative contributions of the two channels.

Second, this paper reconciles the contradicting empirical results obtained in Kashyap, Lamont and Stein (1994) and Gertler and Gilchrist (1994) with Ottonello and Winberry (2020). Gertler and Gilchrist (1994) argue that constrained firms are more responsive than unconstrained firms using an event study analysis around the Romer and Romer (1990) dates, that tend to precede downturns in real activity, and the 1966 credit crunch. Kashyap, Lamont and Stein (1994) reach a similar conclusion by analysing firm behavior around the 1981-82 and the 1974-75 recessions. On the other hand, Ottonello and Winberry (2020) document that unconstrained firms are more responsive to monetary policy shocks during a relatively tranquil period from 1990 through 2007. My sample period runs from 1994 through 2007 and is also relatively tranquil. However, I separate my results into normal times and the 2001 economic downturn. I find that while unconstrained firms are relatively more responsive to monetary policy shocks during normal times, the opposite holds during the economic downturn of 2001. Hence, my results indicate that constrained firms are more responsive to monetary policy shocks during periods of economic downturn when movements in marginal benefit curve are muted due to a lack of investment opportunities or low aggregate demand and the flattening of the marginal cost curve is the dominant force.

Third, I contribute to the long-standing literature operating at the intersection of financial constraints and investment. Fazzari, Hubbard and Petersen (1988), Hoshi, Kashyap and Scharfstein (1991), Whited (1992), Carpenter, Fazzari and Petersen (1998), Rajan and Zingales (1998), and Denis and Sibilkov (2009) among others show that financial constraints dampen firm investment. My findings extend this literature by showing that the investment dampening of financial frictions is amplified in the presence of aggregate shocks that affect firms' marginal costs and marginal benefits of investment.

Fourth, my results are related to the literature on creditor rights. 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 strengthening creditor rights. Li, Whited and Wu (2016) show that firms increase their leverage following the strengthening of creditor rights. Ponticelli and Alencar (2016), Ersahin (2020), Mann (2018), and Favara, Gao and Giannetti (2020) show an increase in investment, firm productivity and innovation output following an increase in creditor rights. I extend this work in two ways. First, I show that the strengthening of creditor rights improves monetary policy transmission. Second, I document that financial constraints are relaxed following the strengthening of creditor rights.

Fifth, my work resonates with the literature on asset pricing using high frequency monetary policy shocks to identify the impact of monetary policy shocks on interest rates (Cook and Hahn (1989), Nakamura and Steinsson (2018*a*)) and stock market returns (Bernanke and Kuttner (2005), Gürkaynak, Sack and Swanson (2005), Gorodnichenko and Weber (2016), Ozdagli and Weber (2017), Ozdagli (2017)). While these studies aim to identify the effect of monetary policy shocks on stock market returns, I attempt to identify the real effects of monetary policy shocks, specifically the effect on private investment.

Next, I lay out the road-map of the paper. Section 2 describes the framework, thought experiment and how it maps with my setting, and a simple model. Section 3 presents the institutional details of the anti-recharacterization law. Section 4 describes the data, empirical strategy, and identification at length. Section 5 presents results from my analysis. Section 6 presents a battery of robustness tests. Section 7 presents the underlying mechanism. Section 8 presents results during the 2001 economic downturn. Section 9 concludes.

2 Framework

This section discusses - (1) the ideal thought experiment required to empirically identify the role of financial frictions in monetary transmission, and (2) a simple model explaining the mechanism and the conditions under which financial frictions affect monetary transmission.

Firms' investment response to monetary policy shocks is theoretically ambiguous. Monetary policy shocks affect the marginal cost and the marginal benefit curve of investment. Bernanke, Gertler and Gilchrist (1999) argue that the monetary policy flattens the marginal cost curve for constrained firms, amplifying their response to monetary policy shocks. Ottonello and Winberry (2020) argue that monetary policy shocks shift the marginal benefit curve of investment for two reasons. First, the shock changes the real interest rates, changing the firm discount rate and consequently the discounted return on capital. Second, the general equilibrium effect of monetary policy shocks changes the relative price of output, real wages, and the relative price of undepreciated capital resulting in changes in the return on capital. Furthermore, Ottonello and Winberry (2020) argue that financial frictions result in a steeper marginal cost curve, dampening the effect of movements in the marginal benefit curve following monetary policy shocks for constrained firms. Hence, in theory, the response of firms to monetary policy depends on the elasticity of the marginal cost curve before the monetary policy shocks, and the shift in the marginal cost and the marginal benefit curves after a monetary policy shock. The theoretical ambiguity in the relative response of constrained and unconstrained firms to monetary policy shocks makes the response of firm investment to monetary policy an interesting empirical question with consequences for the real economy.

2.1 Thought Experiment

A starting point to answer the question at hand is to conceptualize the ideal thought experiment one would need to identify the impact of monetary policy shocks on constrained firms relative to unconstrained firms. This discussion is also useful in understanding the underlying identifying assumptions and how my empirical design relates to the ideal thought experiment.

The thought experiment to address the problem of identification consists of a two-firm, three-period economy. Firms choose their investment level defined by the point of intersection of the marginal cost curve and the marginal benefit curve of investment. Firms face a downward sloping marginal benefit curve, due to the concavity of the production function in capital. Firms face an upward sloping marginal cost curve, due to the presence of adjustment costs and financial frictions.

Let the two firms be identical at $t = 0$. Hence, the two firms, say A and B, operate at the same investment level. At $t = 1$, I randomly reduce the level of financial constraints for one of the firms, say firm A. As a result, the marginal cost curve for firm A shifts rightwards and the slope of the marginal cost curve becomes less steep. This is shown in panel A of figure 1. MC_1^A and MC_1^B shows the marginal cost curves for firms A and B at $t = 1$, respectively. The downward movement of MC_1^A relative to MC_1^B at $t = 1$ results in firm A operating at a higher investment level relative to firm B.

At $t = 2$, I introduce an unexpected aggregate expansionary monetary policy shock shown in panel B of figure 1. This causes the marginal benefit curve to shift outwards to MB_2, as now the firm is discounting its future cash-flows from the investment project at a lower discount rate. The marginal cost curve for firm A (B) shifts to MC_2^A (MC_2^B). The marginal cost curve shifts rightwards and the slope of the marginal cost curve becomes less steep following an expansionary monetary policy shock as financing is cheaper following a decrease in interest rates. The interaction effect of monetary policy with the level of financial constraint is captured by comparing $I_2^A - I_1^A$ with $I_2^B - I_1^B$. If $(I_2^A - I_1^A) - (I_2^B - I_1^B) < 0$, constrained firms react more, else, unconstrained firms are more responsive.

Hence, one can be completely agnostic to the MC and the MB curves to answer the question at hand as long as - (1) the investment levels before and after the monetary policy announcement are observed, (2) monetary policy shocks are unexpected, (3) the differences in the MC curves are exogenously given, and (4) the movement in MB curves is identical for both firms. This thought experiment translates one-to-one with my identification strategy where I measure changes in the level of financial constraint by the enactment of anti-recharacterization laws and combine them with the unexpected monetary policy shocks measured using high-frequency approach employed in Gorodnichenko and Weber (2016). Moreover, I include four digit SIC industry × quarter × year fixed effects and firm fixed effects in my empirical specification identifying the estimate using variation among firms within an industry that are likely to face similar investment opportunities under a spatial equilibrium. Furthermore, I address the issue related to the identical movement in MB curves in section 4.2.1.

2.2 Model

To formally outline the underlying theoretical mechanism, I present a static model featuring convex adjustment costs for new investment in the presence of financial frictions. To outline the key mechanism operating from the steepness of the marginal cost curve and movements in the marginal benefit curve, I present three cases: (1) a frictionless benchmark case, (2) heterogeneity in financial frictions that affects the level of the MC curve but not the slope, and (3) heterogeneity in financial frictions that affects the slope of the MC curve.

2.2.1 Setup

The model has a single period and $i \in I$ firms. Firm i chooses the investment level I_i to maximize its market value. Firms have no internal funds. Each firm has a productivity of α_i, so an investment of I_i results in gross output of $\alpha_i I_i$. Each firm has pledgeable assets with a market value of A_i. Firms face a convex adjustment cost ($\Phi_1(I_i)$) of new investment. The firm borrows I_i at the start of the period and returns $(1+r)I_i$ at the end of the period, where r is the risk-free rate. I assume that $r \geq 0$. In the presence of frictions in creditors' rights, firms face additional convex financing cost ($\Phi_2(I_i)$) of new investment. Firms choose their investment level to maximize the firms' market value.

2.2.2 Case I: Frictionless Benchmark

In a frictionless world, firms maximize the equity market value V_i where $V_i = \alpha_i I_i - (1+r)I_i - \Phi_1(I_i)$. I assume the adjustment cost function to be quadratic in I_i such that $\Phi_1(I_i) = \frac{\phi_i}{2} I_i^2$ where $\phi_i > 0$.

$$V_i = \max_{I_i} \{\alpha_i I_i - I_i - rI_i - \frac{\phi_i}{2} I_i^2\} \tag{1}$$

The function V_i in equation 1 is concave, hence differentiating V_i with respect to I_i gives the value maximizing level of investment in a frictionless world. The value maximizing level of investment is given by:

$$I_i^* = \frac{\alpha_i - 1 - r}{\phi_i} \equiv I_i^{FB} \tag{2}$$

Equation 2 implies that the first-best level of investment I_i^{FB} is increasing in α_i and decreasing in adjustment cost factor ϕ_i and interest rates r. Also, investment takes place only if $\alpha_i > 1 + r$. Moreover, the investment increases with expansionary monetary policy shocks, i.e. $\frac{\partial I_i^{FB}}{\partial r} = \frac{1}{\phi_i} \times (\frac{\partial \alpha_i}{\partial r} - 1) < 0$, if the marginal benefit curve shifts out following an expansionary monetary policy shock, i.e., $\frac{\partial \alpha_i}{\partial r} < 0$.

2.2.3 Case II: Linear Financing Cost in the Presence of Frictions

In this section, I discuss the interest rate response of firm investment in the presence of frictions. To this end, I elaborate on a special case where firms face heterogeneity in their level of MC curves in the presence of frictions but have the same slope. Specifically, I assume that additional financing cost in the presence of financial frictions is linear in investment resulting in MC curves with different levels but same steepness. I assume $\Phi_2(.) = \frac{\theta_i}{A_i} I_i$, where $\theta_i \geq 0$ denotes the looseness of the creditor rights standards. Higher values of

θ_i imply creditor rights are weaker. The creditors discount the asset value A_i to A_i/θ_i while deciding the financing cost for the firm i. The additional financing cost in the presence of friction is proportional to I_i and negatively related to the value of assets discounted for the weakness in creditor rights. Under this setup, firms maximize the equity value V_i given as follows:

$$V_i = \max_{I_i}\{\alpha_i I_i - I_i - rI_i - \frac{\phi_i}{2}I_i^2 - \frac{\theta_i}{A_i}I_i\} \tag{3}$$

The function V_i in equation 3 is concave hence differentiating V_i with respect to I_i gives the value maximizing level of investment:

$$I_i^{*(1)} = \frac{\alpha_i - 1 - r - \frac{\theta_i}{A_i}}{\phi_i} = I_i^{FB} - \frac{\theta_i}{A_i\phi_i} < I_i^{FB} \tag{4}$$

Equation 4 states that the value maximizing level of investment in the presence of frictions is lower than the investment in the absence of frictions. $I_i^{*(1)}$ decreases as creditor rights become weaker. I define the elasticity of firm asset value to changes in interest rate as $\epsilon^i_{A,r} \equiv \frac{r}{A_i}\frac{\partial A_i}{\partial r}$. I assume $\epsilon^i_{A,r} < 0$, and $|\epsilon^i_{A,r}| < \infty$. The first assumption implies that asset values decrease when interest rates increase and the second assumption implies that the interest rate elasticity of assets is finite. Next, I evaluate the response of investment to changes in interest rates.

$$\frac{\partial I_i^{*(1)}}{\partial r} = \underbrace{\frac{\partial I_i^{FB}}{\partial r}}_{<0} + \underbrace{\frac{\theta_i}{A_i\phi_i r}\epsilon^i_{A,r}}_{<0} < 0 \tag{5}$$

In equation 5 changes in interest rates affects investment through two channels. The first term captures the effect through the changes in the direct financing costs and movements in the marginal benefit curve as in the frictionless case. The second term captures the balance sheet effect operating through changes in asset value following interest rate shocks captures the balance sheet effect. The balance sheet effect of monetary policy flattens the MC curve for constrained firms, amplifying their response to monetary policy shocks. This results in a clear prediction of $|\frac{\partial I_i^{*(1)}}{\partial r}| > |\frac{\partial I_i^{FB}}{\partial r}|$, implying that constrained firms are more responsive to monetary policy shocks.

Figure 2a provides a diagrammatic representation of the effect discussed above. The marginal cost curve of the firm in the frictionless environment moves from MC_1 to MC_1' and the marginal cost curve of the firm facing linear financing cost due to the presence of a financial friction shifts from MC_2 to MC_2' following an expansionary monetary policy shock. The MC_2 curve has an additional downward shift due to the presence of financial friction, such that $MC_2 - MC_2' = (MC_1 - MC_1') + \theta \times (\frac{1}{A} - \frac{1}{A'})$, due to the balance sheet effect. This additional downward shift in the MC_2 increases the response of the constrained firm relative to unconstrained firm, i.e., $I_2' - I_2 > I_1' - I_1$. Moreover, the difference increases as the friction (θ) increases. The movement in the marginal benefit curve does not seem to play a significant role in determining the relative response of the two firms.

2.2.4 Case III: Convex Financing Cost in the Presence of Frictions

In this section, I discuss firms' investment response to interest rate changes when financial frictions generate heterogeneity in the slope of the MC curve. For illustration I assume $\Phi_2(.) = \frac{\theta_i}{2A_i} I_i^2$. In this case, the financing cost increases rapidly relative to the linear case. This rapid increase in financing cost reflects that as a firm borrows more, it moves closer to its default frontier and creditors need to be compensated for this additional risk. In this setup, keeping the market value of assets fixed, an increase in financial frictions makes the MC curve steeper. Firms maximize the equity value V_i to choose their value maximizing investment ($I_i^{*(2)}$) level.

$$V_i = \max_{I_i} \{\alpha_i I_i - I_i - rI_i - \frac{\phi_i}{2} I_i^2 - \frac{\theta_i}{2A_i} I_i^2\} \tag{6}$$

$$\Rightarrow I_i^{*(2)} = \frac{\alpha_i - 1 - r}{\phi_i + \frac{\theta_i}{A_i}} = \frac{A_i \phi_i}{\theta_i + A_i \phi_i} I_i^{FB} < I_i^{FB} \tag{7}$$

Given the concavity of V_i in equation 6, differentiating V_i with respect to I_i gives the value maximizing investment ($I_i^{*(2)}$) level as in equation 7 which is lower than I_i^{FB} as $\theta_i > 0$. Next, I evaluate the response of $I_i^{*(2)}$ to changes in interest rates.

$$\frac{\partial I_i^{*(2)}}{\partial r} = \underbrace{\frac{A_i \phi_i}{\theta_i + A_i \phi_i}}_{\in (0,1)} \{ \underbrace{\frac{\partial I_i^{FB}}{\partial r}}_{<0} + \underbrace{\frac{\theta_i}{\theta_i + A_i \phi_i} \frac{I_i^{FB}}{r} \epsilon_{A,r}^{i}}_{<0} \} < 0$$

Monetary policy shocks affect firm investment in this setup via three forces: (1) the direct effect of changes in financing costs and the movements in the marginal benefit curve as in the frictionless benchmark, (2) the amplification of monetary policy changes operating via the balance sheet effect, and (3) financial frictions result in a steep MC curve, dampening the effect of movements in the marginal benefit curve. While expansionary monetary policy shocks flatten the steep MC curve for firms facing convex financing cost due to frictions, the ex-ante steepness of MC curve due to such financial frictions dampens the effect of movements in the marginal benefit curve. Hence, response of constrained firms to monetary policy shocks relative to unconstrained firms is theoretically ambiguous in such a setup. The dampening effect dominates when interest rates are high or when shifts in the MB curve following monetary policy shocks are large. This makes unconstrained firms more responsive to monetary policy shocks. On the other hand the amplification, operating via the balance sheet effect, dominates during periods of low interest rates or during periods when investment opportunities are scarce, such as economic downturns, making constrained firms more responsive to monetary policy shocks.

Figure 2b provides a diagrammatic representation of the two competing effects discussed above. The MC curve, MC_1, for the frictionless firm experiences only a parallel downward movement, to MC_1', following an expansionary monetary policy shock. The MC curve for the constrained firm, denoted by

MC_2, has the same intercept as MC_1, but the presence of quadratic financing cost due to financial frictions increases its steepness. An expansionary monetary policy shock shifts the MC_2 curve downward and flattens it because of increase in the asset value. Furthermore, the marginal benefit curve shifts out from MB to $MB^{'}$. The effect of movement in the marginal benefit curve is dampened when a firm faces a steep MC curve. The net effect of monetary policy shocks on the unconstrained firm relative to constrained firm, in this setup, could be higher if the flattening of the MC curve for the constrained firm following the monetary policy shock is not high enough.

3 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 uncertainity 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

[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.

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 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 indeed the results are driven by state-specific conditions which led to the enactment of the law, I should 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) show that firms' leverage changes significantly after the implementation of anti-recharacterization laws, originating from movements in the position of the collateral constraint. 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 the stronger creditor rights, due to anti-recharacterization laws, relax borrowing constraints and help firms adopt more efficient production technologies. Favara, Gao and Giannetti (2020) 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.

4 Data and Methodology

4.1 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. The data on macroeconomic factors, effective Fed funds rate, GDP,

[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.

[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.

CPI and unemployment rate (UR) is sourced from the website of the Federal Reserve Bank at St. Louis. The data on the economic policy uncertainty index is obtained from the website of the Policy Uncertainty Project.[6]

4.1.1 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 within the Fed Funds futures in 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

$$\Delta\varepsilon_t = \frac{D}{D-d}(\nu_{t+\Delta^+} - \nu_{t-\Delta^-}) \tag{8}$$

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 (2018*a*) 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 (2018*a*), and Bu, Rogers and Wu (2020) – discussed in detail in appendix B.

4.1.2 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

[6]The data on economic policy uncertainty was accessed from https://www.policyuncertainty.com/us_monthly.html.
[7]I use the terms monetary policy surprise and monetary policy shock interchangeably.

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 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 basis points (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.

4.1.3 Treatment and Control Firms

In this section, I discuss the definition of the treated firms and the on-off variable - $1(Law_{st} = 1)$. The treatment is defined 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 observation in the sample.

4.2 Empirical Strategy

I closely follow the thought experiment presented in section 2 to construct my estimation strategy. I begin my analysis by showing that unexpected monetary policy shocks and investment are negatively related, i.e., investment increases (decreases) following expansionary (contractionary) monetary policy shocks. Then, I show that strengthening of creditor rights increases investment and relaxes financial constraints. After establishing these key results, I study the joint impact of the enactment of the law and aggregate monetary policy shocks. My baseline empirical specification is as follows:

$$\Delta logI_{it} = \beta_0 \cdot 1(Law_{st} = 1) \times \Delta\varepsilon_t^q + \beta_1 \cdot 1(Law_{st} = 1) + \gamma_i + \theta_{jt} + \Gamma Z_{it} + \nu_{it} \quad (9)$$

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 $\Delta logI_{it}$, 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. Industry is defined using the four-digit SIC number. In robustness analysis I also include Z_{it}, a vector of firm specific characteristics: natural logarithm

[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.

of the book value of assets, 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 4.1.3. 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).

4.2.1 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. I also control for the interaction term of average Q and monetary policy surprises to best account for any firm-level difference in investment opportunities within an industry.

For identification, I also require that the unexpected monetary policy shocks are uncorrelated with the idiosyncratic conditions in treated states after treatment. The objective of the Fed is overall price stability and nationwide employment hence, by mandate, the Fed is not allowed to react to local economic conditions. Given that the law was active in two states (Texas and Louisiana) from 1997 and 2003, and Alabama for a period of three years it is difficult to argue that the Fed was announcing policy based on conditions in these three states and not aggregate macroeconomic factors. One could argue that idiosyncratic shocks can result in aggregate shocks when firms exhibit a power-law distribution (Gabaix (2011)). However, this would require that the majority of observations in the fat tails (percentage of large firms) to be concentrated in states where the law was passed. The spatial distribution of large firms shows that on average only 11.8% of top 500 firms, by average sales during the sample period, were located in law-active states. Though I cannot completely rule out all explanations that can drive the correlation between monetary policy shocks and idiosyncratic conditions in states where the law was enacted, it is reasonable to assume that this correlation is small or insignificant.

5 Results

5.1 Creditor Rights, Financial Constraints, Investment and Monetary Policy

This section documents the aggregate effect of monetary policy shocks on firm investment and the impact of strengthening creditor rights on firm investment and financial constraints. It is important to establish these relationships to validate the underlying assumptions of the thought experiment.

Table 2 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 3 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.

Lastly, I evaluate the impact of the strengthening of creditor rights on firm financial constraints. The impact of the strengthening of creditor rights is evaluated using four measures of financial constraints: (1) firm size, measured as the natural logarithm of the book value of assets,[9] (2) Size-Age (SA) Index of Hadlock and Pierce (2010), (3) synthetic Kaplan-Zingales (KZ) Index presented in Lamont, Polk and Saaá-Requejo (2001) based on estimates of Kaplan and Zingales (1997), and (4) Whited-Wu (WW) Index of Whited and Wu (2006). A larger magnitude of firm size implies lower financial constraint whereas a larger magnitude of SA, KZ, and WW Index implies greater financial constraint. Table 3 reports the results of the impact of the law on different measures of financing constraints. The enactment of the law increases firm size and decreases different measures of financial constraints among the treated firms relative to the control firms. These results are statistically significant and imply that the level of financial constraints decreased among

[9] Hennessy and Whited (2007) report that external financing costs decreases sharply as firm grows indicating that financing costs are closely related to firm size.

treated firms relative to the control firms following the enactment of the law. The results indicate that firms' experienced reductions in financial constraints across all conventional measures following the enactment of the law.

5.2 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. 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.

Figure 4 provides suggestive evidence that treated firms are more responsive to monetary policy shocks during the period when the law was active. The point estimates for the three periods are estimated separately, regressing the change in natural logarithm of investment on treatment dummy, monetary policy surprise, and the interaction of the two. The first period is the pre-law period before 1997. The second period is between 1997 and 2003 when the law was active, and the third period is the period from 2004 to 2007. The point estimate for the pre-period and the post-period are small in magnitude and statistically indistinguishable from zero. The point estimate for the active period is negative and statistically different from zero. Additionally, the χ^2 statistic for the test that the estimates in the pre and post active periods are equal to the active period is 16.83 indicating that the difference in the estimates are statistically significant.

Table 4 reports the results from the estimation of equation 9 with change in the natural logarithm of capital expenditure as the dependent variable. Column (1) presents the results from the estimation of equation 9 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. Column (2) and (3) re-estimate equation 9 with industry and industry-time fixed effects respectively. Finally, in column (4), equation 9 is estimated with the 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 non-time varying firm specific observable and unobservable characteristics. The point estimates reported in column (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.

[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. The results are robust to computing standard errors two-way clustered at state and quarter-year level estimated using wild bootstrap methodology of Cameron, Gelbach and Miller (2008), or clustering at alternative levels such as firm, four-digit SIC industry, etc., see appendix table C.1.

[11] 1 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.

Next, I evaluate the asymmetric impact of monetary policy shocks. Consistent with the prior work of Bernanke and Kuttner (2005), Ozdagli and Weber (2017), Neuhierl and Weber (2018), among others that document an asymmetric effect of monetary policy shocks on stock market returns, I document an asymmetric impact of monetary policy shocks on firm investment growth in my setting. Columns (5) and (6) re-estimate equation 9 separately for negative and positive surprises respectively. The results indicate that expansionary surprises result in a greater response by unconstrained firms relative to contractionary monetary policy surprises. The response is statistically and economically insignificant for contractionary monetary policy surprises. I conduct a Wald test to evaluate the statistical difference among the estimated coefficients in column (5) and (6). The value of χ^2 test statistic is 3.79, rejecting the null that the two point estimates are the same at the 10% level of significance. The asymmetric effect can be explained by investment being irreversible. Under irreversible investment the impact of contractionary shocks manifests via retardation in announcements of new projects whereas the impact of expansionary shocks propagates via acceleration in announcements of new projects and expansion of existing projects. Moreover, minimum depreciation investment expenses is fundamental to a firm's continued operations. Hence, a contractionary shock would not affect the firm's decision to invest in fundamental minimum depreciation investment expense, whereas cheap financing might encourage firms to incur more than mandatory minimum depreciation investment expense.

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:

$$LogI_{i,t+h} - LogI_{i,t-1} = \beta_h^0 \cdot 1(Law_{st} = 1) * \Delta\varepsilon_t^q + \beta_h^1 \cdot 1(Law_{st} = 1) + \alpha_i + \theta_{jt} + \nu_{it} \quad (10)$$

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 5 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).

5.2.1 Testing for Parallel Trends

A necessary condition for identification is the parallel-trends assumption. The counterfactual outcome in the absence of the law change is unobservable hence I cannot test for this assumption directly. However, I can evaluate the extent to which the impact of monetary policy on firm investment is parallel among treated and control firms before the change in the law. Under the parallel trends assumption, any divergence between the control and the treated firms after the law change can be attributed to the change in law. Hence, the path of the control firms after the law change can be viewed as a valid counterfactual to the trajectory of the treated firms had they not been exposed to the anti-recharacterization laws.

The empirical design is not a pure DID, but an on-off strategy. Hence, I consider the states of Texas, Louisiana and Alabama that passed laws before 2002 and consider the sample up to 2003. This sample cut allows me to do a standard pre-trends assessment.

Figure 6 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. Figure 6 plots the estimates of β_0^k and the 95% confidence intervals for the equation:

$$\Delta log(I_{i,t}) = \sum_{k=-4, k\neq -1}^{k=+4} \beta_0^k \cdot 1(Treatment_i = 1) \times \Delta\varepsilon_t^q \times Time_t^k + \alpha_i + \theta_{jt} + \nu_{it} \tag{11}$$

where $Time_t^k$ takes a value of 1 if the year is k years before or after the passage of the law for treatment firms and years before or after 1997 for the control group. The omitted category is $Time_t^k = -1$ and I interpret β_0^k as the effect of the interaction term on firm investment at $Time_t^k = k$ relative to $Time_t^k = -1$. Based on the point estimates and the 95% confidence interval, I reject (1) the average effect of monetary policy on the treated and the control group is the same before and after the law change and (2) the average effect of monetary policy on the treated and the control group is different before the law change. Hence, I rule out the possibility that my results are driven by any pre-trends.

6 Robustness Checks

In this section I conduct a battery of robustness tests to ensure the stability and the validity of the baseline results. Overall, the tests indicate that the baseline results are not driven by firm-specific or macroeconomic covariates. Results are robust to alternative measurements of firm investment and monetary policy shocks. Results are robust to entry and exit of firms and in samples where control firms are matched with treated firms based on pre-law firm-specific covariates. Moreover, the baseline results cannot be replicated in a placebo test and a falsification test.

6.1 Omitted Variable Bias

Oster Test: The results in table 4 show that the estimate of interest does not change drastically, even though the R^2 increases by 10 pp from column (1) through (4). Oster (2019) suggests a test for the omitted variable bias based on the methodology proposed in Altonji, Elder and Taber (2005). The test uses the information contained in the change in the magnitude of the estimate and the model R^2 as more controls are added. 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, we 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.

Controlling for Firm-specific Characteristics: Appendix table C.2 attempts to address the issue of omission of firm-specific characteristics by controlling for the 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. Values of firm-specific characteristics during the quarter just before the enactment of the law for the treated firms and the values during the fourth quarter of 1996 for the control firms are used instead of contemporaneous time-varying firm characteristics. Contemporaneous time-varying firm characteristics may not serve as a perfect control as they might be responsive to the enactment of the law. Therefore, employing characteristics just before the enactment are better suited to control for other firm-specific characteristics.[12] Specifically, table C.2 controls for the interaction term of these static firm covariates with $\Delta\varepsilon_t^q$ and examines the point estimate of the interaction term of $1(Law_{st} = 1)$ and $\Delta\varepsilon_t^q$. The point estimate of the interaction term of $1(Law_{st} = 1)$ and $\Delta\varepsilon_t^q$ is consistently negative, statistically significant, stable in magnitude and qualitatively similar to the estimates reported in table 4. The point estimates associated with other firm-specific variables are mostly insignificant, consistent with Ottonello and Winberry (2020). Moreover, the significance and the sign of the estimate for cash to assets ratio resonates with the results in Jeenas (2018) indicating the firms with low liquidity are more responsive to monetary policy shocks.

Controlling for Macroeconomic Variables: Appendix table C.4 addresses the issue associated with the omitted variable bias pertaining to macroeconomic variables. While high-frequency identification allows measurement of monetary policy surprises, it does not completely rule out the fact that these surprises could still be reactionary to aggregate macroeconomic conditions. I address this issue, by estimating equation 12, where Δz_t^q denotes a vector of macroeconomic variables including the gross domestic product, unemployment rate, consumer price index, and economic policy uncertainty index.

$$\Delta log(I_{i,t}) = \beta_0 1(Law_{st} = 1) \times \Delta\varepsilon_t^q + \sum_{z \in Z} \beta_z 1(Law_{st} = 1) \times \Delta z_t^q + \beta_1 1(Law_{st} = 1) + \alpha_i + \theta_{jt} + \nu_{it} \tag{12}$$

Appendix table C.4 reports the estimation results for equation 12. The estimated coefficients for the interaction term of the law change and $\Delta\varepsilon_t^q$ are qualitatively similar in magnitude, sign, and statistical significance to the estimates reported in table 4. The interaction terms for most of the macroeconomic variables are insignificant as also observed in Ottonello and Winberry (2020). However, the interaction term of $1(Law_{st} = 1)$ with the change in the consumer price index (ΔCPI_t^q) in column (4) and the change in economic policy uncertainty (ΔEPU_t^q) in column (5) are statistically significant. Unconstrained firms reduce investment more during inflationary periods relative to constrained firms, whereas unconstrained firms reduce investment less during periods of high policy uncertainty relative to constrained firms. The

[12] Nevertheless, I report estimation results similar to table C.2 in appendix table C.3 using contemporaneous time-varying firm characteristics. The estimates in appendix table C.3 are qualitatively similar to the estimated results in table C.2.

second finding is consistent with the theory and evidence on uncertainty multiplier effect presented in Alfaro, Bloom and Lin (2018) and Favara, Gao and Giannetti (2020).

6.2 Other Robustness Tests

This section examines the robustness of baseline results reported in table 4 to alternative measures of firm investment and monetary policy shocks, the entry and exit of firms, and alternative samples based on creating control groups depending on firms in states geographically neighbouring the treated states and a matched sample of control firms.

Identifying Assumption: Industry leaders may have access to better investment opportunities. Moreover, industry leaders could be more responsive to monetary policy shocks (Kroen et al. (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 $Industry \times Size-Declie \times PP\&E-Decile \times Sale-Decile \times Qtr-Year$ fixed effect. Appendix table C.5 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 4.

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 appendix table C.6 reflect 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 (2018*a*) monetary policy shocks.[13] 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 appendix table C.7 reflects that the results are qualitatively similar to the results in table 4.

Entry and Exit of Firms: Third, to verify that the results are not plagued by entry and exit of firms

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

over the sample period, I estimate baseline equation 9 for a balanced panel of firms between 1994 and 2007.[14] The results from a balanced panel estimation of equation 9 reported in table C.8 are qualitatively similar to the baseline results in table 4.

Matched 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 appendix table C.9 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 within the same 4-digit SIC industry. 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.[15] The results reported in column (1) and (2) are qualitatively similar to the baseline results in table 4, indicating that the ex-ante differences in the control and the treatment group are unlikely to drive the results.

Other Sample Concerns: Lastly, appendix table C.9 addresses some other sample issues. 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 only the states of Texas and Louisiana as treated states and drops other treated states. The test in column (4) does not exploit the staggered nature of the laws and thus helps mitigate the concern that a staggered differences-in-differences design may possibly bias the estimate (Borusyak and Jaravel (2017)). Column (5) includes firms headquartered or incorporated in Delaware as treated and the on-off indicator variable switches on for these firms for 2002. As before the estimates in column (3), (4) and (5) are qualitatively similar to the baseline estimate. Moreover, I conduct a jackknife estimation in appendix table C.10 to show that the baseline results are not driven by a specific time-period, state, industry or firm.

[14] It is plausible that the strengthening of creditor rights reduces financial frictions and makes the entry of firms just below the margin feasible, therefore increasing investment due to the entry of new firms. Alternatively, an increase in protection of creditor rights can increase liquidation bias resulting in greater exit. The increase in firm liquidation could either decrease or increase investment. It can increase investment if the increased liquidation is efficient, as now the freed up resources from the liquidated firms can be allocated to more efficient firms. On the other hand, liquidation bias could result in firms following a conservative financing and investment policy (Vig (2013)).

[15] Appendix figure C.1 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 C.2 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.

6.3 Addressing Spuriousness: 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. To address this concern, I conduct a placebo test for my baseline specification 9. 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 placebo on-off variable - $Placebo - Year$. $Placebo - Year$ switches to one after the random year and switches back to zero after 2002. The coefficient of $Placebo - Year \times \Delta\varepsilon_t^q$ in baseline equation 9 is estimated. This exercise of generating the point estimate associated with $Placebo - Year \times \Delta\varepsilon_t^q$ 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 C.3 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 4 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.

6.4 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 show the 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 are 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 C.11 reports the results for the falsification test. Appendix table C.11 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 $1(Pre-2003_{st}=1)\times\Delta\varepsilon_t^q$ is still statistically significant and similar in magnitude to the ones reported in column 4 of table 4. Hence, I can rule out issues related to endogeneity of the law as I do not observe significant treatment effect among firms headquartered or incorporated in the late states.

7 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 high fixed assets, greater asset tangibility and greater reliance of secured debt. Third, the effect is dominant among firms with greater ex-ante likelihood of using an SPV. Fourth, I document that the results seem to be driven in periods when firms face greater contractual and wage rigidity.

7.1 Pure Monetary Policy Effect & Fed Information Effect

The usage of narrow windows around the FOMC announcement allows identification of pure monetary policy shocks under the assumption that no other news is systematically released. However, Romer and Romer (2000), Nakamura and Steinsson (2018*a*), 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.

This is likely to be of little concern for my results for two 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)). 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. Second, 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 (2020) 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 estimates as constrained firms are likely to be more responsive to 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).[16] These alternative shocks measure the pure 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 C.12 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 (2018*a*)). Overall, the results indicate that the baseline estimates reported in table 4 are unlikely to be driven by the Fed information effect.

7.2 Within-Sector Results

This section discusses the cross-sectional response of firms to monetary policy surprises given the treatment shock within sectors.[17] This analysis fosters a better understanding of the underlying mechanism. The enactment of these laws improved the protection of creditor rights in case of secured lending. Some sectors such as construction, mining and manufacturing by 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.

Figure 7 and appendix table C.13 report the results for sector-specific point estimates of the interaction term of law and monetary policy surprise.[18] The baseline result seems to be driven by the manufacturing sector, forming approximately 50% of the observations in the sample. The estimate is highest in magnitude for the mining sector, followed by the construction sector and then the services sector. The greater magnitude of the mining and manufacturing sectors can be attributed to the high amount of fixed assets in these two sectors readily available as collateral for secured borrowing. The high magnitude of the services sector

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

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

[18] 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.

is driven by the high incidence of borrowing secured by patent collateral in this sector. Mann (2018) documents that programming and data processing industry (SIC code 737) within the services sector is the third largest benefactor of patent collateral. The prominence of the result for certain sectors point to the fact that the results are driven by firms engaged in secured lending as these firms are likely to be the primary beneficiaries of the strengthening of creditor rights to seize collateral.

7.3 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.[19] The likelihood of SPV usage of firms is a non-time-varying estimate and estimated using the pre-law sample 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 5 tests whether firms with 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 $\times$ industry $\times$ quarter $\times$ 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 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.

7.4 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 increase their investment relative to similar but more constrained firms following a relaxation of monetary policy. Specifically, table 6 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, this effect on debt growth

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

is more significant for firms with a higher likelihood of SPV usage, which are likely to benefit the most from the anti-recharacterization laws.

7.5 Contractual and Wage Rigidity

A class of macroeconomic theories exploit contractual rigidities to explain why monetary policy shocks could affect the real output (Christiano, Eichenbaum and Evans (2005)). Weber (2014) argues that an increase in nominal rigidities is associated with a greater response to monetary policy shocks. Consistent with the extant literature, this section documents that the effect of monetary policy shocks on treated (unconstrained) firms relative to control (constrained) firms is more pronounced when monetary shocks occur during periods of greater contractual and wage rigidity.

I exploit the uneven staggering of nominal rigidities across quarters, exploited earlier in Olivei and Tenreyro (2007), to identify the cross-sectional response to monetary policy shocks during times of greater rigidity relative to times of lower rigidity. Olivei and Tenreyro (2007) document that firms face higher wage and contractual rigidity in the first and the second quarter of the year relative to the last two calendar quarters of the year.[20]. They document a differential response of real output to monetary policy shocks based on the timing of these shocks during the year, i.e., the response of real output to monetary policy surprises is smaller in the second half of the year as these are periods of lower rigidity.

I show that the results are more prominent - in terms of magnitude, direction of response, and the longevity of response - in the first two calendar quarters of the year when firms face high wage and contractual rigidity. Figure 8 reports the results from the Jordà (2005) style linear projection for each quarter. Panel 8a reports the response of investment of unconstrained firms relative to constrained firms to monetary policy surprises occurring in the first quarter. The differential impact rises monotonically until seven quarters after the shock indicating a high elasticity of -0.08. Panel 8b reports the results for shocks in the second quarter. The impact in the second quarter is smaller relative to the impact in the first quarter, however the effect is strongly persistent two quarters after the shock. The results in panel 8c reports that the response to shocks in the third quarter dampen quickly after three quarters, and the impact of shocks in the fourth quarter as shown in panel 8d goes in the wrong direction. Figure 8 shows that the heterogeneous response of firm investment to monetary policy surprises in the first and second quarter is larger in magnitude, more persistent and goes in the expected direction in contrast to the response to surprises occurring in the third and the fourth quarter. Economically a 25 bps expansionary monetary policy shock results in a persistent 4 pp increase in investment growth of unconstrained firms relative to constrained firms following a shock in the second quarter of the calendar year and a maximum impact of 8 pp increase in investment growth of unconstrained firms relative to constrained firms following a shock in the first quarter of the calendar year.

A related concern is that the different responses to monetary policy surprises in different quarters results from different types of shocks over the year. Uhlig (2005) shows that differences in the type of shocks could produce different impulse responses. I explore this issue by testing for the equality of distribution of

[20] See the discussion in Olivei and Tenreyro (2007) for more details of the evidence that points to the fact that firms face higher contractual and wage rigidity during the first half of the year.

monetary policy surprises across quarters using the Kolmogorov-Smirnov test. In a pairwise comparison of distributions of monetary policy surprises for each quarter, I cannot reject the null hypothesis of identical distributions while comparing any two quarters. This indicates that the differences in the directions of the shocks across quarters are unlikely to provide a counter-explanation for the different impulse responses.

7.6 Disentangling the Marginal Benefit and Marginal Cost Channels

This section develops a heterogeneous firm New Keynesian model. This model is a simplified version of Ottonello and Winberry (2020) without idiosyncratic capital quality shocks and adds to my analysis in two ways.[21] First, it extends the discussion of section 2.2 and allows me to interpret the evidence in a dynamic framework. Second, I can study the relative quantitative importance of the marginal benefit and the marginal cost channels in driving the cross-sectional result. This is the key advantage of the model as my empirical tests cannot completely disentangle the contributions of the two channels.

7.6.1 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 (2014) 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). Each firm produces an undifferentiated good using capital stock and labor as inputs. The idiosyncratic shocks to TFP are realized at the beginning of each period. A firm decides to default or continue its operations. Conditional on default, the firm ceases to exist, lenders recover a fraction of the firm's capital stock with remaining capital being transferred lump-sum to households. Continuing firms must pay back the face value of their outstanding debt and a fixed operating cost. Firms purchase new capital. Firms have two sources of investment finance, each of which is subject to frictions. First, firms can issue new nominal debt. Lenders offer a price schedule for this debt such that it prices the firm-specific default risk competitively. Second, firms can use internal finance by lowering dividend payments but cannot issue new equity, which bounds dividend payments to greater than equal to zero. Appendix section D.1 provides details of this ingredient and also the solution to the firm problem.

The second ingredient 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. Appendix section D.2 provides details of this ingredient of the model. 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. Appendix section D.3 provides details of this ingredient of the model.

7.6.2 Discussion on Channels

The objective of this exercise is to quantitatively analyze the relative effects of monetary policy surprises – given by the innovations to the Taylor rule – on constrained and unconstrained firms and characterize the

[21] I direct the readers to appendix D for the details of the model.

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. Appendix section D.4 provides the mathematical expressions associated with the two channels.

Marginal Cost Curve: The MC curve is the product of two terms. The first term is the relative price of capital net of interest savings due to higher capital. The interest savings result from the fact that higher capital decreases expected losses due to default to the lender, *ceteris paribus*. The second term is related to borrowing cost and denotes that higher interest rate spreads or higher slope of that spread result in higher borrowing costs. The MC curve is flat when capital accumulation can be financed without incurring default risk and becomes upward sloping when borrowing creates default risk as it creates a credit spread. Monetary policy shocks affect the MC curve through three forces. First, these shocks affect the aggregate investment demand changing the relative price of capital. Second, monetary policy shocks affect firms' net worth, which changes the amount the firm needs to borrow to finance any level of investment and its probability of default. Third, monetary policy shocks affect the credit spreads both directly and indirectly. The indirect effect on credit spreads occurs due to its impact on the relative price of capital which changes the lenders' recovery rate. 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).

Marginal Benefit Curve: 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 and the change in default threshold. Finally, the effect of the monetary policy shocks on investment due to movements in the MB curve is more pronounced for unconstrained firms as they face a flatter MC curve of investment and is similar in spirit to the effect presented in Ottonello and Winberry (2020).

7.6.3 Decomposing the Channels of Monetary Policy Transmission

This exercise aims to quantitatively discipline the shifts in the MC and the MB curve – following monetary policy shocks – and their relative impacts on constrained and unconstrained firms.[22]

I then estimate the monetary policy semi-elasticity of investment for unconstrained firms relative to constrained firms. This estimate of semi-elasticity is presented in table 7. Although I do not target this semi-elasticity, it is remarkably close to my baseline empirical estimate. I proceed by eliminating from the model the movements in the MC curve and the MB curve one at a time. This counterfactual exercise analyzes how the absence of each of these channels affects the relative response of unconstrained and constrained

[22] I discipline the model by targeting the empirical moments on log(investment), Δlog(investment), mean gross leverage ratio, firms with positive debt and mean default rate, and fitting key parameters. The model does a good job in matching the empirical moments. I refer the readers to appendix section D.5 for the details of this exercise.

firms to monetary policy. Row 2 of table 7 presents the estimate of semi-elasticity from a version of the model without movements in the MC curve. I find that the sensitivity of unconstrained firms to monetary policy shocks relative to the constrained firms increases by 73%. Row 3 of table 7 presents the estimate of semi-elasticity from a version of the model without movements in the MB curve. I find that the sensitivity of unconstrained firms to monetary policy shocks relative to the constrained firms decreases by 173%, and the overall estimate of semi-elasticity is positive. The two results taken together indicate that the movement in the MB curve due to monetary policy shocks amplifies the response of unconstrained firms, and the movement in the MC curve due to monetary policy shocks amplifies the response of constrained firms. Overall, the movement in the MB curve due to monetary policy shocks dominates the financial accelerator effect. Hence, the response of unconstrained firms to monetary policy shocks is greater than the constrained firms' response.

8 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). However, 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. Additionally, periods of economic downturn are often marked by a reduction in interest rates by central banks. The model presented in section 2.2 shows that during periods of low-interest rates the amplification effect via the firm balance sheet channel gains dominance. The reversal effects of monetary policy at low interest rates has also been documented in Brunnermeier and Koby (2018) and Wang et al. (2020). Therefore, I exploit the recession of 2001 characterized by decline in aggregate demand, binding financial constraints, and low interest rates to test for the presence of the financial accelerator effect.

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 values 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 a Fed Funds rate of 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 8 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 is still 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.

A key point to discuss is if this change in the result during the 2001 economic downturn is driven by a lack of investment opportunities or the relationship reversal in a low-interest rate regime. Wang et al. (2020) document that the reversal-rate phenomenon is observed in a region when interest rates are below 0.9%. However, the effective Fed funds rate reached a minimum value of 1.82% during the 2001 economic downturn and straddled the value of 1% in 2003. Therefore, since the effective Fed funds rate did not enter the Wang et al. (2020) reversal-rate region, it is unlikely that the reversal rate effect drives my results. Moreover, 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 C.4).

9 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 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 the protection of creditor rights to identify a decrease in financial constraint, I show that the investment growth of treated firms is more sensitive to monetary policy shocks relative to the control firms. Second, I identify the underlying forces via which the strengthening of creditor rights relaxes financial constraints and amplifies monetary transmission. Greater investment in treated firms following a monetary policy surprise is concentrated in sectors associated with extensive usage of fixed assets and engagement in secured borrowing. The effect is dominant among firms with a greater likelihood of using an SPV and during periods of greater contractual and wage rigidity.

However, I show that during periods of economic downturn marked by low investment opportunities, constrained firms are more responsive to monetary policy shocks relative to unconstrained firms. This is because 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.

The results improve our understanding of the monetary transmission mechanism. The results could independently inform policymakers about the differential impact of monetary policy across firms. Conventional wisdom suggests that monetary policy affects constrained firms more than the unconstrained firms. In contrast, my results imply that unconstrained firms respond more relative to constrained firms, at least during normal times. However, constrained firms exhibit greater sensitivity to monetary policy shocks relative to unconstrained firms during periods of economic downturn marked by low interest rates. The cross-sectional elasticity identified in this paper can potentially be useful in disciplining quantitative macroeconomic models with competing mechanisms - in the spirit of Nakamura and Steinsson (2018*b*) - which I leave for future work.

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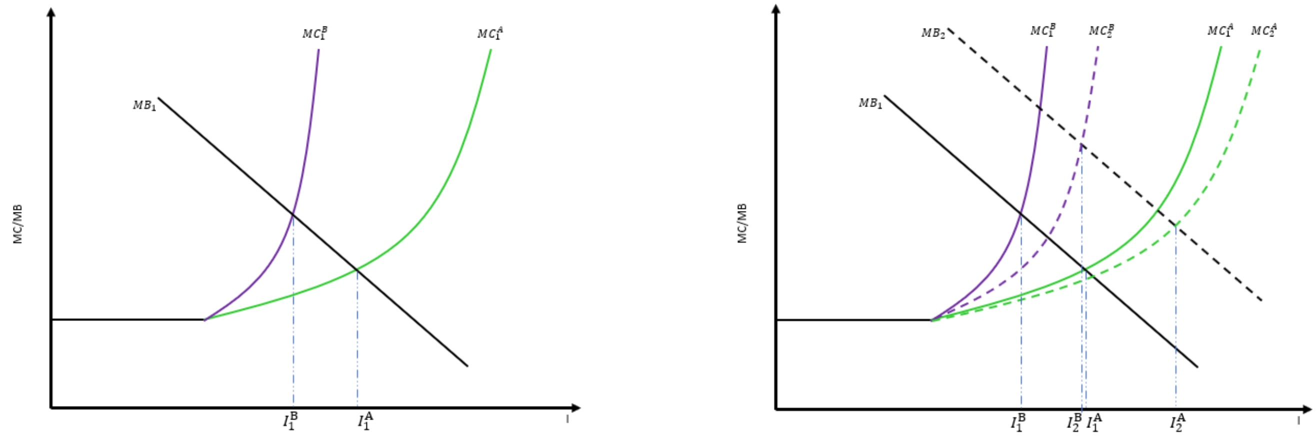
Figure 1: Thought Experiment



(a) Economy at $t = 1$

(b) Economy at $t = 2$

The figure plots the marginal cost and the marginal benefit curves of investment for firms. MC and MB denote marginal cost and marginal benefits respectively. There are two firms A and B. Firm A is less financially constrained relative to firm B. The subscript on MC and MB denote the time and the superscript denotes the firm A or B. The following time-line shows the series of events in the thought experiment.

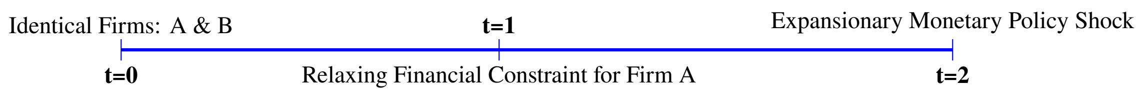
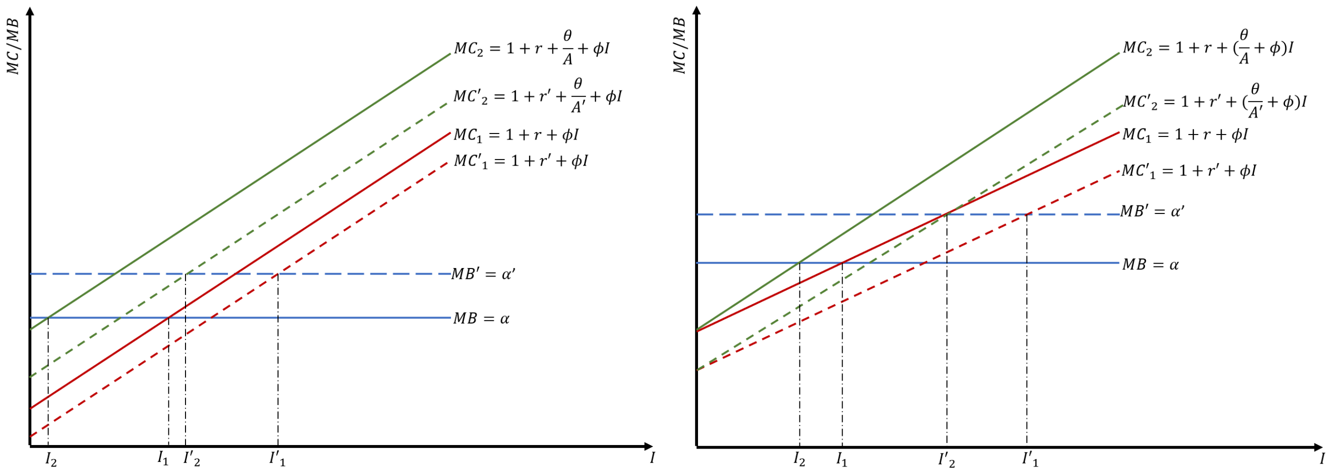


Figure 2: Response of firms with different MC curves to expansionary monetary policy shock

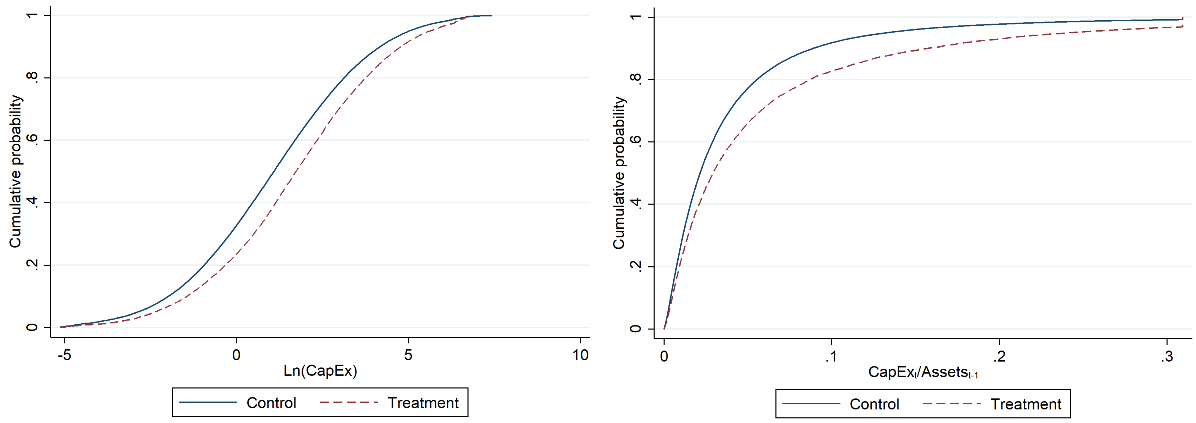


(a) Case II: Linear Financing Cost in the Presence of Frictions

(b) Case III: Convex Financing Cost in the Presence of Frictions

The figure plots the response of firms with different marginal cost (MC) curves to an expansionary monetary policy shock. Investment is on the X-axis and the MC/MB is on the Y-axis. r denotes the risk-free rate. θ denotes the creditor rights friction, $\theta = 0$ implies no friction and the creditor rights become weak as θ increases. A denotes the value of firm assets and ϕ denotes the adjustment cost parameter. α denotes the marginal benefit of investment and $\alpha > 1 + r$. Figure 2a compares the monetary policy response of a firm facing linear financing cost due to the presence of financing frictions (denoted by MC_2) with a firm operating in a frictionless environment (denoted by MC_1). An expansionary monetary policy shock moves the MC curves of both firms downwards. Figure 2b compares the monetary policy response of a firm facing convex (quadratic cost in the stylized model) financing cost due to the presence of financing frictions (denoted by MC_2) with a firm operating in a frictionless environment (denoted by MC_1). An expansionary monetary policy shock moves the MC curves of both firms downwards and flattens the slope of the firm facing convex financing cost due to the presence of financing frictions. The new MC curves for the two firms are denotes by $MC_1^{'}$ and $MC_2^{'}$. The new MC curves for the two firms in both panels following an expansionary monetary policy shock are denoted by $MC_1^{'}$ and $MC_2^{'}$. The marginal benefit curve for all firms is same , denoted by MB, and shifts out to $MB^{'}$ following an expansionary monetary policy shock. The investment level is determined by the intersection of the marginal cost curve, for the respective firm, with the marginal benefit curve. I_1 and I_2 denotes initial investment levels for the two firms and $I_1^{'}$ and $I_2^{'}$ denotes investment levels for the two firms following the expansionary monetary policy shock.

Figure 3: Response of Investment to the Change in Law

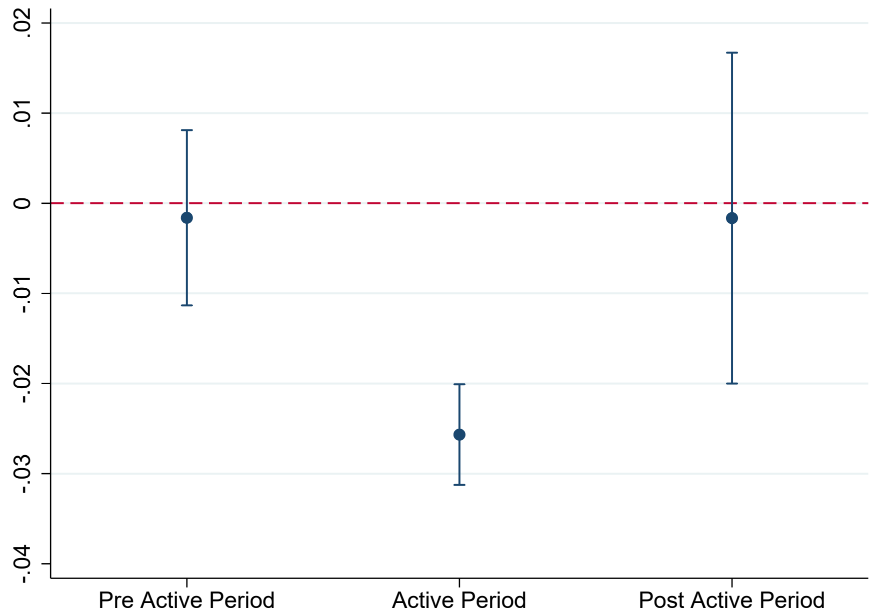


(a) $Ln(I_t)$ (b) $I_t/Assets_{t-1}$

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

Figure 4: Baseline OLS Estimate of the Interaction Term for Three Periods

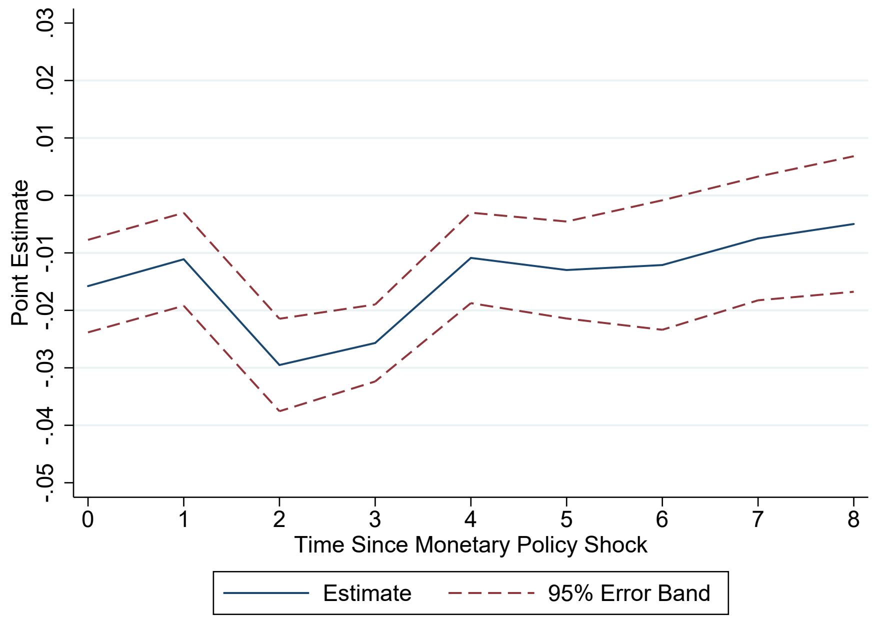


This figure plots the estimates of β_1 obtained from following specification for three different periods.

$$\Delta log I_{it} = \beta_0 + \beta_1 \cdot 1(Treated = 1) \times \Delta\varepsilon_t^q + \beta_2 \cdot 1(Treated = 1) + \beta_3 \Delta\varepsilon_t^q + v_{it}$$

where i denotes firm, $1(Treated = 1)$ is an indicator variable that equals one if a firm is headquartered or incorporated in TX, LA or AL. $\Delta\varepsilon_t^q$ 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 the standard errors at the state level. The first period (pre active period) spans from 1994 to 1996. The second period (active) is between 1997 and 2003 when the law was active, and the third period (post active period) is the period from 2004 to 2007.

Figure 5: Dynamics of Differential Response to Monetary Shocks: Jordà (2005) projection

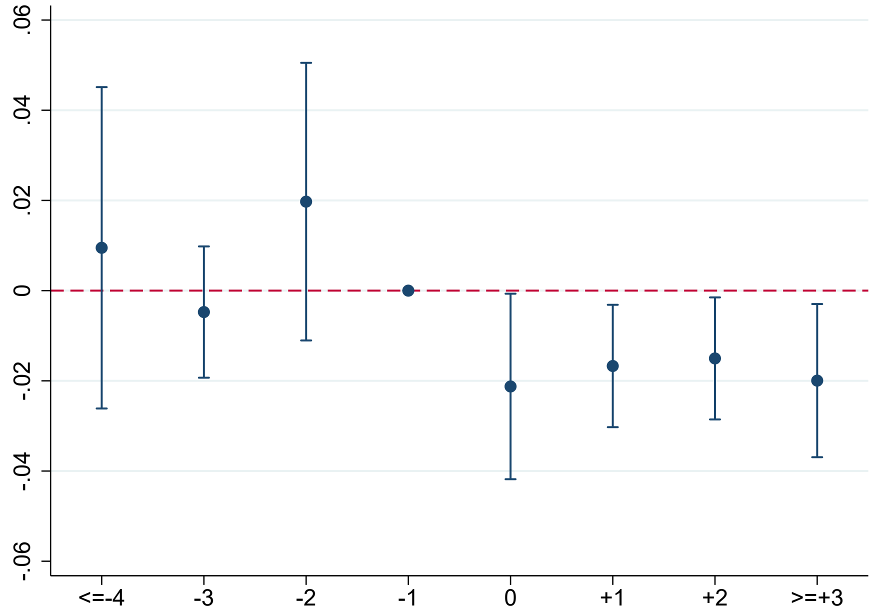


This figure plots the dynamics of the interaction coefficient of anti-recharacterization laws and monetary policy surprise over time. I estimate Jordà (2005) style projection regression until 8 steps. The specification is as follows and h takes an integer value between 0 and 8, where h = 0 and h=3 give 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 6: Parallel Trends Assumption: Assessment of Pre-Trends

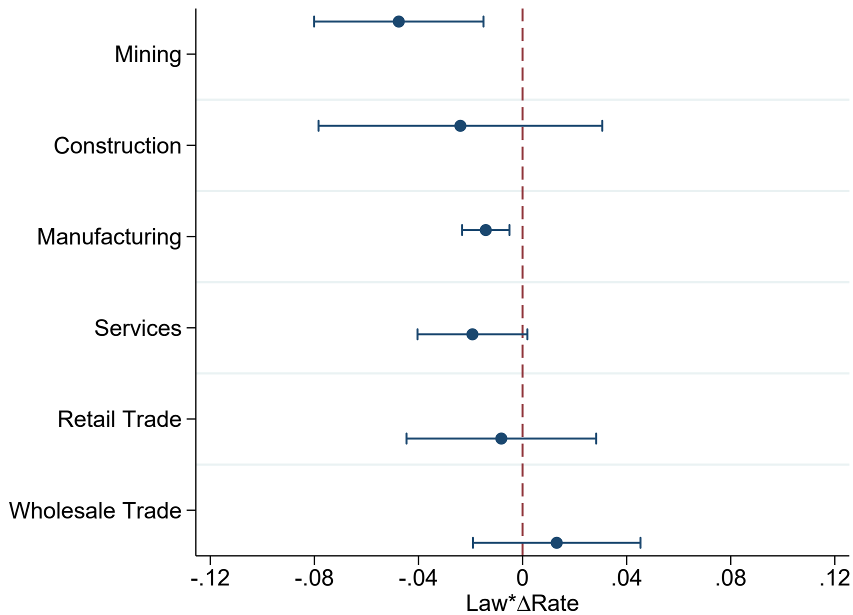


The figure plots the estimates of β_0^k and the 95% confidence intervals from the following regression equation:

$$\Delta log(I_{i,t}) = \sum_{k=-4,k\neq-1}^{k=+3} \beta_0^k \cdot 1(Treatment_i = 1) \times \Delta\varepsilon_t^q \times Time_t^k + \alpha_i + \theta_{jt} + \nu_{it}$$

where i denotes firm, j is industry, s is the state of headquarters or incorporation of the firm i and t is the quarter year. α_i denotes firm fixed effects, θ_{jt} denotes industry-quarter-year fixed effects. $1(Treatment_i = 1)$ 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. $Time_t^k$ takes a value of 1 if the year is k years before/after the passage of the law for treatment firms and years before or after 1997 for the control group 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 95% error bands are estimated by two-way clustering of the standard errors at state and quarter-year level.

Figure 7: Sector Specific Point Estimates

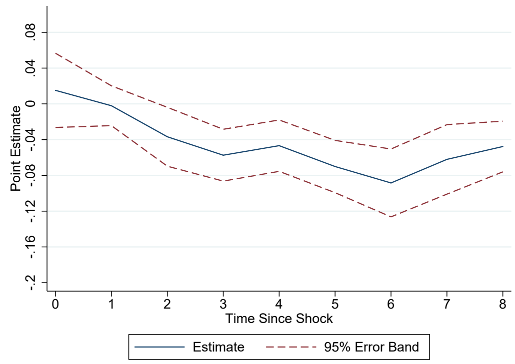


The figure plots the point estimates, β_k^1, for the six sectors from the following regression:

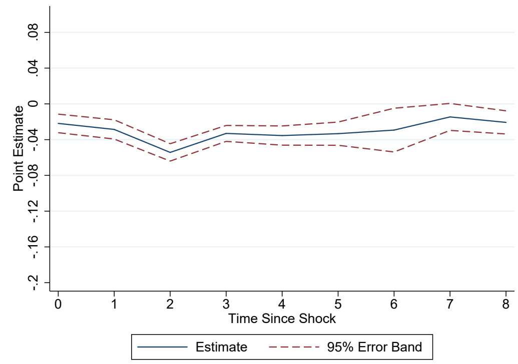
$$\Delta log(I_{i(i\in k),t}) = \beta_k^1 \cdot 1(Law_{st} = 1) \times \Delta\varepsilon_t^q + \beta_k^0 \cdot 1(Law_{st} = 1) + \alpha_{i(i\in k)} + \theta_{(j\in k)t} + \nu_{it}$$

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 C.13 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 95% error bands are estimated by two-way clustering of the standard errors at state and quarter-year level.

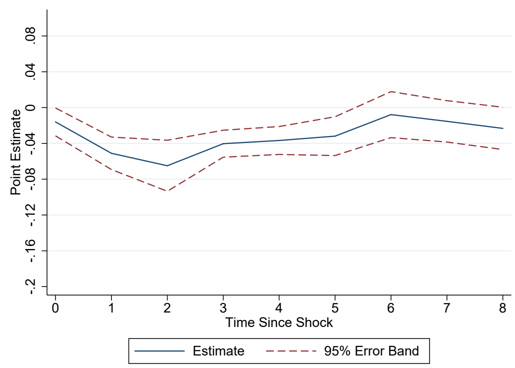
Figure 8: Timing of Monetary Policy Surprises



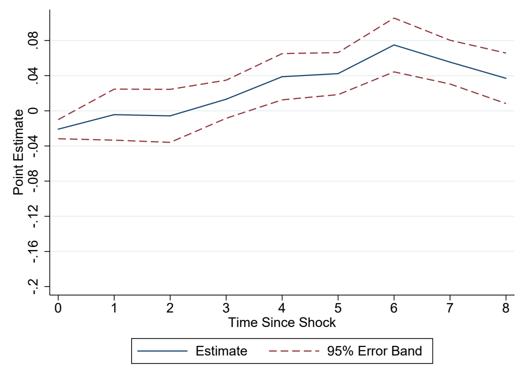
(a) Q1 Shocks



(b) Q2 Shocks



(c) Q3 Shocks



(d) Q4 Shocks

The figure plots the point estimates from a Jordà (2005) style projection regression until 8 steps for each quarter separately. The specification is as follows and h takes an integer value between 0 and 8.

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

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, $\theta_{j,t}$ denotes industry year fixed effects. $1(Law_{st} = 1)$ 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 95% error bands are estimated by clustering the standard errors at state level. The table below reports the p values for the Kolmogorov-Smirnov test for the equality of the distribution of shocks across quarters.

	Quarter 1	Quarter 2	Quarter 3
Quarter 2	0.3752	-	-
Quarter 3	0.3752	0.6604	-
Quarter 4	0.1813	0.9995	0.6604

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

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: 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							11311.31	17128.70

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, $\Delta logI_{it}$. 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 $\Delta logI_{it}$ on $\Delta\varepsilon_t^q$. Column (5) and (6) report results from a simple OLS regression of $\Delta logI_{it}$ 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 two-way clustered at state and quarter-year level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Anti-Recharacterization Laws and Financial Constraints

	(1)	(2)	(3)	(4)
	Firm Size	SA-Index	KZ-Index	WW-Index
$1(Law_{st} = 1)$	0.0341***	-0.0373**	-0.0827***	-0.0445***
	(0.0120)	(0.0159)	(0.0211)	(0.0131)
Firm FE	Yes	Yes	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes	Yes	Yes
# Obs	203,091	112,192	185,083	185,280
R^2	0.9520	0.9280	0.5986	0.9302

This table presents the estimates of firm-level impact of anti-recharacterization laws on different measures of financial constraints. The dependent variable is the natural logarithm of book value of assets in column (1), the Size-Age (SA) index of Hadlock and Pierce (2010) in column (2), the synthetic Kaplan Zingales (KZ) Index presented in Lamont, Polk and Saaá-Requejo (2001) based on regression estimates of Kaplan and Zingales (1997) in column (3), and the Whited-Wu (WW) Index of Whited and Wu (2006) in column (4). The main independent variable is $1(Law_{st} = 1)$. $1(Law_{st} = 1)$ 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. 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 4: Anti-Recharacterization Laws, Firm Investment and Monetary Policy Surprise

$\Delta log(I_{it})$	(1) All	(2) All	(3) All	(4) All	(5) Neg	(6) Pos
$1(Law_{st}=1)\times\Delta\varepsilon_t^q$	-0.0189**	-0.0189**	-0.0165***	-0.0158***	-0.0202***	-0.0080
	(0.0073)	(0.0072)	(0.0034)	(0.0036)	(0.0060)	(0.0111)
$1(Law_{st}=1)$	-0.0027	-0.0027	0.0043	0.0008	-0.0013	-0.0092
	(0.0115)	(0.0114)	(0.0062)	(0.0102)	(0.0298)	(0.0178)
Qtr × Year FE	Yes	Yes				
State FE	Yes	Yes	Yes			
Industry FE		Yes				
Industry × Qtr × Year FE			Yes	Yes	Yes	Yes
Firm FE				Yes	Yes	Yes
# Obs	203,091	203,091	203,091	203,091	69,083	133,146
R^2	0.2231	0.2235	0.3059	0.3151	0.3180	0.3546

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 5: 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 one year before the passage of the law for the treated firms and characteristics on 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 6: 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 7: Estimates of Semi-Elasticity & Counterfactual Estimates

	Description	Relative Semi-Elasticity		% Contribution
		Model	Data	
(1)	Both MC & MB Channels Present	-0.015	-0.016	
(2)	No MC Channel	-0.026		-73.33%
(3)	No MB Channel	0.011		173.33%

This table presents the semi-elasticity of investment to monetary policy for unconstrained firms relative to constrained firms. 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.

Table 8: 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, $\Delta logI_{it}$. 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. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Online Appendix for: “What Does Financial Heterogeneity Say about the Transmission of Monetary Policy?”

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 (capexq). I use capxy, which is year-to-date capital expenditures. For the second through fourth quarters of the year, I subtract the value of capxy in the prior quarter from the value of capxy for the current quarter to compute quarterly capital expenditures. I call this variable capexq.
- $\Delta Ln(I_{it})$: Change in investment, defined as the log differences in capexq between t and $t+1$
- $Ln(A_{it})$: Firm Size is defined as the natural logarithm of the total book value of assets (atq)
- $Debt/Assets$: Leverage, defined as the ratio of total debt (sum of dlcq and dlttq) to total assets (atq)
- Avg Q: Average Q, defined as the ratio of market to the book value of assets. The market value of assets is measured as the book value of assets (atq), plus the market value of common stock, minus the book value of common stock (ceq). The market value of common stock is calculated as the product of stock quarter closing stock price (prccq) and common shares outstanding at the end of the quarter (cshoq). The book value of assets is measured using atq.
- $g(Sales)$: Sales growth, defined as the difference in the natural logarithm of sales (saleq)
- $EBITDA/Equity$: 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 (cheq) to the book value of assets (atq)
- $\frac{I_{it}}{A_{i,t-1}}$: Investment to assets ratio is defined as the period t capital expenditure (capexq) scaled by period $t-1$ book value of assets (atq)

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

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

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

- 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:

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

A.3 Timeline of the enactment of the Law

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

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 4.1.1.
- **Bernanke-Kuttner Shock (Tight) (HF-Wide)**: See section 4.1.1.
- **Nakamura-Steinsson Shock (NS)**: I directly use the data provided by Nakamura and Steinsson (2018*a*). 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 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 (2018*a*) 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 dientangle 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 compnent 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 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 (2018*a*). 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 (2018*a*). 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 Robustness of Baseline Results

This section reports results for the robustness of baseline results reported in table 4.

Table C.1: Baseline Result with Alternative Clustering

$\Delta log(I_{it})$	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q$	-0.0158***	-0.0158**	-0.0158**	-0.0158**	-0.0158***	-0.0158***	-0.0158***
	(0.0040)	(0.0064)	(0.0070)	(0.0065)	(0.0006)	(0.0035)	(0.0020)
$1(Law_{st} = 1)$	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
	(0.0046)	(0.0099)	(0.0088)	(0.0125)	(0.0100)	(0.0111)	(0.0088)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# Obs	203,091	203,091	203,091	203,091	203,091	203,091	203,091
R^2	0.3151	0.3151	0.3151	0.3151	0.3151	0.3151	0.3151
Cluster	State	Industry	Firm	State, Qtr-Year (Wild)	Industry, Qtr-Year	Firm, Qtr-Year	State, Industry, Qtr-Year

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 clustered at the state level in column (1), clustered at 4 digit SIC industry level and firm level in column (2) and (3) respectively, two-way clustered by state and quarter-year in column (4) estimated via wild bootstrap as in Cameron, Gelbach and Miller (2008), two-way clustered by 4 digit SIC industry and quarter-year in column (5), two-way clustered by firm and quarter-year in column (6), and multi-way clustered by state, industry and quarter-year in column (7). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.2: Controlling for Static Firm Characteristics

$\Delta log(I_{it})$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$1(Law_{st}=1) \times \Delta\varepsilon_t^q$	-0.0158***	-0.0172***	-0.0173***	-0.0174***	-0.0175***	-0.0177***	-0.0172***	-0.0177***
	(0.0036)	(0.0051)	(0.0049)	(0.0060)	(0.0053)	(0.0061)	(0.0054)	(0.0064)
$Ln(Asset) \times \Delta\varepsilon_t^q$		-0.0056						-0.0073
		(0.0066)						(0.0072)
$Debt/Asset \times \Delta\varepsilon_t^q$			-0.0001					-0.0013
			(0.0041)					(0.0062)
$AvgQ \times \Delta\varepsilon_t^q$				-0.0011				0.0002
				(0.0024)				(0.0017)
$g(Sales) \times \Delta\varepsilon_t^q$					-0.0052			-0.0048
					(0.0034)			(0.0032)
$EBITDA/Equity \times \Delta\varepsilon_t^q$						-0.0046		-0.0062
						(0.0048)		(0.0082)
$Cash/Asset \times \Delta\varepsilon_t^q$							0.0020	0.0032*
							(0.0013)	(0.0019)
$1(Law_{st}=1)$	0.0008	-0.0010	-0.0008	-0.0008	-0.0008	-0.0008	-0.0009	-0.0009
	(0.0102)	(0.0109)	(0.0109)	(0.0111)	(0.0110)	(0.0110)	(0.0110)	(0.0110)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# Obs	203,091	153,158	153,158	153,158	153,158	153,158	153,158	153,158
R^2	0.3151	0.3045	0.3045	0.3045	0.3045	0.3045	0.3045	0.3045

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 term of firm-specific characteristics and monetary policy surprises. Firm specific covariates are measured as values 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. 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 firm specific covariates 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 C.3: Controlling for Time-Varying Firm Characteristics

$\Delta log(I_{it})$	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$1(Law_{st}=1)\times\Delta\varepsilon_t^q$	-0.0152***	-0.0156***	-0.0161***	-0.0160***	-0.0159***	-0.0158***	-0.0158***
	(0.0035)	(0.0033)	(0.0036)	(0.0041)	(0.0037)	(0.0040)	(0.0047)
$Ln(Asset)\times\Delta\varepsilon_t^q$	-0.0072						-0.0075
	(0.0057)						(0.0062)
$Ln(Asset)$	0.0479***						0.0677***
	(0.0124)						(0.0134)
$Debt/Asset\times\Delta\varepsilon_t^q$		0.0000					0.0003
		(0.0035)					(0.0043)
$Debt/Asset$		-0.0452***					-0.0343***
		(0.0048)					(0.0040)
$AvgQ\times\Delta\varepsilon_t^q$			-0.0033*				-0.0037
			(0.0018)				(0.0023)
$AvgQ$			0.0459***				0.0370***
			(0.0042)				(0.0042)
$g(Sales)\times\Delta\varepsilon_t^q$				0.0055			0.0057
				(0.0036)			(0.0036)
$g(Sales)$				0.0971***			0.0954***
				(0.0068)			(0.0070)
$Cash/Asset\times\Delta\varepsilon_t^q$					-0.0020		-0.0029
					(0.0034)		(0.0048)
$Cash/Asset$					0.0618***		0.0492***
					(0.0055)		(0.0043)
$EBITDA/Equity\times\Delta\varepsilon_t^q$						0.0031**	0.0046***
						(0.0015)	(0.0016)
$EBITDA/Equity$						0.0067***	0.0027*
						(0.0013)	(0.0015)
law_rep	0.0002	0.0004	0.0021	0.0003	0.0012	0.0009	0.0006
	(0.0103)	(0.0101)	(0.0102)	(0.0109)	(0.0101)	(0.0103)	(0.0110)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# Obs	203,091	203,091	203,091	203,091	203,091	203,091	203,091
R^2	0.3152	0.3156	0.3159	0.3229	0.3158	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 while controlling for the interaction term of firm-specific characteristics and monetary policy surprises. 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 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 C.4: Is it Really Monetary Policy or Other Macroeconomic Factors?

$\Delta log(I_{it})$	(1)	(2)	(3)	(4)	(5)	(6)
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q$	-0.0162***	-0.0148***	-0.0158***	-0.0150***	-0.0154***	-0.0155***
	(0.0038)	(0.0046)	(0.0035)	(0.0033)	(0.0038)	(0.0038)
$1(Law_{st} = 1) \times \Delta gdp_t^q$	0.0012				0.0017	0.0044
	(0.0063)				(0.0081)	(0.0080)
$1(Law_{st} = 1) \times \Delta UR_t^q$		0.0034			-0.0007	0.0015
		(0.0036)			(0.0053)	(0.0054)
$1(Law_{st} = 1) \times \Delta CPI_t^q$			-0.0228***		-0.0273***	-0.0274***
			(0.0084)		(0.0068)	(0.0073)
$1(Law_{st} = 1) \times \Delta EPU_t^q$				0.0105**	0.0146***	0.0164***
				(0.0044)	(0.0048)	(0.0050)
$1(Law_{st} = 1)$	0.0006	-0.0000	-0.0060	0.0005	-0.0077	-0.0086
	(0.0106)	(0.0104)	(0.0113)	(0.0099)	(0.0122)	(0.0127)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls						Yes
# Obs	203,091	203,091	203,091	203,091	203,091	203,091
R^2	0.3151	0.3151	0.3151	0.3151	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 while controlling for the interaction term of other macroeconomic characteristics with $1(Law_{st} = 1)$. 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 vector of macroeconomic variables include change in gross domestic product, unemployment rate, consumer price index, and economic policy uncertainty index. 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 C.5: 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.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.6: Alternative Measures of Firm Investment

	(1)	(2)	(3)	(4)
	$\frac{I_{i,t}}{A_{i,t-1}}$	$\frac{I_{i,t}}{K_{i,t-1}}$	$\Delta log(R\&D_{it})$	$\Delta log(PP\&E_{it})$
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q$	-0.0201**	-0.0071***	-0.0380***	-0.0108*
	(0.0085)	(0.0019)	(0.0082)	(0.0073)
$1(Law_{st} = 1)$	-0.0128	-0.0007	-0.0170	0.0084
	(0.0163)	(0.0072)	(0.0260)	(0.0076)
Firm FE	Yes	Yes	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes	Yes	Yes
# Obs	203,081	146,368	77,240	202,790
R^2	0.5243	0.2217	0.1003	0.2198

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 $\frac{I_{i,t}}{A_{i,t-1}}$ 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. 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 in column (1), clustered at state level and 4 digit SIC industry level in column (2) and (3) respectively, two-way clustered by industry and quarter-year in column (4), two-way clustered by state and industry in column (5), multi-way clustered by state, industry and quarter-year in column (6), and two-way clustered by firm and quarter-year in column (7). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.7: Alternative Measures of Monetary Policy Shocks

$\Delta log(I_{i,t})$	(1) OLS	(2) OLS	(3) 2SLS	(4) OLS	(5) OLS	(6) OLS
$1(Law_{st}=1)\times Wide$	-0.0162***					
	(0.0036)					
$1(Law_{st}=1)\times \Delta FFR_t^q$		-0.0282***	-0.0262***			
		(0.0048)	(0.0074)			
$1(Law_{st}=1)\times NS$				-0.0156***		
				(0.0007)		
$1(Law_{st}=1)\times Sum$					-0.0135***	
					(0.0014)	
$1(Law_{st}=1)\times Wt-Avg$						-0.0111***
						(0.0010)
$1(Law_{st}=1)$	0.0004	-0.0048	-0.0041	-0.0012	0.0018	-0.0017
	(0.0102)	(0.0113)	(0.0100)	(0.0113)	(0.0105)	(0.0102)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
# Obs	203,091	203,091	203,091	187,891	203,091	203,091
R^2	0.3151	0.3151		0.3204	0.3151	0.3151

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 term of firm-specific characteristics and monetary policy surprises. 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 different measures of monetary policy shocks. $1(Law_{st}=1)$ 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. Wide denotes the quarterly average of monetary policy surprise measures in the wide window of 45 minutes. ΔFFR_t^q denotes the quarterly change in effective fed funds rate. NS denotes the quarterly monetary policy shocks as calculated in Nakamura and Steinsson (2018*a*) and are available only since 1995. The shocks used in column (5) are simple sum of all tight window shocks during the quarter, and the shocks used in column (6) are a weighted average of tight window shocks during the quarter. Column 1, 2, 4, 5 and 6 are estimated via OLS. column 3 is estimated via 2SLS. The instrument used for $1(Law_{st}=1)*\Delta FFR_t^q$ in column 3 is the interaction term of the law and the tight window monetary policy surprise $1(Law_{st}=1)*\Delta\varepsilon_t^q$. The model R^2 between the two is 37% making the instrument relevant. The Kleibergen-Paap rank Wald F statistic for the weak identification test is 36.583. 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 C.8: Robustness to Entry and Exit of Firms

$\Delta log(I_{i,t})$	(1)	(2)
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q$	-0.0220***	-0.0237***
	(0.0034)	(0.0037)
$1(Law_{st} = 1)$	-0.0083	-0.0064
	(0.0164)	(0.0142)
Firm FE	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes
Firm Controls		Yes
# Obs	62,795	62,795
R^2	0.3551	0.3673

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 entry and exit oof firms. 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 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. 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 a balanced panel of Compustat non-financial and non-utilities firms that have existed continuously 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 C.9: Robustness: Baseline Results with Alternative Samples

$\Delta log(I_{it})$	(1)	(2)	(3)	(4)	(5)
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q$	-0.0104**	-0.0235***	-0.0113***	-0.0174***	-0.0195***
	(0.0046)	(0.0072)	(0.0038)	(0.0043)	(0.0061)
$1(Law_{st} = 1)$	0.0135	0.0078	0.0068	0.0010	0.0001
	(0.0184)	(0.0225)	(0.0071)	(0.0090)	(0.0106)
Firm FE	Yes	Yes	Yes	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes	Yes	Yes	Yes
Sample	Neighbouring States	Matched Sample	No O&G Firms	No AL	DE is treated
# Obs	41,052	16,338	194,701	201,898	203,091
R^2	0.4390	0.4474	0.3091	0.3147	0.3151

This table presents the estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on change in firm investment using alternative samples. 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. 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 matched sample where each treated firm is matched with one control firm within the same 4-digit SIC industry matched on pre-1997 investment growth, investment level, size, leverage, cash-flow ratio, liquidity ratio and Tobin's Q. Figures C.1 and C.2 compare the key variables across the treated and the control firms before 1996. Column (3) drops all the oil and gas firms associated with SIC codes 1311, 1381, 1382, and 1389. Column (4) uses only the states of Texas and Louisiana as treated states and drops the state of Alabama. Column (5) includes the firms headquartered or incorporated in the state of Delaware (DE) as treated firms. $1(Law_{st} = 1)$ 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, or DE between 2002 and 2003. 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 C.10: Robustness: Jackknife Estimation

$\Delta logI_{it}$	(1)	(2)	(3)	(4)
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q$	-0.0158***	-0.0158***	-0.0158**	-0.0158**
	(0.0012)	(0.0006)	(0.0066)	(0.0070)
$1(Law_{st} = 1)$	0.0008	0.0008	0.0008	0.0008
	(0.0047)	(0.0006)	(0.0104)	(0.0089)
Firm FE	Yes	Yes	Yes	Yes
Industry × Qtr × Year FE	Yes	Yes	Yes	Yes
# Obs	203,091	203,091	203,091	203,091
R^2	0.3151	0.3151	0.3151	0.3151
Cluster	Qtr Year	State	4 digit SIC	Firm
# Cluster	56	51	350	8,224

This table presents the estimates of firm-level impact of anti-recharacterization laws and monetary policy surprises on change in firm investment using jackknife estimation. 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 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. 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 jack-knife standard errors. The standard errors are jackknifed by estimating the regression once for each cluster in the dataset, leaving the associated cluster out of the calculations. Column (1), (2), (3) and (4) use time – quarter-year, state of incorporation or headquarter, 4 digit SIC code and firm unique code as cluster variables respectively. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.11: 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, $\Delta log I_{it}$. 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. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.12: 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

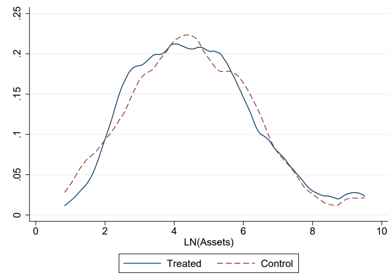
This table presents the estimates of firm-level impact of anti-recharacterization laws and pure monetary policy surprises on change in firm investment. The dependent variable is the change in the natural logarithm of capital expenditure, $\Delta log I_{it}$. The main independent variable is the interaction 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 C.13: Sector Specific Results

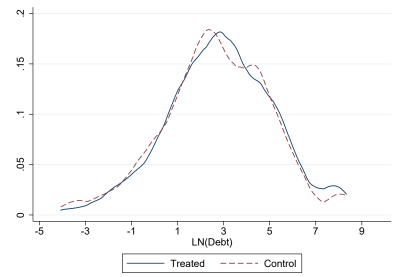
$\Delta log(I_{i,t})$	(1)	(2)	(3)	(4)	(5)	(6)
$1(Law_{st} = 1) \times \Delta\varepsilon_t^q$	-0.0476***	-0.0141***	-0.0239	-0.0193*	-0.0082	0.0131
	(0.0160)	(0.0045)	(0.0267)	(0.0110)	(0.0181)	(0.0159)
$1(Law_{st} = 1)$	-0.0419*	0.0136**	0.0948***	-0.0007	-0.0231	0.0211
	(0.0208)	(0.0057)	(0.0271)	(0.0045)	(0.0374)	(0.0201)
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. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

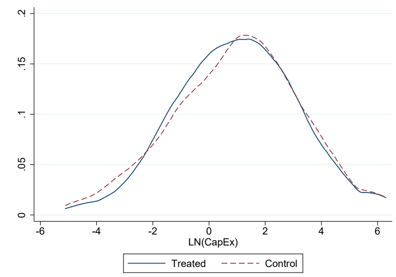
Figure C.1: Comparing the Control and the Treated Firms in the Matched Sample



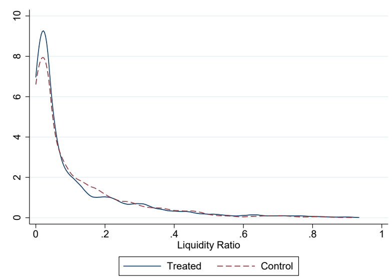
(a) $Ln(Assets)$



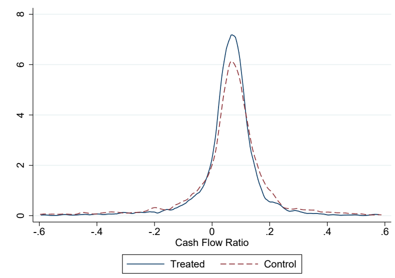
(b) $Ln(Debt)$



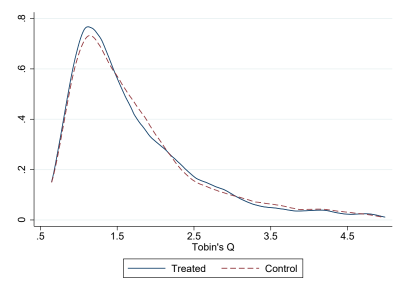
(c) $Ln(CapEx)$



(d) $\frac{Cash}{Assets}$



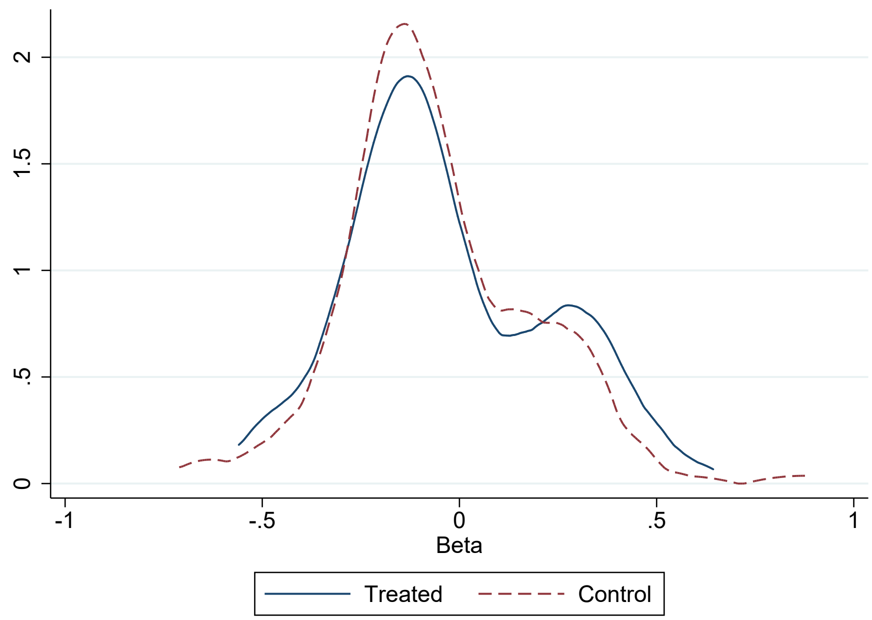
(e) $\frac{EBITDA}{Equity}$



(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 within the same 4 digit SIC industry using pre-1997 average of investment growth, investment, size, debt, liquidity ratio, cash-flow ratio and Tobin's Q.

Figure C.2: Comparing the Sensitivity of Investment Growth to Monetary Policy Shocks for the Control and Treated Firms (Pre 1997)

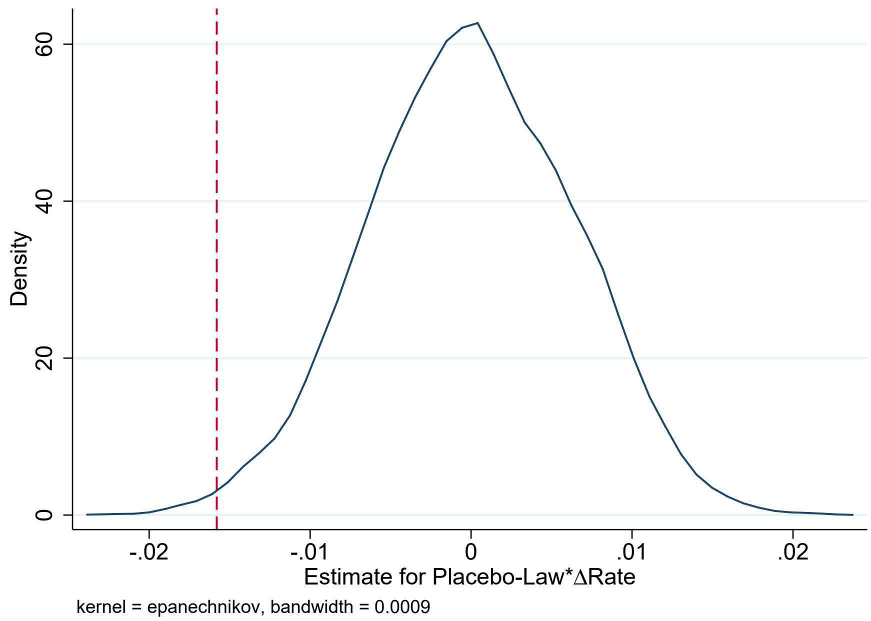


The figure plots the kernel density of the estimated coefficients, β_i, for the treated and the control firms from the following equation:

$$\Delta log I_{i,t} = \alpha_i + \beta_i \Delta \varepsilon_t^q + \mu_{i,t}$$

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 within the same 4 digit SIC industry 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.

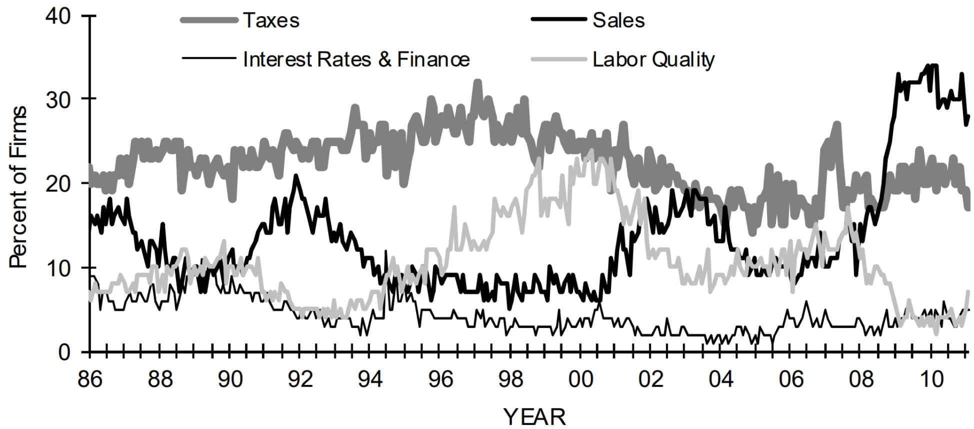
Figure C.3: Placebo Test



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 4. Less than 0.61% of the point estimates among the 10,000 simulations lie to the left of the red dashed line.

Figure C.4: What are the Small Business Worried About?



Source: National Federation of Independent Businesses (NFIB) Small Business Economic Trends, March 2011. The report can be accessed at 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.

Appendix D Model

This section describes the heterogeneous firm New Keynesian model to interpret the evidence and study the relative importance of the marginal benefit and the marginal cost channels in driving the cross-sectional result.

D.1 Firms

Each firm produces an undifferentiated good y_{jt} using the production function $y_{jt} = z_{jt} k_{jt}^{\theta} l_{jt}^{\nu}$, where k_{jt} and l_{jt} denotes firm's capital stock and labor input, respectively. z_{jt} is an idiosyncratic total factor productivity (TFP) shock and $\theta + \nu < 1$. The idiosyncratic TFP shock follows a log - AR(1) process $\log z_{jt+1} = \rho \log z_{jt} + \varepsilon_{jt+1}$, where $\varepsilon_{it+1} \sim N\left(0, \sigma^2\right)$. The idiosyncratic shocks to TFP are realized at the beginning of each period. A firm decides to default or continue in operation. Conditional on default the firm ceases to exist, lenders recover a fraction of the firm's capital stock with remaining capital being transferred lump-sum to households. A mass $\bar{\mu}_t$ of new firms equal to the mass of firms that exit, enter the economy. These new firms are endowed with k_0 units of capital from households and have no debt.[23] Continuing firms must pay back the face value of its outstanding debt ($b_{j,t}$) and pay a fixed operating cost ξ in units of the final good. Firms purchase new capital at relative price q_t. Firms have two sources of investment finance, each of which is subject to a frictions. First, firms can issue new nominal debt with real face value $b_{jt+1} = \frac{B_{jt+1}}{P_t}$, where B_{jt+1} is the nominal face value and P_t is the nominal price of the final good. Lenders offer a price schedule $Q_t\left(z_{jt}, k_{jt+1}, b_{jt+1}\right)$ for this debt. Second, firms can use internal finance by lowering dividend payments d_{jt} but cannot issue new equity, which bounds dividend payments $d_{it} \geq 0$. 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 two state variables of a firm are its TFP shocks z and net worth n. Firm's net worth is the total amount of resources available to the firm other than borrowing and is given by:

$$n = \max_{l} \; p_t z k^{\theta} l^{\nu} - w_t l + q_t(1-\delta)k - \frac{b}{\Pi_t} - \xi$$

where b is the borrowing, $\Pi_t = \frac{P_t}{P_{t-1}}$ is realized gross inflation, δ is depreciation, p_t is the relative price of output – expressed in terms of the final good – sold in a competitive market. Firms hire labor from a competitive labour market at real wage w_t.

D.1.1 Lenders

A representative bank lends resources from the representative household to firms at the firm specific price schedule given by $Q_t\left(z, k', b'\right)$. In the case, when firm defaults, the bank recovers a fraction α of the market value of the firm's capital stock $q_{t+1}k'$. The debt price schedule is such that it prices the firm-specific default risk competitively. Specifically, the debt price schedule is given by: $Q_t\left(z, k', b'\right) =$

[23]New entering firms receive a productivity shock from a time-invariant distribution $\mu(z) \sim logN(-m\frac{\sigma}{\sqrt{1-\rho^2}}, \frac{\sigma}{\sqrt{1-\rho^2}})$ with $m \geq 0$.

$\mathbb{E}_t\left[\Lambda_{t+1}\frac{1}{\Pi_{t+1}}\left(1-\left(1-\chi_{t+1}\left(z',\hat{n}_{t+1}\left(z',k',b'\right)\right)\right)\left(1-\min\left\{\frac{\alpha q_{t+1}(1-\delta)k'}{b'/\Pi_{t+1}},1\right\}\right)\right)\right]$ where Λ_{t+1} is the stochastic discount factor, χ_{t+1} is an indicator variable taking a value of zero if the firm defaults and $\hat{n}_{t+1}\left(z',k',b'\right)\equiv \max_{l'} p_{t+1}z'k'^{\theta}l'^{\nu}-w_{t+1}l'+q_{t+1}(1-\delta)k'-b'\frac{1}{\Pi_{t+1}}-\xi$.

D.1.2 Solution to the Firm Problem

Conditional on continuing, the real equity value $v_t(z,n)$ solves the Bellman equation D.1. The solution to the Bellman equation is characterized by proposition 1.[24]

$$\begin{aligned} v_t(z,n) =& \max_{k',b'}\left\{n-q_tk'+Q_t\left(z,k',b'\right)b'\right. \\ &\left.+\mathbb{E}_t\left[\Lambda_{t+1}\chi_{t+1}\left(z',\hat{n}_{t+1}\left(z',k',b'\right)\right)v_{t+1}\left(z',\hat{n}_{t+1}\left(z',k',b'\right)\right)\right]\right. \\ &\text{s.t. } n-q_tk'+Q_t\left(z,k',b'\right)b'\geq 0 \end{aligned} \tag{D.1}$$

PROPOSITION 1: Consider a firm at time t that is eligible to continue into the next period, has idiosyncratic productivity z, and has net worth n. The firm's optimal decision is characterized by one of the following three cases:

(i) **Default Decision**: A firm defaults if $n<\underline{n}_t(z)$ as it cannot satisfy the non-negativity constraint on dividends.

(ii) **Decision of Unconstrained Firms**: A firm is financially unconstrained if $n>\bar{n}_t(z)$. Unconstrained firms follow the *frictionless* capital accumulation policy $k_t'(z,n)=k_t^*(z)$ which solves $q_t=\mathbb{E}_t\left[\Lambda_{t+1}MRPK_{t+1}\left(z',\ k_t^*(z)\right)\mid z\right]$, where $MRPK_{t+1}\left(z',k'\right)=\frac{\partial}{\partial k'}\left(\max_{l'}p_{t+1}z'k'^{\theta}l'^{\nu}-w_{t+1}l'+q_{t+1}(1-\delta)k'\right)$ 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.

(iii) **Decision of Constrained Firms**: A firm with $n\in\left[\underline{n}_t(z),\bar{n}_t(z)\right]$ is financially constrained. Constrained firms with optimal investment $k_t'(z,n)$ and borrowing $b_t'(z,n)$ decisions solve the Bellman equation D.1. Constrained firms also pay zero dividends because the value of resources inside the firm, used to lower borrowing costs, is higher than the value of resources outside the firm.

D.2 Aggregation and Monetary Policy

This section of the model introduces three important forces in the model. First, the retailers set prices and face price adjustment cost. Second, the central bank that 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.

D.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 its only input: $\widetilde{y}_{it}=y_{it}$. y_{it} is the amount of the undifferentiated good

[24] I only present the intuition for this proposition. I direct the readers to Ottonello and Winberry (2020) for a detailed proof of this proposition.

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.

D.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.

D.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.

D.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, $\Phi\left(\frac{I_t}{K_t}\right) = \frac{\hat{\delta}^{1/\phi}}{1-1/\phi}\left(\frac{I_t}{K_t}\right)^{1-1/\phi} - \frac{\hat{\delta}}{\phi-1}$, and $\hat{\delta}$ is the steady-state investment rate. Profit maximization pins down the relative price of capital as $q_t = \left(\frac{I_t/K_t}{\hat{\delta}}\right)^{1/\phi}$ where $\widehat{\delta}$ is given by $\hat{\delta} = \delta\left(1+\frac{k_0\bar{\mu}}{K^*}\right)$, with K^* is the steady-state capital stock and $\bar{\mu}$ the steady-state level of new entrants.

D.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 $\log R_t^{\text{nom}} = \log\frac{1}{\beta} + \varphi_\pi \log \Pi_t + \varepsilon_t^m$, where R_t^{nom} 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.

D.3 Household

There is a representative household that allows me to derive the stochastic discount factor and close the model. The household owns all firms in the economy. The representative household with consumption C_t

and labor supply L_t has the following utility function:

$$\mathbb{E}_0 \sum_{t}^{\infty} \beta^t \left(\log C_t - \Psi L_t\right)$$

where β is the discount factor and Ψ controls the disutility of labor supply. The Euler equation for bonds gives $\frac{1}{R_t^{\text{nom}}} = \frac{\Lambda_{t+1}}{\Pi_{t+1}}$.

D.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.

D.4.1 Marginal Cost Curve

The marginal cost (MC) is given by the following expression:

$$MC = \left(q_t - \varepsilon_{Qk'} \frac{Q_t\left(z, k', b'\right) b'}{k'}\right) \frac{R_t^{sp}}{1 - \varepsilon_{Rb'}}$$

where $\varepsilon_{Qk'}$ is the elasticity of the bond price schedule with respect to investment k', $R_t^{\text{sp}}\left(z, k', b'\right) = R_t\left(z, k', b'\right) / R_t^{\text{nom}}$ is a measure of the borrowing spread with $R_t\left(z, k', b'\right) = \frac{1}{Q_t\left(z, k', b'\right)}$ is the firm's implied interest rate schedule, $\varepsilon_{Rb'}$ is the elasticity of the interest rate schedule with respect to borrowing. The MC is the product of two terms. The first term is the relative price of capital net of interest savings due to higher capital. The interest savings result from the fact that higher capital decreases expected losses due to default to the lender, *ceteris paribus*. The second term is related to borrowing cost and denotes that higher interest rate spreads or higher slope of that spread results in higher borrowing costs. The MC curve is flat when capital accumulation can be financed without incurring default risk and becomes upward sloping when borrowing creates default risk as it creates a credit spread.

Monetary policy shocks affect the MC curve through three forces. First, these shocks affect the aggregate investment demand changing the relative price of capital. Second, monetary policy shocks affect firms' net worth, which changes the amount the firm needs to borrow to finance any level of investment and its probability of default. Third, monetary policy shocks affect the credit spreads both directly and indirectly. The indirect effect on credit spreads occurs due to its impact on the relative price of capital which changes the lenders' recovery rate. The flattening on 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).

D.4.2 Marginal Benefit Curve

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

$$MB = \frac{1}{R_t}\mathbb{E}_t\left[\mathrm{MRPK}_{t+1}\left(z',k'\right)\right] + \frac{1}{R_t}\frac{\mathbb{C}ov_t\left(\mathrm{MRPK}_{t+1}\left(z',k'\right),1+\lambda_{t+1}\left(z',\hat{n}_{t+1}\left(z',k',b'\right)\right)\right)}{\mathbb{E}_t\left[1+\lambda_{t+1}\left(z',\hat{n}_{t+1}\left(z',k',b'\right)\right)\right]}$$

where R_t is the real risk-free rate between t and $t+1$, $\lambda_t(z,n)$ is the Lagrange multiplier on the non-negativity constraint on dividends. 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 and the change in default threshold. Finally, the effect of the monetary policy shocks on investment due to movements in the MB curve is more pronounced for unconstrained firms as they face a flatter MC curve of investment and is similar in spirit to the effect presented in Ottonello and Winberry (2020).

D.5 Calibration

The goal of this exercise is to quantitatively discipline the shifts in the MC and the MB curve – following monetary policy shocks – and their relative impacts on constrained and unconstrained firms.

D.5.1 Fixed Parameters

Table D.1 presents the list of fixed parameters. I set the discount factor $\beta = 0.99$. I set the coefficient on labor $\nu = 0.64$. I choose the coefficient on capital $\theta = 0.21$ to imply a total returns to scale of 85%. Capital depreciates at rate $\delta = 0.025$ quarterly. We choose the elasticity of substitution in final goods production $\gamma = 10$, implying a steady state markup of 11%. This choice implies that the steady state labor share is $\frac{\gamma-1}{\gamma}\nu \approx 58\%$, close to the U.S. labor share reported in Karabarbounis and Neiman (2014). I choose the coefficient on inflation in the Taylor rule $\varphi_\pi = 1.25$. I set the price adjustment cost parameter $\varphi = 90$ to generate a Phillips Curve slope equal to 0.1, as in Kaplan, Moll and Violante (2018). Finally, I set the curvature of the aggregate adjustment costs $\phi = 4$ following Bernanke, Gertler and Gilchrist (1999). This level of adjustment costs roughly matches the peak response of investment relative to the peak response of output estimated in Christiano, Eichenbaum and Evans (2005).

Table D.1: List of Fixed Parameters

Parameter	Description	Value
Household		
β	Discount factor	0.99
Firms		
ν	Labor coefficient	0.64
θ	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

This table reports the parameters exogenously fixed in the calibration.

D.5.2 Fitted Parameters and Calibration Targets

I target the empirical moments in table D.2 and fit the parameters in table D.3. The first two moments in table D.3 govern the idiosyncratic shock processes and the next two moments in table D.3 govern the financial frictions. Specifically, I target the moments on log(investment), Δlog(investment), mean gross leverage ratio, firms with positive debt and mean default rate and fit the parameters $(\rho, \sigma, \alpha, \xi)$.

Table D.2: Calibration Targets

Description	Data	Model
$log(I)$	1.119	1.163
$\Delta log(I)$	0.025	0.029
Mean gross leverage ratio	0.208	0.352
Firms w/ positive debt	0.83	0.79
Mean default rate	3.0%	2.9%

Table D.3: Fitted parameters

Parameter	Description	Value
Idiosyncratic shock processes		
ρ	Persistence of TFP	0.84
σ	SD of innovations to TFP	0.06
Financial frictions		
α	Loan recovery rate	0.63
ξ	Operating cost	0.05

D.5.3 Discussion on Identification

Table D.4 reports the elasticities which can help in evaluating the sources of identification in the calibration exercise following Ottonello and Winberry (2020). Panel A reports the local elasticities of targeted moments with respect to the parameters chosen in the calibration, computed at the estimated parameters. Panel B reports the local elasticities of estimated parameters with respect to moments as in Andrews, Gentzkow and Shapiro (2017) which show how variation in targeted moments would influence estimated parameter values, taking into account the joint dependencies across moments in the data. The results from panel A shows that the rate of change of investment across firms increases with an increase in the volatility of productivity shocks σ but does not change with an increase in operating cost or decrease in lenders' recovery rate. Whereas the results from panel B show that the rate of change of investment is an informative moment for all the parameters. This is because change in productivity process changes other moments, as shown in panel A, and thereby other parameter estimates. An increase in the volatility of productivity shocks strongly influences the fraction of firms with positive debt and mean default rate. The results also show that decreasing the lender's recovery rate or increasing the operating costs, which corresponds to tightening the financial frictions, increases the default rates among firms. But the mean default rate is particularly an informative moment for the parameter governing lender's recover rate α. A change in the lender's recovery rate not only affects the default rates among firms but also fraction of firms with positive debt which is particularly an informative moment for the parameter governing operating costs ξ. Overall, the elasticity estimates from both panels show how the results would change for any violation in the identifying assumptions of the calibration exercise.

Table D.4: Identification

Panel A: Elasticities of moments w.r.t. parameters			
	σ	α	ξ
$\Delta log(I)$	0.86	0.03	0.02
Mean gross leverage ratio	-0.96	0.01	-0.01
Firms w/ positive debt	-11.65	-2.07	4.37
Mean default rate	-1.74	6.93	1.56

Panel B: Elasticities of parameters w.r.t. moments			
	σ	α	ξ
$\Delta log(I)$	0.47	-0.31	0.24
Mean gross leverage ratio	0.63	-0.15	-5.62
Firms w/ positive debt	0.15	-0.01	-0.63
Mean default rate	0.01	0.14	0.02