The Impact of Securities Regulation on New Keynesian Firms*

Erica Xuenan Li[†], Jin Xie[‡], and Ji Zhang[§]

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Abstract

Borrowing firms resetting output prices infrequently are less able to insulate their profits from economic shocks, the impact of which on performance is costly for lenders to verify. If securities regulation is lenient, sticky-price firms might face greater financial frictions due to managerial misreporting. We document that S&P 500 firms with stickier prices paid lower loan spreads and provided collateral less often following the passage of Sarbanes-Oxley Act (SOX), and the results are robust to using staggered implementations of Section 404 to isolate the effects that were uniquely due to SOX. Firms with stickier prices are negatively associated with daily returns around the Enron scandal but positively associated with returns around the SEC's approval of the change in listing requirements. We develop a New Keynesian model of an economy in which firms feature differential output-price stickiness. The model mirrors both pre- and post-SOX scenarios and shows that when paying higher credit spreads, firms with stickier prices have lower debt capacity, are endogenously more volatile in equity returns, and display higher capital-investment and stock-price sensitivities to monetary policy shocks. Our further empirical analyses yield results that are in line with these model predictions.

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†Department of Finance, Cheung Kong Graduate School of Business, 1 East Chang An Avenue, Beijing, 100738, P. R. China. Email: xnli@ckgsb.edu.cn.

‡Peking University HSBC Business School, Xili University Town, Nanshan District, Shenzhen, Guangdong Province, P.R. China, 518055. Email: jinxie@phbs.pku.edu.cn.

§PBC School of Finance, Tsinghua University, 43 Chengfu Road, Haidian District, Beijing, 100083, P. R. China. Email: zhangji@pbcsf.tsinghua.edu.cn.

The sticky-price goods that make up the remaining 70 percent of the CPI market basket don't appear to respond to economic conditions. Wall Street Journal (May 21, 2010)

Claims that the disclosure of the impact of inflation will impair the ability of those in a given industry to raise capital are overstated ... The need for disclosure of the impact of inflation on corporate performance is simply no longer open to serious debate. The question is not whether it should be disclosed, but how. Harold Williams, Chairman of SEC (1977)

1 Introduction

In a seminal work, Bernanke, Gertler, and Gilchrist (1999) propose a New Keynesian model with a finance accelerator to explain how monetary policy influences the real economy through two independent channels. First, firms holding output prices fixed respond to monetary-policy-stimulated demand by selling more (e.g., Taylor, 1980; Calvo, 1983). Second, expansionary monetary policy increases borrowers' net cash flows and collateral value, relaxes their financial constraints, and amplifies the effects of monetary policy (e.g., Bernanke and Gertler, 1989, 1995). What is worth noting is that Bernanke et al. (1999) assume firms' inability to adjust prices does not limit their access to credit markets. Under this assumption, firms with differential price stickiness are equally able to finance inputs and production after monetary shocks and, when studying the interaction between financial frictions and monetary policy transmission, scholars often isolate the effect of price stickiness from financial frictions (for important works, see Fisher, 1933; Gertler and Gilchrist,1994; Ippolito, Ozdagli, and Perez-Orive, 2018; Ozdagli, 2018; Ozdagli and Velikov, 2020; Ottonello and Winberry, 2020; Ozdagli and Weber, 2021).

In this paper, we document that firms with stickier prices (stickier firms, hereafter) face greater financial frictions.[1] Our study is motivated by the fact that sticky-price firms are

[1] Reasons why firms adjust their output prices less frequently include coordination failure among industry peers (Blinder, 1994; Blinder, Canetti, Lebow, and Rudd, 1997), managerial inefficiency (Zbaracki, Ritson, Levy, Dutta, and Bergen, 2004), customer antagonization (Anderson and Simester, 2010), firms anchoring on reference prices and costs (Eichenbaum, Jaimovich, and Rebelo, 2011), and, more generally, menu costs (Anderson, Jaimovich, and Simester, 2015). Exploring the determinants of output-price stickiness is beyond the scope of this paper.

less able to insulate their profits from economic shocks (e.g., Gorodnichenko and Weber, 2016), but because lenders cannot costlessly verify the impact of these shocks on borrower performance, firms' inability to reset output prices naturally delays the revelation of profit-damaging news to the public.[2] Although voluntary disclosure could address the problem, managers often keep such information confidential either because of their conflict of interest with shareholders or for a variety of strategic motives.[3] For this reason, firms' inflexibility in adjusting price to a variety of economic shocks increases the cost for lenders to verify the performance-impact of these shocks, and therefore, require a higher return on loans extended to sticky-price borrowers, especially when managers of borrowing firms have greater discretion over financial reporting (e.g., Gale and Hellwig, 1985; Ozdagli, 2018). Indeed, prior literature documents that the quality of borrowers' financial statements plays a pivotal role in determining the design of a contract governing a lender-borrower relationship, even though lenders often acquire borrowers' private information.[4]

A recent literature has documented that sticky-price firms have lower leverage and pay higher cost of debt, primarily because such firms have higher cash-flow volatility (D'Acunto, Liu, Pflueger, and Weber, 2018; Augustin, Cong, Corhay, and Weber, 2021). We share with these papers the study of the role of nominal rigidities on financial frictions. However, we distinguish our study from these two papers by emphasizing on the role of managerial misreporting rather than cash-flow volatility.

We start our empirical analysis by matching the frequency of price adjustment (FPA) at the level of granular North American Industry Classification System (NAICS) sectors with S&P 500 constituent firms over the sample period of 1997-2012.[5] D'Acunto et al.

[2]Gorodnichenko (2010) theoretically shows firms reveal their private information about demand by resetting output prices. Xie (2020) empirically shows managers of sticky-price firms more frequently manage expectations of financial analysts. Gu and Xie (2021) find a public release of information about input-costs better addresses information asymmetry among investors holding stakes in sticky-price firms.

[3]For surveys on corporate disclosure, see Verrecchia (2001), Healy and Palepu (2001), and Graham, Harvey, and Rajgopal (2005), among others.

[4]For related literature, see Graham, Li, and Qiu (2008), Bushman, Smith, and Wittenberg-Moerman (2010), and Costello and Wittenberg-Moerman (2011).

[5]Pasten, Schoenle, and Weber (2017) use the confidential microdata underlying the Producer Price Index (PPI) program from the Bureau of Labor of Statistics (BLS) to aggregate such frequencies at the individual-goods level into the North American Industry Classification System (NAICS) sectors of different granularities.

(2018) confirm FPA is an extremely persistent feature consistent with a large literature in macroeconomics.[6] The authors find a firm-level regression of post-1996 price stickiness on pre-1996 price stickiness yields a slope coefficient of 0.93. D'Acunto et al. (2018) also verify bank debt is an important source of both long-term and short-term financing for S&P 500 firms in our sample period.

To build our empirical laboratory, we bring firms with differential output-price stickiness into the context of a securities regulation and its financial-market consequences (e.g., Bushee and Leuz, 2005; Greenstone, Oyer, and Vissing-Jorgensen, 2006). Specifically, we exploit the passage and implementation of the Sarbanes-Oxley Act (SOX) in July 25, 2002, the most far-reaching securities legislation since the Securities Acts of 1933 and 1934. The legislation mandated managers individually certify the accuracy of financial reporting, substantially increased penalties for fraudulent misreporting, and increased external auditors' independence to review financial statements.[7] Because SOX was triggered directly by the collapse of Enron in late 2001, the regulation was plausibly exogenous to both fundamentals and price stickiness for a majority of publicly listed firms that were not involved in financial scandals and bankruptcies (see Ozdagli, 2018 and D'Acunto, Xie, and Yao, 2020).

Our difference-in-differences (DID) design allows us to estimate the precise impact of securities regulation on price-stickiness-induced financial friction after partialling out time-invariant unobservables at the firm level, as well as time-varying unobservables at the industry level, that might exert influence on both firms' product pricing and their credit-market outcome. By holding cash-flow volatility constant, our DID approach helps isolate the effects of managerial misreporting in exacerbating sticky-price firms' credit-market frictions.

One possibility is that the nationalwide implementation of SOX was accompanied by other major economic and political news (e.g., the impending war in Iraq or the creation of the Department of Homeland Security), which might confound the SOX effects (see Leuz, 2007, for a thoughtful discussion). We examine this possibility by performing two separate

[6] Nakamura, Steinsson, Sun, and Villar (2018) find that (non-sale) prices have not become more flexible over the past 40 years.

[7] The sections of the bill cover responsibilities of a public firm's board of directors, add criminal penalties for certain misconduct, and require the Securities and Exchange Commission (SEC) to create regulations to define how public firms are to comply with the law.

tests. First, we use the staggered timing in the compliance of firms with the most contentious aspect of SOX — Section 404, which required companies to file the first management report and independent auditor report for the fiscal year ending on or after November 15, 2004 — to isolate the effects that were uniquely due to SOX.[8] We use the differences in the timing of SOX implementation based on whether firms' fiscal year ends before or after November 15, which are arguably exogenous to unobservables driving financial frictions, to carry out the DID design.

Second, we analyze stock-market reactions to show that stocks of stickier firms experienced more negative daily abnormal returns surrounding the date on which Enron filed earnings restatements and bankruptcy;[9] by contrast, such firms experienced more positive returns around the time the SEC approved proposals made by the NYSE and NASDAQ to reform public firms' disclosure practices and corporate governance.[10] Our tight-window evidence suggests investors' concern about corporate misreporting was indeed concentrated on stickier firms.

Turning to the effect of SOX on sticky-price firms' access to the credit market, the picture that emerges is striking: SOX has substantially reduced both loan spreads and the frequency with which lenders require collateral for sticky-price borrowers, and the DID effect monotonically increases with the extent to which firms are unable to adjust output prices to shocks. Before July 2002, a one-standard-deviation increase in price stickiness increases (the logarithm of the) loan spread by 8 percentage points, which is equivalent to 8.43% of the sample mean; after July, 2002, a one-standard-deviation increase in stickiness reduces loan spread by 12.2% of the sample mean. Our results are fairly robust to the inclusion of firm characteristics used by D'Acunto et al. (2018), time-, industry-, and firm-fixed effects. In the most restrictive specification, we exploit variations within both firms and industry-time to exclude the possibility that both time-invariant unobservables and industry-level time trend

[8] As the most complicated and expensive provision, Section 404 requires that top executives report their findings in a special management's report, and that an outside auditor attest to management's assessment of the company controls.

[9] Commission File Number 1-13159 (U.S. Securities and Exchange Commission, November 8, 2001).

[10] "SEC Approves NYSE, NASDAQ Strengthening of Corporate Governance Standards for Listed Companies" (U.S. Securities and Exchange Commission, November 4, 2003).

might drive the DID effects. We also use the compliance with Section 404 that is staggered cross firms as an alternative timing treatment and show our results are not confounded by nationalwide macro trends.

Our DID strategy provides an estimate of the casual impact of information friction on borrowers' debt costs through their inability to adjust output prices. For two reasons, however, evaluating the implication of this DID effect to the aggregated economy is challenging. First, treated firms — S&P 500 firms with stickier prices — are not representative of the entire economy. Hence, even though the SOX effect is well identified, the direct causal effect could account for only a small share of the overall impact of price-stickiness-induced financial frictions. Second, we build the identification strategy solely upon the passage of SOX, the impact of which is only restricted to firms publicly listed in the US surrounding the legislative event. To more thoroughly tackle our research question, we need to expand the scope of focus to generalized firms operating on a normal daily basis.

We therefore present a New Keynesian model à la Li and Palomino (2014) to assess the real impacts of price-stickiness-induced financial friction on the economy, including the leverage of sticky-price firms, the behavior of their asset prices, and their resulting responsiveness to monetary policy (and technology) shocks. A departure from prior literature (Bernanke et al., 1999; Ottonello and Winberry, 2020), we assume borrowing firms with stickier prices have to pay higher loan spreads because verifying the impact of a variety of shocks on the performance of such borrowers is more costly for lenders. More importantly, the difference between spreads paid by sticky- and flexible-price borrowers is counter-cyclical, which we show is the key driver of model results.

Our New Keynesian model predicts that stickier firms have lower debt capacity, are endogenously more volatile in equity returns, and exhibit a higher capital-investment sensitivity to unexpected changes of monetary policy, as well as to real shocks (e.g., shocks to total factor productivity (TFP)). In particular, we show that the counter-cyclical interest-rate premium paid by sticky-price borrowers is what endogenously drives these firms' return volatility. The reason is that, when facing greater financial frictions, such firms' capital investment and debt financing are more sensitive to economic and credit-market conditions;

for example, stickier firms borrow and invest more (less) after expansionary (contractionary) monetary policy shocks. In fact, if we model financial friction by assuming stickier firms are associated with a lower loan-to-collateral ratio, instead of paying a higher credit spread, the two types of firms become equally volatile, although they are characterized with differential price stickiness.

To quantify the impact of financial frictions on sticky-price firms, we calibrate the model using both observable features of raw data and realistic parameters employed by prior literature. We also change the parameter governing the credit spread to mirror the pre- and post-SOX scenarios in which stickier firms face more and less financial frictions. We show that a sizable reduction in lenders' required return on loans extended to such firms expands these firms' debt capacity, weakens their responsiveness to monetary policy surprises, and reduces these firms' return volatility.

We perform empirical analysis to test the above model predictions. Together, our findings can be summarized as follows. First, unconditionally, stickier firms are underleveraged, consistent with D'Acunto et al. (2018); such firms, however, increased leverage by a sizable magnitude after SOX relative to before. Prior to the legislation, a firm's long-term debt ratio was 3% lower if its output price was one-standard-deviation stickier; after the legislation, the negative correlation between price stickiness and leverage was dwarfed by a half. Moreover, the size and significance of results are unchanged when we account for measurement error using the errors-in-variables estimator based on the linear cumulant equations of Erickson, Jiang, and Whited (2014).

Second, following the SOX act, stickier firms became less volatile in equity returns. These findings are consistent with our model predictions that in the face of heightened financial frictions, sticky-price firms' higher return volatility is attributable to their lumpy investment and debt financing in response to nominal or real shocks.

Third, stickier firms' capital investment was sensitive to unexpected changes in monetary policy; that is, firms invested more (less) after monetary expansions (contractions) before SOX but became insensitive to monetary policy changes afterwards. During the pre-period, a firm's capital investment was 0.04 more sensitive to monetary policy surprises if output price was one-standard-deviation stickier; during the post-period, the impact of price stickiness on such a sensitivity became virtually zero.

Fourth, also consistent with our theoretical insights, our empirical results show that output-price stickiness increased the monetary policy sensitivity of stock prices significantly, and that this effect became essentially zero after SOX.

Literature: Our paper adds to several strands of literature. The first strand of literature is related to the study on how credit-market friction influences the aggregate economy. Carlstrom and Fuerst (1997) embed borrower-agency costs of a lending relationship into a real-business cycle model. Bernanke et al. (1999) incorporate agency costs into a New Keynesian model to examine the interaction of credit-market frictions with shocks to monetary policy. Ottonello and Winberry (2020) build on Bernanke et al.'s (1999) framework to include firm heterogeneity in default risk. Bernanke et al. (1999) and Ottonello and Winberry (2020) assume price stickiness is independent from financial friction.

Specifically, we show monetary policy shocks affect the real economy through information-sensitive external financing. Ozdagli (2018) exploits Arthur Andersen's demise to document that Anderson's clients, which were more costly to audit, have a lower leverage and a weaker reaction to expansionary monetary shocks.[11] Ozdagli and Velikov (2020) create a monetary policy exposure index based on observable firm characteristics that capture the credit channel, balance sheet liquidity, discount rate effect, and nominal rigidities. The authors show that the index successfully captures stocks' responses to monetary policy. Armstrong et al. (2019) find better accounting quality moderates firms' stock price response and future investment sensitivity to unexpected changes in monetary policy.

The second strand is the emerging literature that establishes a link from product pricing to financial-market frictions. Li and Palomino (2014) and Hsu, Li, and Palomino (2019) analyze asset-return and bond-yield implications of output-price stickiness in a general equilibrium. Weber (2015) examines the asset-pricing implications of nominal rigidities and

[11] The key to explain Ozdagli's (2018) finding is that bank debt usually has a floating interest rate, which makes stock prices more responsive to monetary policy (Ippolito, Ozdagli, and Perez-Orive, 2018).

finds firms that adjust product prices inflexibly earn an equity premium 4% per year. Gorodnichenko and Weber (2016) show that after monetary-policy announcements, the conditional volatility of stock market returns increases more for firms that cannot freely adjust product prices. D'Acunto et al. (2018) document that sticky-price firms have lower leverage ratios and they increase leverage more following bank branching deregulation. Xie (2020) shows firms' downward nominal rigidities reduce the persistence of their operating income and increases return volatility. Gu and Xie (2021) show that the impact of price rigidities on information asymmetry among investors is largely mitigated by public information disseminated by government statistical agencies. Augustin et al. (2021) show that, both analytically and empirically, sticky-price firms have lower financial leverage, shorter debt duration, higher cost of debt, more stringent debt covenants, and higher precautionary cash holdings.

The third strand is the literature on the role of wage rigidities played in financial markets. Recently, several authors propose that the cross-industry variation in the degree of wage rigidity and labor shares leads to differences in credit risk and helps rationalize several asset pricing puzzles (Belo, Lin, and Bazdresch, 2014; Favilukis and Lin, 2016a,b; Belo, Li, Lin, and Zhao, 2017; Favilukis, Lin, and Zhao, 2020). In a New Keynesian framework, we examine the effect of rigidities on the revenue rather than on the cost side.

2 Institutional Background and Data

2.1 The Sarbanes-Oxley Act

The Sarbanes-Oxley Act was passed in Congress on July 25, 2002, in response to several high-profile financial scandals in corporate America, which resulted in billions of dollars of losses for investors. President George W. Bush signed the bill into law on July 30, 2002.[12] The Act has widely been considered the most far-reaching securities legislation since the Securities Acts of 1933 and 1934. The implementation of SOX started soon after its passage and the rulemaking activities continued in 2003.[13]

[12]For institutional details, see H.R.3763 – Sarbanes-Oxley Act of 2002.

[13]The SEC adopted rules on management report of internal controls on May 27. The Public Company Accounting Oversight Board (PCAOB) audit standard of internal controls was approved by the SEC in June

SOX consists of 11 sections, including new requirements on accounting firms, corporate officers, corporate directors, and security analysts. Several key provisions are worth mentioning. First, Section 302 of the Act requires firm chief executive officers (CEOs) and chief finance officers (CFOs) to certify the veracity of firms' financial statements, and demands more timely and detailed disclosures. Companies must disclose transactions on a "rapid and current" basis and provide more detail regarding off-balance-sheet transactions and special-purpose entities.

Second, the "real time issuer disclosure" mandate in Section 409 of the Act was intended to provide investors with better and faster disclosure of important material corporate events. Accordingly, the SEC expanded the number of material events that are reportable on Form 8-K under the Security Exchange Act of 1934 and shortened the Form 8-K filling deadline to four business days after the occurrence of a material event.[14]

Third, Section 404 requires companies to put in place and periodically test procedures that monitor the internal control systems ensuring accurate financial reports. This Section also requires that managers report their findings in a special management report; in addition, external auditors of the company must attest to management's evaluation. Fourth, SOX sets more stringent standards for audit-committee membership. All members of the audit committee must be independent, and firms must disclose whether at least one member is a financial expert.[15]

Fifth, SOX requires CEOs and CFOs to disgorge bonus compensation and stock-sale profits during any 12-month period following a financial report that is subsequently restated due to their misconduct.

Finally, SOX defines some new criminal offenses (i.e., destruction of documents with intent to obstruct justice) and raises criminal penalties attached to existing offenses. Executives who knowingly certify false financial reports are subject to a fine of $5 million, a 20-year prison term, or both. Criminal penalties are increased for mail fraud, violation of

2004, which completed the major rulemaking activities directed by SOX.

[14] "SEC Adopts Rules on Provisions of Sarbanes-Oxley Act" (U.S. Securities and Exchange Commission, January 15, 2003).

[15] "Final Rule: Management's Report on Internal Control Over Financial Reporting and Certification of Disclosure in Exchange Act Periodic Reports" (U.S. Securities and Exchange Commission, August 28, 2008).

the Employee Retirement Income Security Act of 1974 (ERISA) reporting and disclosure rules, and violation of the Securities Exchange Act of 1934.[16]

2.2 Data

We focus on U.S.-headquartered, S&P 500 constituent firms in the sample period of 1997-2012.[17] For most of the empirical exercises, we start the sample from 1997Q1 because the NAICS system was first established in 1997 by the BEA. To convert SIC into NAICS for years before 1997, the BEA relied heavily on concordances developed in 1997. Such a single-year static concordance becomes increasingly unreliable in early years before 1997 as the true relationship between NAICS and SIC changes over time. Because output-price stickiness is prepared in accordance with the NAICS system, we set 1997 as the beginning of the sample. These firms capture approximately 80% of the available stock market capitalization in the U.S., thereby maintaining the representativeness for the whole economy in economic terms.

Output-price stickiness is measured at the 6-digit NAICS sector. We assume different firms in the same 6-digit NAICS sector are subject to the same degree of price inflexibility. This assumption is reasonable because firms operating in the same granular sector are similar in many aspects, including product functions, inputs, labors, technologies, and other business conditions.

We use the data for frequency of price adjustment (FPA) provided by Pasten, Schoenle, and Weber (2017) to measure price stickiness.[18] Using the confidential microdata underlying the PPI from 2002 to 2012, the authors calculate the FPA at the goods level as the ratio of the number of price changes to the total number of sample months. For example, if an observed price path is $5 for three months and then $10 for another two months, one price change occurs during five months, and the frequency is 1/5. The authors then aggregate

[16] "Attorney General August 1, 2002 Memorandum on the Sarbanes-Oxley Act of 2002" (U.S. Department of Justice, August 1, 2002).

[17] For similar applications, see Bernanke and Kuttner (2005), Weber (2015), Gorodnichenko and Weber (2016), and D'Acunto et al. (2018).

[18] We match FPA to Compustat firms based on the 6-digit NAICS sector codes. If Compustat firms' 6-digit NAICS codes are not matched with those in the adjustment-frequency data, we switch to using 5-digit codes. We repeat this procedure until 3-digit codes.

goods-based frequencies into 674 data points at the level of 6-digit NAICS sectors. FPA measures the mean fraction of months with price changes during the sample period à la Calvo (1983) and is time invariant. The data are consistent with the finding by Nakamura and Steinsson (2008) that a median duration of prices is between eight and 11 months.

The syndicated loan sample is a set of loan issuances from the Dealscan database provided by the Loan Pricing Corporation (LPC). We collapse a package with multiple facilities contracted on the same date into one observation. Loan spread is calculated as the sum of the amount across facilities, the average maturity, and the average all-in-drawn spread over the London Interbank Offered Rate (LIBOR).[19] We collect stock returns from the daily and monthly stock- return file from the Center for Research in Security Prices (CRSP). We obtain financial and balance-sheet variables from Compustat. We gather quantitative (numeric) managerial expectations from the I/B/E/S Guidance.

Panels A and B of Table 1 present descriptive statistics on the Compustat and DealScan samples, respectively. The sample unit with the Compustat sample is at the level of firm-year-quarter; the sample unit with the DealScan sample is at the level of loan package. Price stickiness varies substantially across firms. On average, a firm will keep prices constant for eight months.[20] Panels C of Table 1 presents descriptive statistics on the FOMC-meeting sample. The sample unit with this sample is at the level firm-event-day.

3 Empirical Findings

In this section, we provide two stylized facts after the passage of SOX; namely, borrowers with stickier prices paid lower spreads in the syndicated loan market.

[19] We match loans to Compustat via the August 2012 version of the Dealscan-Compustat linking table introduced by Chava and Roberts (2008).

[20] We use $-1/\log(1\text{-adjustment frequency})$ to calculate implied duration.

3.1 Empirical Strategy

Throughout the paper, we stick to the following design:

$$Y_{i,s} = \alpha + \beta \times Sticky_j + \gamma \times Sticky_j \times Post\ SOX_{i,s} + \delta \times Post\ SOX_{i,s} \\ + X'_{i,t-1} \times \theta + \eta_s + \eta_i + \epsilon_{i,s}, \tag{3.1}$$

where i, j, s, and t index the firm, the 6-digit NAICS sector, year-quarter, and year, respectively. $Post_{i,s}$ is an indicator equal to 1 if time is after 2002Q3, and 0 otherwise. A set of firm (η_i) or Fama-French 12-industry (η_k) fixed effects absorb time-invariant characteristics that differ across firms or industries.[21] In the most restrictive specification, we add industry-year-quarter fixed effects ($\eta_{k,s}$) to absorb time-varying shocks at the industry level.

$X_{i,t-1}$ is a set of control variables employed by D'Acunto et al. (2018), including firm size, book-to-market ratio, profitability, long-term debt, price-to-cost margin, intangible assets to assets, and the Herfindahl-Hirschman Index (HHI) measuring market concentration. We cluster standard errors at the 6-digit NAICS level.

Because the passage of SOX is a nationalwide shock, our results might be affected by other contemporaneous major macroeconomic or political news (Leuz, 2007). For the purpose of improving identification, we exploit the staggered implementation of SOX Section 404. In 2003, the SEC implemented Section 404 of SOX to require that managers report earnings in a special management report and that an outside auditor attest to management's assessment of the company controls. As the most expensive SOX provision, Section 404 procedures are intended to deter financial fraud and improve the reliability of financial statements.

We estimate the following regression:

$$Y_{i,s} = \alpha + \beta \times Sticky_j + \gamma \times Sticky_j \times Post\ SOX404_{i,s} + \delta \times Post\ SOX404_{i,s} \\ + X'_{i,t-1} \times \theta + \eta_s + \eta_i + \epsilon_{i,s}, \tag{3.2}$$

where $Post\ 404_{i,s}$ is an indicator equal to 1 if firm i in year-quarter s complies to the SOX Section 404, and 0 otherwise. We use differences in firms' fiscal year-ends as an exogenous

[21] Because price s is measured at the 6-digit NAICS industry, we use industries under other classifications to control for industry fixed effects. Our results are not materially altered if we use Hoberg-Phillips text-based or Fama-French 48-industry classification.

source of cross-firm variation in compliance with SOX. The final SOX Section 404 rules required all domestic firms except those with a public float under $75 million with fiscal year ends on or after November 15, 2004, to comply with the SOX reporting requirements in their 2004 financial statements. All other non-small firms had to comply with the SOX reporting requirements in their 2005 financial statements. Firms with fiscal year-ends on or after November 15, 2004, complied with the section in their fiscal year of 2004; all other firms complied with the section in their fiscal year of 2005.[22]

3.2 Loan Spreads

We now document that SOX reduced spreads paid by stickier borrowers of loans. The findings are broadly consistent with prior literature on how information asymmetry is linked to syndicated loan contracts (e.g., Sufi, 2007, 2009; Graham et al., 2008; Wittenberg-Moerman, 2008; Ivashina, 2009; Costello and Wittenberg-Moerman, 2011). In particular, Graham et al. (2008) and Costello and Wittenberg-Moerman (2011) find that lenders increase interest rates and impose tighter monitoring following borrowers' financial misreporting. The findings by Costello and Wittenberg-Moerman (2011) suggest that even lenders acquire private information, borrowers' reporting quality still plays a non-negligible role in the design, of debt contracts.

For several reasons, we focus on syndicated loans rather than public bonds. First, compared with small firms, S&P 500 firms rely more on bank debt (Beck, Demirgüç-Kunt, and Maksimovic, 2008). D'Acunto et al. (2018) find the vast majority of the firm-year observations in our sample have a credit line open with at least one bank (94.6%). Second, these large firms had infrequently issued bonds over the period of 1997 – 2012; for example, only 125 firms issued bonds both before and after SOX, rendering our DID design uninformative about the true effect of securities regulation on borrowing cost.[23] Third, compared with

[22] Since our sample consists of only S&P 500 constituent firms, we did not find any firm-year observations for which the most recent year-quarter-end market value was within $75 million of the $75 million public float requirement for accelerated filer status.

[23] Our unreported results, however, suggest bond issuers also experienced a larger post-SOX decline in bond spread if their output-prices are stickier.

non-bank debt, most bank loans have floating rates mechanically tied to monetary policy rates (Faulkender, 2005; Vickery, 2008). Indeed, Ippolito et al. (2018) document strong evidence that monetary policy can directly affect the liquidity and balance-sheet strength of firms through changing the interest rate of existing loans. Fourth, Augustin et al. (2021) also study the relation between price stickiness and credit-market frictions using yield spreads from the secondary bond market. The sample period of transactions for U.S. corporate bonds from the TRACE Enhanced database starts in July 2002 and, hence, we unfortunately do not observe yield spreads before SOX.

We estimate the following difference-in-differences design:

$$\begin{aligned} log(Spread)_{n,i,s} = \alpha + \beta \times Sticky_j + \gamma \times Sticky_j \times Post_{i,s} + \delta \times Post_{i,s} \\ + X'_{i,t-1} \times \theta + \eta_t + \eta_i + \epsilon_{n,i,s}. \end{aligned} \tag{3.3}$$

For each loan package n signed by firm i in year-month s, $log(Spread)_{n,i,s}$ is the logarithm of the average all-in-drawn spreads over the London Interbank Offered Rate (LIBOR).[24]

Panel A of Table 2 presents the regression results. Unconditionally, firms pay a similar loan-spread amount regardless of price stickiness (column (1)). Stickier firms, however, paid much lower loan spreads following the SOX legislation. Before SOX, a one-standard-deviation increase in price stickiness is associated with an 8-percentage-point increase in $log(spread)$; after SOX, a one-standard-deviation increase in stickiness is associated with a 13-percentage-point decrease in $log(spread)$ (column (2)). These numbers speak to a sizable change in the loan-spread value: 8.43% and 12.2%, respectively. The results are not materially altered when we exploit variations within year, industries, firms, and industry-year. In Panel B of Table 2, we estimate the effect of the staggered timing of Section 404 on loan spreads. We report results that are similar to Panel A; that is, the size of debt-cost reduction post the SOX Section 404 increases with price stickiness.

A necessary condition for identification is the parallel-trends assumption, which states that the evolution of loan spreads of sticky-price firms (treated) and flexible-price firms (controlled) would have followed common trends before and after SOX, had the securities

[24] We collapse a package with multiple facilities contracted on the same date into one observation.

regulation not happened. We estimate the following regression to assess this assumption:

$$log(Spread)_{n,i,s} = \alpha + \sum_{s=-10}^{10} \beta_s \times Sticky_j + \sum_{s=-10}^{10} \gamma_s + X'_{i,t-1} \times \theta + \eta_k + \epsilon_{n,i,s}, \qquad (3.4)$$

where $-10 \leq s \leq 10$ indicates the sth event year (12 months) relative to July 25, 2002. We drop the interaction for year 1990, and thus, the effect is normalized to zero for that year. We can interpret β as the change in the effect of price stickiness on firm-level outcomes from 1990 to event quarter s. Figure 2 shows the trends in spreads were parallel across treated and control firms in periods before SOX was implemented.

3.3 Collateral

Rajan and Winton (1995) theoretically show collateralized debt should be observed more in firms that need monitoring, because collateral can be motivated as contractual devices that increase a lender's incentive to monitor.

In Table 3, we find a lower frequency with which lenders require collateral from sticky-price borrowers following both the passage of SOX and the staggered implementation of Section 404, and the size of our estimates monotonically increases with firms' inflexibility to adjust output prices to economic shocks. After July 2002, a one-standard-deviation increase in price stickiness is associated with a 2- to 3-percentage-point decrease in the frequency with which borrowers pledge assets against loans, and this number is approximately 20%-30% of the sample mean. Figure 3 provides evidence that the treated and control groups follow the same pre-trends before SOX, and the drop in the likelihood of loan collateralization occurs two years after SOX.

Figure 2 tells us that syndicated loan borrowers with stickier prices paid lower spreads during the Great Recession, whereas Augustin et al. (2021), by contrast, document that yield spreads of sticky-price bond issuers increased more in response to the Lehman Brothers' bankruptcy in September 2008. We articulate the reasoning process we use to reconcile these contradictory results. First, Augustin et al. (2021) source transaction data from the secondary bond market, thereby comparing spreads for the same bond before and after

September 2008. However, we source data from the primary syndicated loan market, thereby allowing for the selection of the same borrower with different borrowing purposes into our sample. Second, the heightened uncertainty in the case of traded bonds could be considerably attenuated in the case of newly issued syndicated loans, because lead lenders frequently acquire private/soft information from borrowers. To the extent that the 2008-09 financial crisis was largely exogenous to the fundamental of a majority of non-banking sectors, and all else equal, borrowing firms' product-market operations were not significantly altered. Indeed, Ivashina and Scharfstein (2010) find new lending for real investment (e.g., working capital and capital expenditures) fell by only 14% in the last quarter of 2008 relative to the prior quarter, whereas new lending for restructuring (LBOs, M&As, share repurchases) contracted by almost 80% relative to the peak of the credit boom. Third, we observe in Figure 3 that sticky- and flexible-price firms became equally likely to secure loans by providing collateral, even though stickier firms had a persistently lower likelihood of doing so in other years during the entire post-SOX period, suggesting lenders did behave cautiously during the unusual episodes.

3.4 Event Stock Returns

In this section, we perform cross-sectional regression of daily stock returns around several major events on price stickiness. The analysis not only establishes a casual link from price stickiness to corporate misreporting, but also addresses the concern that results in Table 2 are driven by industry-level time trends.

We estimate the following regression model:

$$CAR_i = \alpha + \beta \times Sticky_j + X_i' \times \theta + \epsilon_i, \tag{3.5}$$

where for each firm i, CAR_i is the cumulative abnormal returns estimated over the window of [-1, +1] days relative to the dates on which the following occurred: (1) Enron filed earnings restatement (November 8, 2001); (2) Nasdaq's Executive Committee approved first round of governance requirements (December 4, 2002); (3) WorldCom announced its profits had been inflated by $3.8 billion (June 25, 2002); (4) the Senate passed the bill of Senator Sarbanes to enhance auditing related procedures, corporate responsibility, and financial disclosure (July 15, 2002); (5) the House and Senate approved the Sarbanes-Oxley bill (July 25, 2002); and (6) SEC approved proposals by the NYSE and NASDAQ on corporate governance reforms (November 4, 2003).

Table 4 presents our tight-window estimates. Stickier firms experienced more negative abnormal returns around the confirmation of Enron and WorldCom scandals, suggesting stock markets expressed more concerns about stickier firms regarding the revelation of corporate fraud. Specifically, the evaporation of firm value amounts to 2% and 0.7% around the Enron and WorldCom scandals, respectively, if a firm's product price is a one-standard-deviation stickier. By contrast, stickier firms experienced more positive returns around April 12, 2002, and November 4, 2003. The former and latter are the beginning and ending dates on which the two stock exchanges proposed changes in listing standards with the SEC to improve corporate governance, particularly in the areas of board and shareholder monitoring. Specifically, the creation of firm value amounts to 1.8% if output price is one-standard-deviation stickier. In addition, stickier firms experienced neither negative nor positive daily returns around the key SOX events, indicating net private costs (e.g., non-audit services, corporate responsibilities, and internal controls) imposed by SOX provisions on firms do not increase with price stickiness.

3.5 Discussion

Our findings suggest securities regulation improves financial transparency for stickier firms, which in turn attenuates financial frictions these firms face. However, a body of conflicting literature has evolved to address the debate as to whether SOX carries a net benefit or cost to firms and investors. We reconcile our findings with prior literature from the following perspectives.

First, one could argue our results on loan spreads might be driven by managers of stickier firms taking fewer risks during the post-SOX period (e.g., Kang, Liu, and Qi, 2010; Bargeron, Lehn, and Zutter, 2010). For example, Kang et al. (2010) structurally estimate the effect of SOX on the rate U.S. firm managers apply to discount investment projects. The authors conclude that firms, especially small ones, cut investment after SOX.[25] By contrast, we report in Table A.1 that after SOX, stickier firms did not cut capital investment more, suggesting managers engaging in fewer risk-taking activities cannot explain the reduction in loan spreads.

Second, several authors argue Section 404 compliance imposed real costs on both foreign and domestic firms (e.g., Holmstrom and Kaplan, 2003; Zhang, 2007; Engel et al., 2007; Morosi and Marroud, 2008; Iliev, 2010). However, we use a sample that consists of only the largest firms in the economy, whereas the big complaint about Section 404 (and SOX compliance in general) has been that small firms pay disproportionately high costs because of the fixed-cost nature of compliance (Engel, Hayes, and Wang, 2007; Iliev, 2010). Consistent with this view, Chhaochharia and Grinstein (2007) document that large firms that are less compliant earn positive abnormal returns, but small firms that are less compliant earn negative abnormal returns around key SOX events.[26]

Third, Leuz (2007) argues using cross-sectional tests to inform the costs or benefits of particular SOX provisions is hard. One potential problem is that the optimal levels of variables such as internal controls, corporate governance, or non-audit services are not only unobservable, but also differ across individual firms, which in turn makes the effect of SOX hard to predict. However, we sort a continuum of firms based on an innovative characteristic (i.e., firms' inability to reset prices) that a priori has unambiguous predictions about the effect of SOX through the lens of this characteristic. Furthermore, such a characteristic is determined by factors orthogonal to what SOX aims to improve. Specifically, our identification strategy relies on the fact that stickier firms are more exposed to idiosyncratic and aggregate shocks (Li and Palomino, 2014; Weber, 2015; Gorodnichenko and Weber, 2016; D'Acunto et al., 2018; Xie, 2020; Gu and Xie, 2021).

[25] Bargeron et al. (2010) find several measures of risk-taking decline significantly for US firms after SOX.

[26] Engel et al. (2007) and Iliev (2010), among others, document similar findings suggesting SOX destructed the value of small firms.

4 Model

In this section, we develop a New Keynesian model of an economy in which firms feature differential inflexibility in adjusting output prices. Specifically, we follow Li and Palomino (2014) to incorporate two sectors in the economy, which are characterized by high and low output-price stickiness or, equivalently, by sticky- and flexible-output prices. To mirror the pre-SOX credit-market scenario, we assume firms in the sticky sector face greater financial friction than firms in the flexible sector; to mirror the post-SOX scenario, we also assume firms in the two sectors face the same financial friction. We then simulate the economy to examine how investment, debt capacity, product prices, output, sales, return volatility, and dividends for sticky-price firms to react to nominal and real shocks. We also vary the specific forms of financial friction to examine how the real effects of nominal and real shocks vary between circumstances in which firms facing greater financial frictions pay higher debt costs and circumstances in which firms facing greater financial frictions are associated with lower loan-to-collateral ratios.

In the following sections, we first introduce different model ingredients and then use the model to derive several theoretical predictions that are empirically testable.

4.1 Households

The household maximizes her lifetime utility:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\log C_t - (L_t)^{1+\phi_L}/(1+\phi_L) \right],$$

where β is the discount factor, C_t is consumption, L_t is the hours of work, and ϕ_L is the parameter of the Frisch elasticity of labor. Households lend in nominal terms at time $t-1$ by a loan amount of B^P_{t-1}, and receive R_{t-1} for each unit of loan at time t. The budget constraint of households follows:

$$C_t + \frac{B^P_t}{P_t} = \frac{R_{t-1} B^P_{t-1}}{P_t} + w_t L_t + \mathcal{D}_t - \mathcal{T}^P_t,$$

where w_t is the real wage, P_t is the price of consumption goods at time t, $\Pi_t \equiv P_t/P_{t-1}$ is the gross inflation rate, $\mathcal{D}_t$ is the lump-sump profits received from the retailers, and $\mathcal{T}_t^P$ is the lump-sum tax.

The first-order conditions for consumption and labor supply are

$$\frac{1}{C_t} = \mathbb{E}_t\left(\frac{\beta R_t}{\Pi_{t+1}C_{t+1}}\right), \tag{4.1}$$

and

$$w_t = (L_t)^{\phi_L} C_t. \tag{4.2}$$

We define $M^h_{t+1} \equiv \frac{\beta C_t}{C_{t+1}}$ as the household pricing kernel so that (4.1) can be expressed as

$$\mathbb{E}_t\left[R_t M^h_{t+1}/\Pi_{t+1}\right] = 1. \tag{4.3}$$

4.2 Entrepreneurs

Two types of entrepreneurs (denoted by superscript j, $j = 1, 2$) exist, differing in the degree of output-price stickiness. Specifically, type 2 entrepreneurs encounter greater inflexibility than type 1 entrepreneurs in adjusting output prices. For simplicity, we call the goods sector occupied by type 2 entrepreneurs "sticky" sector and that occupied by type 1 entrepreneurs "flexible" sector. We label the latter as flexible sector not because output price in this sector is perfectly flexible but to distinguish this sector from the former. Entrepreneur i of type j produces intermediate good $Y_{jt}(i)$ according to a Cobb-Douglas function:

$$Y_{jt}(i) = A_t(K_{jt-1}(i))^{\alpha}(L_{jt}(i))^{1-\alpha}, \tag{4.4}$$

where the technology A_t has a random shock $A_t/A = (A_{t-1}/A)^{\rho_a}\,\varepsilon_{a,t}$ and A is normalized to be 1.

The physical capital $K_{jt-1}(i)$ used for the period t production are determined at time $t-1$. Entrepreneurs purchase investment goods from capital producers at price P^k_t, and capital accumulates following the law of motion:

$$K_{jt}(i) = e^{z_t} I_{jt}(i) + (1-\delta)K_{jt-1}(i), \tag{4.5}$$

where δ is the depreciation rate and $I_{jt}(i)$ is investment. Capital accumulation yields the investment adjustment cost:

$$\xi^I_{j,t}(i) = \frac{\kappa_I K_{jt-1}(i)}{2}\left(\frac{I_{jt}(i)}{K_{jt-1}(i)} - \delta\right)^2.$$

Entrepreneurs sell the intermediate goods to retailers at price $P_{jt}(i)$. The markup for retailers is

$$X_{jt}(i) \equiv P_t/P_{jt}(i).$$

Define the markup for sector j:

$$X_{jt} \equiv P_t/P_{jt},$$

so that

$$P_{jt}/P_{jt}(i) = X_{jt}(i)/X_{jt}\,.$$

Changing the price for intermediate goods yields an adjustment cost in real terms:

$$\xi^P_{j,t}(i) = \frac{\phi_j Y_t}{2}\left(\frac{P_{jt}(i)}{P_{jt-1}(i)} - \Pi\right)^2 = \frac{\phi_j Y_t}{2}\left(\frac{X_{jt-1}(i)\Pi_t}{X_{jt}(i)} - \Pi\right)^2,$$

where Y_t is the amount of final goods, and $\phi_2 > \phi_1$ echos our assumption that type 2 entrepreneurs incur higher costs than type 1 entrepreneurs to adjust output prices.

Entrepreneurs choose real dividend $d_{jt}(i)$, capital stock $K_{jt}(i)$, price $X_{jt}(i)(p_{jt}(i))$, real loans $b_{jt}(i)$, and labor input $L_{jt}(i)$ to maximize their discounted sum of future dividends $\mathbb{E}_0 \sum_{t=0}^{\infty} M_{0\to t} d_{jt}(i)$, subject to constraints (4.4)-(4.9), where $M_{0\to t} \equiv \Pi^t_{s=0} M_s$. Define the firm's pricing kernel as $M_t = (M^h_t/\beta) \times \gamma$, where γ is the discount rate applied to an entrepreneur, and $\gamma < \beta$ indicates entrepreneurs are less patient than the households, and therefore ensures a positive dividend.

The borrowing constraint the entrepreneurs face is

$$b_{jt}(i) \leq \mu_j \mathbb{E}_t[K_{jt}(i)\Pi_{t+1}/R^B_{jt}], \tag{4.6}$$

where μ_j is the loan-to-value ratio, R^B_{jt} is the return on loans extended to borrowing firms of type j, and $B_{jt}(i)$ is the nominal loan the entrepreneurs borrowed from the household.

For simplicity, we assume that, when securities regulation is too lenient to eliminate managerial misreporting, the loan rate for flexible-price firms is the risk-free rate R_t and that the loan rate for sticky-price firms is τR. We assume R^B_{jt} is larger for the industry featured with stickier price, that is, $\tau > 1$. This simplified assumption serves the following three purposes.

First, the assumption that borrowing firms with stickier prices bear less debt costs is motivated by our empirical observation in Subsection 3.2 that stickier S&P 500 firms paid lower loan spreads after SOX, consistent with information asymmetry between borrowers and lenders worsening loan-contract terms (Sufi, 2007; Graham et al., 2008; Wittenberg-Moerman, 2008; Ivashina, 2009). Second, Augustin et al. (2021) also document robust evidence that, in the cross section, output-price stickiness is positively associated with spreads in both loan and bond terms. Third, this assumption implies the credit spread between sticky- and flexible-price firms is counter-cyclical, which is consistent with the data. In the model, when the economy is good, consumption growth is positive. Therefore, interest rates are lower, as is the credit spread. The opposite happens when the economy gets worse. Under this specification of credit spread, even sticky- and flexible-price firms have the same loan-to-collateral ratio (μ), and the firm with sticker prices has lower leverage.

The budget constraint in real terms for entrepreneur i of type j is given by

$$\begin{aligned} \frac{Y_{jt}(i)}{X_{jt}(i)} + b_{jt}(i) = d_{jt}(i) + \left[K_{jt}(i) - (1-\delta)K_{jt-1}(i)\right] e^{-z_t} + \frac{R^B_{jt-1} b_{jt-1}}{\Pi_t} \\ + w_t L_{jt}(i) + \xi^P_{j,t}(i) + \xi^I_{j,t}(i). \end{aligned} \tag{4.7}$$

The entrepreneur i of type j faces a downward-sloping demand curve:

$$Y_{jt}(i) = \left(\frac{X_{jt}(i)}{X_{jt}} \right)^{\epsilon} Y_{jt}, \tag{4.8}$$

where ϵ is the degree of substitution among differentiated type j goods. Entrepreneur i of type j also faces a positive-dividend constraint:

$$d_{jt}(i) \geq 0. \tag{4.9}$$

4.3 Intermediate Goods

Intermediate-goods sector j purchases type j entrepreneurs' products and compose them into type j intermediate goods Y_t^j:

$$Y_{jt} = \left[\int_0^{\zeta_j} (Y_{jt}(i))^{(\epsilon-1)/\epsilon} di \right]^{\frac{\epsilon}{\epsilon-1}},$$

where ζ_j is the size of sector j, and $\zeta_1 + \zeta_2 = 1$. Profits maximization and zero profits lead to the demand function (4.8).

4.4 Final Goods

Final-goods-sector purchases intermediate goods and composites them into identical final goods the repacked goods:

$$Y_t = \left[\sum_{j=1}^{2} (Y_{jt})^{(\eta-1)/\eta} \right]^{\frac{\eta}{\eta-1}},$$

where η is the degree of substitution between the two types of intermediate goods. The demand for sectors 1 and 2 are:

$$Y_{jt} = X_{jt}^{\eta} Y_t \,, \qquad \text{for } j = 1, 2 \,. \tag{4.10}$$

4.5 Monetary Policy

The monetary authority implements a Taylor-type interest rate rule:

$$r_t = (1 - \rho_r)log(R) + \rho_r r_{t-1+}(1 - \rho_r)\phi_\pi(\pi_t - \pi) + \varepsilon_{R,t}, \tag{4.11}$$

where $\pi_t = log(\Pi_t)$ and $\varepsilon_{R,t+1}$ is the i.i.d. shock.

4.6 Equilibrium

The final goods market, capital good market, labor market, and loan market are all clear:

$$Y_t = C_t + I_t + G_t \tag{4.12}$$

$$K_t = \zeta_1 K_{1t} + (1 - \zeta_1)K_{2t} \tag{4.13}$$

$$I_t = \zeta_1 I_{1t} + (1 - \zeta_1)I_{2t} \tag{4.14}$$

$$L_t = \zeta_1 L_{1t} + (1 - \zeta_1)L_{2t} \tag{4.15}$$

$$b_t = \zeta_1 b_{1t} + (1 - \zeta_1)b_{2t}, \tag{4.16}$$

where

$$G_t = GoY \times Y_t \tag{4.17}$$

is government spending and is a fixed proportion of output.

4.7 Calibration and Results

Calibration: The parameters of the model are calibrated as follows and listed in Table 5. The unit of time is a quarter. We assume a zero-trend inflation rate, so $\Pi = 1$. We set $\epsilon = 11$, which implies a steady state price markup of 10%. The parameter representing the elasticity of substitution between the two types of intermediate goods, η, is also 11. The discount factor of the household is set at $\beta = 0.99$, which together with $\Pi = 1$ implies a steady-state short-term rate of 400 basis points at an annualized frequency (i.e., $R = 1.01$). By following Iacoviello (2005), we then set the discount factor of the entrepreneur at $\gamma = 0.98$. The inverse Frisch elasticity, ϕ_L, is set to 5 according to Galí (2015), which implies the Frisch elasticity of labor supply is 0.2. We set the capital depreciation rate at $\delta = 0.025$ according to Christiano, Motto, and Rostagno (2014). We set capital share at $\alpha = 0.35$ and the labor share in the private non-farm business sector at 0.65.

We set ϕ_1 and ϕ_2 to target the Calvo parameters at 0.6 and 0.9[27]: the relationship between the price-adjustment cost parameter ϕ_j and the Calvo parameter θ_j satisfies $\phi_j = \frac{\theta_j(\epsilon_j - 1)}{(1-\theta_j)(1-\beta\theta_j)}$, which ensures the New Keynesian Phillips curves with the two different types of price rigidity yield the same slope. We assume the loan-to-value ratio is 0.8 for both types of firms, regardless of price stickiness, considering the estimated values for entrepreneurs and impatient households are 0.89 and 0.55 in Iacoviello (2005). We set the parameter for the investment-adjustment cost κ_I to be 66.67 according to Iacoviello (2005). The ratio of loan rate paid by stickier firms over the rate paid by less sticky firms, τ, is set at 2 before the passage of SOX and set at 1 afterwards.

We assume the Taylor-rule inflation parameter is $\phi_\pi = 1.5$, and the smoothing parameter is $\rho_r = 0.8$ according to Sims, Wu, and Zhang (2021). We set government spending to 18% of GDP according to Smets and Wouters (2007). The auto-regressive parameter of the technological shock process, ρ_a, is set to 0.9. We set the standard deviations of technological and monetary policy shocks at 6.5×10^{-6} and 8×10^{-7}, respectively, to match with standard deviations of consumption and inflation in real data: the simulated standard deviations of consumption and inflation when $\tau = 1$ (or 2) are 0.0069 (or 0.0068) and 0.0019 (or 0.0022), while the numbers in the data are 0.0070 and 0.0020.

Results: Table 6 reports the volatility of return under different shocks and parameter values. When stickier firms are subject to greater financial frictions, which corresponds to the pre-SOX scenario in our setting, that is, when $\tau = 2$, returns of stickier firms are always more volatile than returns of less sticky firms. The gap in return volatility, however, largely

[27] In the macroeconomics literature, the Calvo parameter is usually set at around 0.75 according to the Bayesian estimation of medium-scale New Keynesian DSGE models; for example, the estimated mean and standard deviation for the parameter are 0.74 and 0.035 , respectively, in Christiano, Motto, and Rostagno (2014). We choose a wide enough range (about 4-standard-deviations) for the estimated Calvo parameter, and map the upper and lower bounds to ϕ_1 and ϕ_2.

shrinks when financial friction is eliminated ($\tau = 1$), which corresponds to the post-SOX scenario.

To emphasize the importance of credit spread between sticky- and flexible-price firms, we also investigate the model with the assumption that borrowing firms with differential price stickiness pay the same amount of loan cost, but stickier firms are associated with a lower loan-to-value ratio ($\mu_1 > \mu_2$ in (4.6)). In Table A.2, we show return volatility for the two types of firms after both monetary policy and technology shocks. The result of our baseline model is reversed: more flexible, instead of stickier firms, are more volatile in equity returns. As a result, without credit spread, the collateral constraint itself cannot generate higher return volatility for stickier firms.

Figure 6 present the impulse responses of key variables of the high-stickiness sector (sector 2) in the model, to a contractionary monetary policy shock in Panel A and a positive technological shock in Panel B. A general pattern from these impulse responses is that the investment, output, product price, and debt financing of firms with high price stickiness are more volatile when information friction is in its force. As a result, both the dividend and stock price of sticky-price firms are more volatile. Next, we explain the impulse responses in detail.

IRFs of a contractionary monetary policy shock — After a contractionary monetary policy shock (i,e., an increase in the various base interest rates controlled by central banks), nominal interest rate goes up, but both output and the general price level go down. A higher interest rate leads to a lower debt capacity and a higher investment cost; consequently, investments fall. Compared with flexible-price firms, sticky-price firms cut price less because doing so is more costly for them. As a result, the relative price of sticky-price firms goes up and the relative price of flexible-price firms goes down.

In such a bad time, the amount of debt that stickier firms facing greater financial frictions can borrow drops more because the credit spread between the two types of firms also increases; as a result, sticky-price firms cut capital investment more because they are more financially constrained after monetary policy tightening. Sticky-price firms' financial condition enters into a downward spiral because their lower level of capital further reduces debt capacity. For the above reasons, with financial friction, sticky-price firms' product price and output become more volatile, thereby increasing the sales volatility, as shown in Panel A in Figure 6.

IRFs of a positive TFP shock — After a positive total factor productivity (TFP) shock, total output goes up but both the average price level and interest rate go down. A lower interest rate leads to higher debt capacity and lower financing costs. Because the marginal benefit of investment becomes higher, firms invest more to take advantage of the higher productivity. Due to higher price-adjustment costs, sticky-price firms cut prices less. Therefore, the relative price of sticky-price firms goes up and the relative price of flexible-price firms goes down.

Facing greater financial frictions, sticky-price firms' debt capacity increases more after a positive TFP shock, because both the interest rate and credit spread go down, the latter of which is due to the counter-cyclicality of credit spread. As a result, sticky-price firms' investment rises more sharply than in the scenario in which such firms do not face greater financial friction. Moreover, relative output price goes up more after a positive TFP shock. The reason is that sticky-price firms have smaller capital stock due to their lower debt capacity and thus contribute a smaller fraction to the final consumption goods. The log-difference of the demand curve in equation (4.10) shows that the relative price of sticky-price firms, that is, $P_2 = 1/X_2$, increases by a larger amount in response to a one-unit increase in output Y_2, if Y_2 is a smaller fraction of final output Y_t. As such, sticky-price firms' both product price and output become more volatile. However, because price and output move in opposite directions, sales volatility can go either way. Panel B in Figure 6 shows that sales becomes slightly less volatile.

Overall, the dividend payout of sticky-price firms subject to greater financial frictions becomes more volatile due to more volatile investment and debt financing.

To summarize, returns of sticky-price firms are more volatile when they are more opaque due to lenient securities regulation, because these firms' investment and debt financing are more volatile. The key intuition is that, due to information friction in credit markets, sticky-price firms have lower debt capacity, and their investments are more likely to be constrained by internal funds. As a result, their investments become more sensitive to economic and credit conditions, and their levels of capital stock are lower. Debt financing becomes more volatile due to the counter-cyclicality of credit spread.

5 Testing Model Predictions

We now bring several key predictions derived from the New Keynesian model into the data. These testable predictions are based on the assumption that, when managers have discretion over reporting choices, output-price stickiness constitutes a source of credit-market friction, summarized as follows.

(a) Stickier firms are more underleveraged but experience a post-SOX larger increase in their leverage ratio.

(b) Stickier firms are more volatile in equity returns but experience a post-SOX larger decline in return volatility.

(c) Capital investment made by stickier firms is more sensitive to monetary policy shocks (i.e., firms invest more (less) after expansionary (contractionary) policy shocks), but these firms display a post-SOX larger decline in such sensitivity.

(d) Stock price of stickier firms is more sensitive to monetary policy shocks (i.e., firms' value increases (decreases) after expansionary (contractionary) policy shocks), but these firms display a post-SOX larger decline in such sensitivity.

5.1 Leverage

We first estimate the differences in the time trend of leverage across firms with differential price stickiness. Figure 4 plots another striking pattern — the stylized fact in D'Acunto et al. (2018) that firms with stickier prices are underleveraged disappeared within three to four years following the SOX legislation, despite parallel pre-trends of leverage between treated and control groups.

In Panel A of Table 7, we estimate the following DID design:

$$\begin{aligned} Leverage_{i,s} = \alpha + \beta \times Sticky_j + \gamma \times Sticky_j \times Post_{i,s} + \delta \times Post_{i,s} \\ + X'_{i,t-1} \times \theta + \eta_s + \eta_i + \epsilon_{i,s}, \end{aligned} \quad (5.1)$$

where $Leverage_{i,s}$ is the long-term debt over total assets as of quarter s for firm i.

We first show the relation between output-price stickiness and leverage is in line with D'Acunto et al. (2018) — the estimated coefficient of *Sticky* is -0.11 (column (1) of Table 7). More important, stickier firms borrowed significantly more than their less sticky counterparties after SOX. As column (2) shows, firms have 1.7% higher leverage if output price becomes a one-standard-deviation stickier during the post-SOX period. The number accounts for 8.5% of the sample mean as well as 10% of the marginal impact of output-price stickiness on leverage. Our estimates are similar if we exploit variation within industries or within firms. The effects, however, become statistically insignificant if we exploit variation within both industry-year-quarter and firm, but the economic magnitude remains sizable.

In Panel B of Table 7, we use the firms' specific timing of Section 404 compliance as treatment timing. We report a slightly larger effect of SOX on leverage through price stickiness. In particular, the interaction term *Sticky* × *Post* is statistically and economically significant even if we exploit variation within both firms and industry-time (see column (5)).

The industry-specific measure of price-adjustment frequency is constructed using a representative set of price spells at the granular industry level. Although Pasten et al. (2017) have several hundred spells per industry to construct the frequencies, measurement error could still be a concern. To tackle this problem, we follow the novel methodology by Erickson et al. (2014) to account for the measurement error in explanatory variables using linear cumulant equations. Specifically, we assess the robustness of the association between price stickiness and long-term leverage around the SOX Act, correcting for measurement error in key variables. We also follow Erickson et al. (2014) and D'Acunto et al. (2018) to assume measure error comes into play through asset intangibility and book-to-market ratio. Additionally, we also assume price stickiness is measured with error.

In Table 8, we report the estimated coefficients when implementing the cumulant equation method of Erickson et al. (2014) for the third, fourth, and fifth cumulants.[28] Comparing the estimated association of price stickiness with leverage across different specifications, the size and significance of the coefficients are similar in the baseline OLS specification.

5.2 Return Volatility

One prevailing explanation for why sticky-price firms are more volatile in returns is important but different from the mechanism proposed by our New Keynesian model. That is, firms' inability to adjust prices widens the range in which the discounted present value of cash flows can fluctuate after monetary policy shocks (Gorodnichenko and Weber, 2016). This insight has wide application in corporate finance and industry organization. For example, D'Acunto et al. (2018) and Gu and Xie (2021), among others, control for return volatility (as a proxy for cash-flow volatility) when regressing financial outcomes on output-price stickiness.

Our general equilibrium model predicts a new channel through which sticky-output price is linked to return volatility; that is, the credit-market friction, particularly the countercyclical credit spread charged to stickier firms due to managerial misreporting, causes such firms' capital investment and debt financing to be more responsive to nominal (and real) shocks, which in turn boosts their return volatility. Below, we provide empirical evidence that sticky-price firms experienced a post-SOX larger decline in equity returns than flexible-price firms.

Figure 5 proposes a visual assessment for whether the trends in the volatility of raw returns were parallel across treated and control firms prior to SOX. Although volatility slightly declined one to four quarters prior to the legislative event, no discernable pre-trends existed, and the changes in the continuing direction only became statistically significant after the SOX. The figure shows a striking pattern that sticky- and flexible-price firms became almost identically volatile after SOX.[29]

[28] We do not report the estimates for higher-order cumulants, because of the sample size. Using higher-order cumulants results in estimates of similar size and substantially lower standard errors.

[29] What puzzles us is that stickier firms' return volatility was extremely low during the 2008 financial crisis.

In Panel A of Table 9, we rigorously estimate the effects of SOX on return volatility. Consistent with Gorodnichenko and Weber (2016) and Xie (2020), firms with a higher inability to adjust prices have higher return volatility (column (1)); such firms, however, became much less volatile after SOX, and the point estimates stay similar with different specifications. In column (2), for example, a one-standard-deviation increase in output-price stickiness is positively associated with total volatility of 4.9 percentage points (13.4%) of the sample mean, but such an effect vanished after 2002Q3. Panel B of Table 9 suggests our estimation results are not driven by broad market trends but are due to the unique effects of SOX provision, as represented by Section 404.

In Table A.3, we show our empirical results are robust to using idiosyncratic returns to account for the cross-sectional variation due to factors that are not attributable to price stickiness (columns (1)-(5) of each panel), including firm size, book-to-market, and momentum. We also use the implied volatility of option contracts as a proxy for forward-looking and subjective measure of firm volatility, and we find similar patterns (columns (6)-(10) of each panel).[30]

5.3 Investment Sensitivity to Monetary Policy Shocks

For press releases of the Federal Open Market Committee (FOMC), our sample period ranges from February 5, 1997, through December 12, 2012. To measure monetary policy shocks, we use innovations in the fed funds futures by following Gorodnichenko and Weber (2016) and Bergman, Masta, and Weber (2021). Specifically, v_d (expressed in percent) is the surprise component of the announced change in the fed funds rate on the FOMC meeting data, calculated as follows. A positive (negative) surprise component corresponds to an expansionary (a contractionary) monetary policy shock or, equivalently, a decrease (an increase) in interest rates:

$$v_d = \frac{D}{D-t}(ff^0_{\tau+\Delta\tau^+} - ff^0_{\tau-\Delta\tau^-}), \tag{5.2}$$

One possible explanation is that the rising micro economic uncertainty was concentrated among flexible-price firms (Bloom, Floetotto, Jaimovich, Saporta-Eksten, and Terry, 2018).

[30] In the cross section, implied volatility matches the realized volatility; in the time series, implied volatility is systematically related to realized volatility (Mixon, 2009).

where τ is the time when the FOMC issues an announcement, $ff^0_{\tau+\Delta\tau^+}$ is the federal funds futures rate shortly after τ, $ff^0_{\tau-\Delta\tau^-}$ is the fed funds futures rate just before τ, and D is the number of days in the month. The $\frac{D}{D-d}$ term adjusts for the fact that the fed funds futures settle on the average effective overnight fed funds rate. In our main specification, we consider "tight" time windows where the scaled change of the fed funds futures implied rate within a 30-minute event window around the FOMC press release (-10 min, +20 min).[31]

Similar to a careful specification used by Ottonello and Winberry (2020), we employ the following triple-interaction strategy to estimate the sensitivity of firms' capital investment to monetary policy surprises:

$$\begin{aligned} \Delta log(Capital)_{i,s} = \alpha + \beta \times Sticky_j \times \overline{v}_s + \gamma \times Sticky_j \times \overline{v}_s \times Post_{i,s} \\ + \delta \times Sticky_j \times Post_{i,s} + Z'_{i,t-1} \times \theta + \eta_i + \eta_s + \epsilon_{i,s}. \end{aligned} \tag{5.3}$$

$\Delta log(Capital_{i,s})$ is the change in logarithm of invested capital from quarter s-1 to quarter s for each firm i. Following Ottonello and Winberry (2020), we time aggregate the high-frequency shocks as in Equation 5.3 to the quarterly frequency to merge them with Compustat data at the firm-year-quarter level. We construct $\overline{v}_s$, a moving average of the monthly raw shocks weighted by the number of remaining days in quarter s after the shock occurs on day d. The time-aggregation strategy ensures we weight monetary shocks by the amount of time firms have had to react to them.[32]

The firm fixed effects (η_i) capture permanent differences in investment behavior across firms, and in the most restrictive specification, the industry-time fixed effects $\eta_{j',s}$ capture differences in how broad sectors are exposed to aggregate shocks. Similar to Ottonello and Winberry (2020), we include the logarithm of total assets, sales growth, and current assets over total assets in the vector $Z'_{i,t-1}$.

Our first coefficient of interest is (1) β, the unconditional sensitivity of investment $\Delta log(Capital)_{i,s}$ with respect to monetary policy shocks $\overline{v}_s$. Our β is driven by perma-

[31]The results are not sensitive to a "wide" window where the scaled change in the implied rate is within a 60-minute event window around the FOMC press release (-15 min, +45 min).

[32]Our baseline results also hold if we time-aggregate the high-frequency shocks by taking the simple sum within the quarter.

nent heterogeneity in responsiveness across firms, because price stickiness is a time-invariant constant. The second coefficient is γ, which measures the extent to which β is changed during the post-SOX period. By interacting *Sticky* and $\overline{v}_s$ with *Post*, we allow the responsiveness to vary across regulatory regimes governing firm disclosure.

Panel A of Table 10 reports the results from estimating Equation 5.3. For simplicity, we only report coefficients that are relevant for the inference. Column (1) shows that stickier firms are more responsive to monetary shocks. Column (1) implies a firm has approximately a 0.025-unit higher sensitivity of investment to monetary policy when its output price is one standard deviation stickier than it typically is. Column (2) shows such an investment-monetary-shock sensitivity was 0.046 units before SOX but was completely vanished after SOX. Adding year-quarter, industry, and firm fixed effects, as well as interactions of industry fixed effects with monetary policy shocks, does not significantly change our point estimate in column (2). Panel B of Table 10 suggests our results hold when we exploit the staggered timing of implementation of Section 404 across firms.

5.4 Stock-Price Sensitivity to Monetary Policy Shocks

Our last effort is to examine whether sticky-price firms' stock prices were significantly more responsive to monetary policy before 2002Q3 and whether the Sarbanes-Oxley Act of 2002 has reduced the responsiveness of sticky-price firms. This is a testable prediction that is naturally derived from our New Keynesian model. We employ an event study approach in the tradition of Cook and Hahn (1989), Bernanke and Kuttner (2005), and more recently Ippolito et al. (2018), Ozdagli (2018), Armstrong et al. (2019), and Ozdagli and Velikov (2020).

Specifically, we estimate the following difference-in-differences design in a spirit similar to Equation 5.3:

$$\begin{aligned} Ret_{i,d} = \alpha + \beta \times Sticky_j \times v_d + \gamma \times Sticky_j \times v_d \times Post_{i,d} + \delta \times Sticky_j \times Post_{i,d} \\ + Z'_{i,s-1} \times \theta + \eta_i + \eta_d + \epsilon_{i,d}, \end{aligned} \tag{5.4}$$

where $Ret_{i,d}$ is the raw stock return (in percentage points) on FOMC announcement date d for firm i. Again, the sign of v_d is flipped so that a positive (negative) shock corresponds to an expansionary (a contractionary) monetary policy shock. In particular, our model studies how the stock-price reaction to monetary policy surprises varies with the degree of output-price stickiness and how the passage of SOX changes this relationship.

Table 11 reports the results from estimating Equation 5.4. The first column in Panel A of Table 11 shows that a one-standard-deviation (0.184) increase in output-price stickiness causes the stock price to increase 1.35 (= 7.31 × 0.184) percentage points more in response to a 1-percentage-point surprise decrease in the fed funds rate. To illustrate the economic magnitude, the same surprise decrease in the fed funds rate causes the stock price of the firm with the average level of stickiness to increase 5.93% on average. The last three columns in Panel A show the incremental contribution of price stickiness to the stock-price responsiveness disappeared after SOX. Our estimates are similar across different regression specifications and robust to using staggered implementations of Section 404.

Following Ippolito et al. (2018) and Ozdagli (2018), we perform placebo experiments. Specifically, we use the same specification as in Equation 5.4 but replaces the dependent variable with the last two-day raw returns prior to the FOMC meetings. Because of the blackout period preceding an FOMC announcement and the resulting little, if any, monetary-policy-related news prior to an announcement, the two-day pre-FOMC period would be an ideal pseudo-control sample where one would expect no significant difference in stock-price sensitivity caused by price stickiness. As Table A.4 shows, the coefficients of $Sticky \times v$ are indistinguishable from zero in most columns. As for the coefficients of v and $Sticky \times v \times Post$, the placebo experiment results go in the opposite direction of the effect observed on FOMC announcement dates.

A skeptical reader might argue that because stickier firms experienced a moderate increase in leverage post SOX (see Figure 4), the floating-rate channel proposed by Ippolito et al. (2018) (i.e., interest-rate fluctuations directly influence firm liquidity through existing bank loans) predicts that stickier firms should display stronger, not weaker, sensitivities of fixed capital investment and stock price to unexpected changes in monetary policy.[33] In our empirical environment, however, a positive impact of bank loan on sensitivity can be more than offset by a negative impact of improved borrowing conditions. As both our empirics and model show, stickier firms enjoyed a sizable decline in debt cost post SOX, which in turn substantially relaxed their financial constraint, making the interest-expense saving on existing debt less attractive.

6 Conclusion

Bernanke et al. (1999) introduces information asymmetry between borrowers and lenders into a New Keynesian dynamic general equilibrium model to explain how credit market frictions amplify nominal and real shocks to the economy. As a violation of the assumption underlying the Modigliani and Miller (1958) paradigm, financial structure in Bernanke et al. (1999) is relevant to economic decisions. In their model, however, financial structure is independent of a firm's inability to adjust prices.

In this paper, we exploit a quasi-natural experiment to provide micro-founded evidence that firms' output-price stickiness constitutes a source of financial frictions. After Congress's passage and implementation of SOX — a significant legislative event triggered by unprecedented accounting scandals — firms with stickier prices paid less loan spreads in the credit market. We build a New Keynesian model of an economy in which firms are featured with differential inflexibility to adjust prices and lenders require a higher return on loans extended to borrowing firms with stickier prices. We show such a modification of Bernanke et al. (1999) yields a set of theoretical predictions concerning the difference between sticky- and flexible-price firms. We empirically verify these predictions in the data.

Rather than restating our results, we close with a discussion of caveats and possible avenues for future research. Surprisingly, our DID estimates suggest that following the passage of SOX, firms with stickier prices face even fewer financial frictions and are less volatile, which seems to be at odds with prior literature that finds sticky-price firms' fundamentals

[33] Ippolito et al. (2018) calculate that the floating-rate channel is likely to be at least as large as the shortfall caused by the bank lending channel.

are unconditionally more volatile (Gorodnichenko and Weber, 2016; D'Acunto et al., 2018). We offer other two possible interpretations, articulated as follows.

Our first interpretation is that, by observing the sign and magnitude of price changes, investors holding stakes in flexible-price firms have already had access to a rich set of private information about firm performance, and, with strategic motives to coordinate, these stakeholders might overweight newly released public information after securities regulation becomes more stringent. If so, the size of DID estimates attributable to changes in outcome variables on the side of flexible-price firms are broadly consistent with theoretical predictions proposed by Morris and Shin (2002) that the detrimental effects of public information can dominate in equilibrium when agents have access to independent sources of private information. Indeed, recent theoretical literature explores the welfare implication for firms (as opposed to firms' stakeholders) to be better informed about the state of the economy and, as a result, better coordinate their production and pricing decisions (e.g., Amador and Weill, 2010; Angeletos, Iovino, and La'O, 2016; D'Acunto, Weber, and Xie, 2019). To assess the importance of this issue, an empirical examination of the impact of public information on firms' pricing decisions would be interesting.

Our second interpretation is that, except for increasing outsiders' information-acquisition costs, the observed price stickiness does not expose shareholders to macro shocks (e.g., Caplin and Spulber, 1987; Golosov and Lucas, 2007; Head, Liu, Menzio, and Wright, 2012). Profits of firms voluntarily adopting a constant pricing schedule can be much less risky, even compared with the profits of flexible-price firms. For example, Head et al. (2012) present a theoretical model in which rigid prices arise endogenously even if adjusting prices is costless. The authors show that when monetary shocks hit, some sticky-price firms earn less per unit but make up the difference in volume, so profit stays constant. Our findings have implications for future research to distinguish between the New Keynesian models and alternative ones in explaining the observed nominal price rigidities.

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Figure 1: **Distribution of Monthly Frequency of Price Adjustment**

The figure plots the distribution of the monthly frequency of price adjustment (FPA). The samples are restricted to S&P 500 constituent firms headquartered in the United States. The sample period is 1997Q1 – 2012Q4. Utilities and Financial sectors are excluded. In the sample period of 2002-2012, the FPA at NAICS sectors of different granularities is calculated by Pasten et al. (2017). Equal-weighted probabilities of price adjustments at the goods level are calculated using the micro-data underlying the Producer Price Index constructed by the BLS. The granularity for FPA is at the 6-digit level.

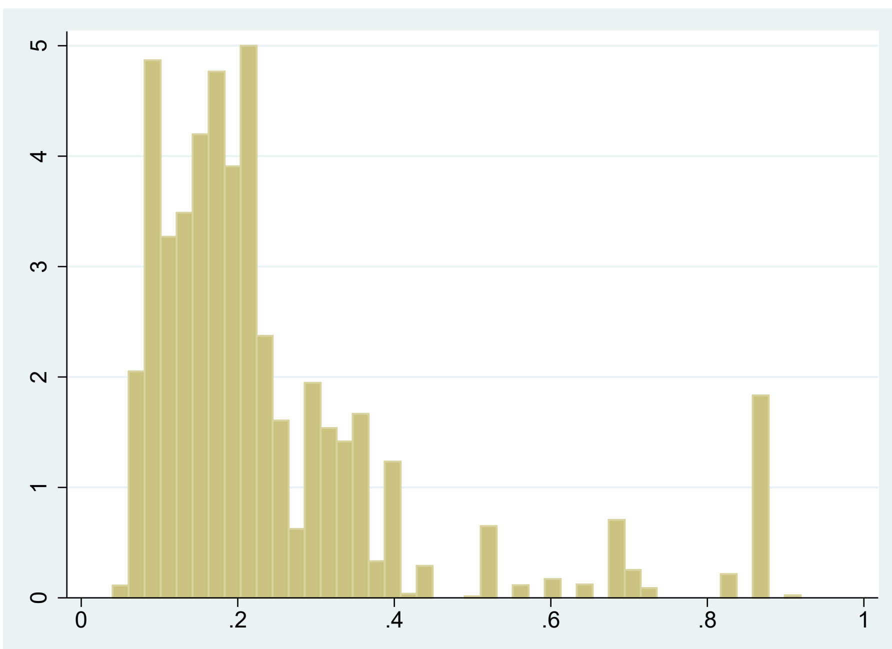


Figure 2: **Dynamics of Loan Spread**

The figure plots the estimates of β and the 90% confidence intervals from the following ordinary least squares equation:

$$log(Spread)_{n,i,s} = \alpha + \sum_{s=1991}^{2012} \beta_s \times Sticky_j + \sum_{s=1991}^{2012} \gamma_s + X'_{i,t-1} \times \theta + \eta_k + \epsilon_{n,i,s},$$

which includes a set of leads of the interactions between output-price stickiness and event-year fixed effects for the time periods before and after July 25, 2002. For each loan package n signed by firm i in year-month s, $log(Spread)_{n,i,s}$ is the logarithm of the average all-in-drawn spreads over the London Interbank Offered Rate. Sticky is the frequency of price adjustment multiplied by -1. $-10 \leq s \leq 10$ indicates the sth event year (12 months) relative to July 25, 2002. The excluded event year is 1990. Standard errors are clustered at the level of 6-digit NAICS sectors.

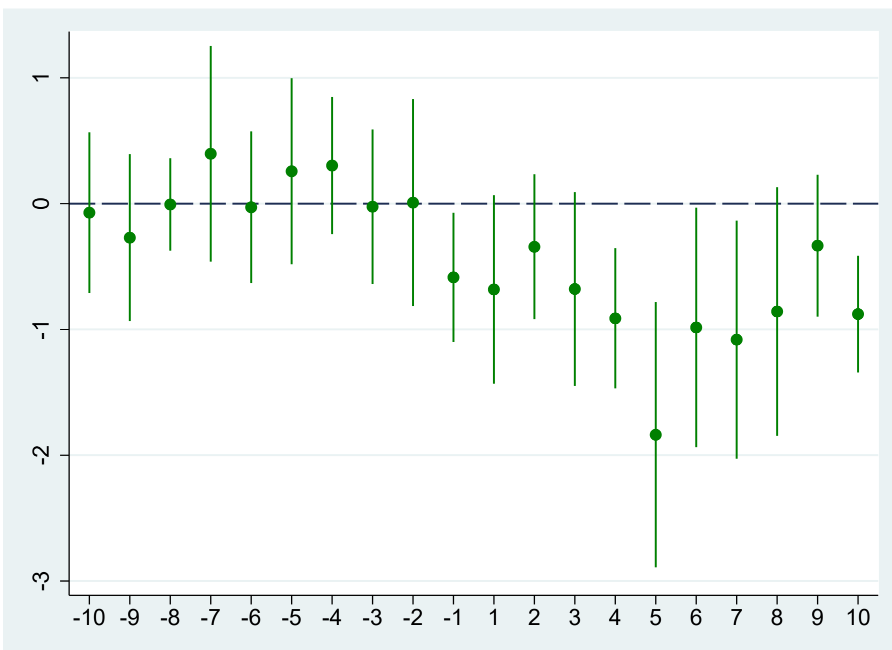


Figure 3: **Dynamics of Collateralization**

The figure plots the estimates of β and the 90% confidence intervals from the following ordinary least squares equation:

$$Collateral_{n,i,s} = \alpha + \sum_{s=1991}^{2012} \beta_s \times Sticky_j + \sum_{s=1991}^{2012} \gamma_s + X'_{i,t-1} \times \theta + \eta_k + \epsilon_{n,i,s},$$

which includes a set of leads of the interactions between output-price stickiness and event-year fixed effects for the time periods before and after July 25, 2002. For each loan package n signed by firm i in year-month s, $Collateral_{n,i,s}$ is an indicator equal to 1 if lenders require collateral, and 0 otherwise. Sticky is the frequency of price adjustment multiplied by -1. $-10 \leq s \leq 10$ indicates the sth event year (12 months) relative to July 25, 2002. The excluded event year is 1990. Standard errors are clustered at the level of 6-digit NAICS sectors.

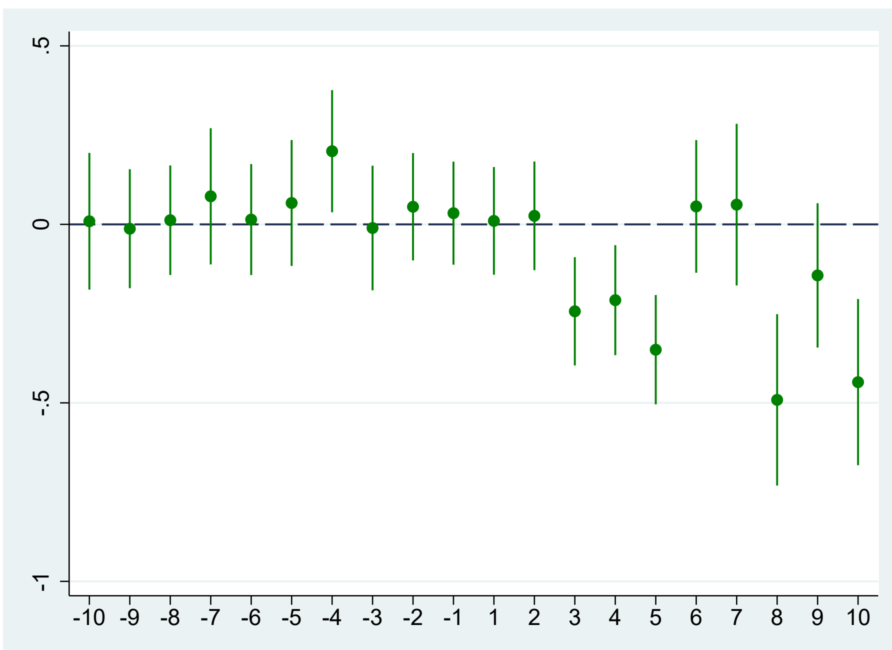


Figure 4: **Dynamics of Long-Term Debt**

The chart plots the estimates of β and the 90% confidence intervals. We estimate the following ordinary least squares equation:

$$Leverage_{i,s} = \alpha + \sum_{s=1997Q2}^{2012Q4} \beta_s \times Sticky_j + \sum_{s=1997Q2}^{2012Q4} \gamma_s + X'_{i,t-1} \times \theta + \eta_i + \epsilon_{i,s},$$

which includes a set of leads of the interactions between price stickiness and year-quarter fixed effects for the quarters before and after 2002Q3. The excluded quarter is 1997Q1. Sticky is the frequency of price adjustment multiplied by -1. $Leverage_{i,s}$ *is the long-term debt over assets in quarter s for firm i. Time 0 is the third quarter of 2002, during which the US Congress passed and implemented the Sarbanes-Oxley Act. Standard errors are clustered at the level of 6-digit NAICS sectors.*

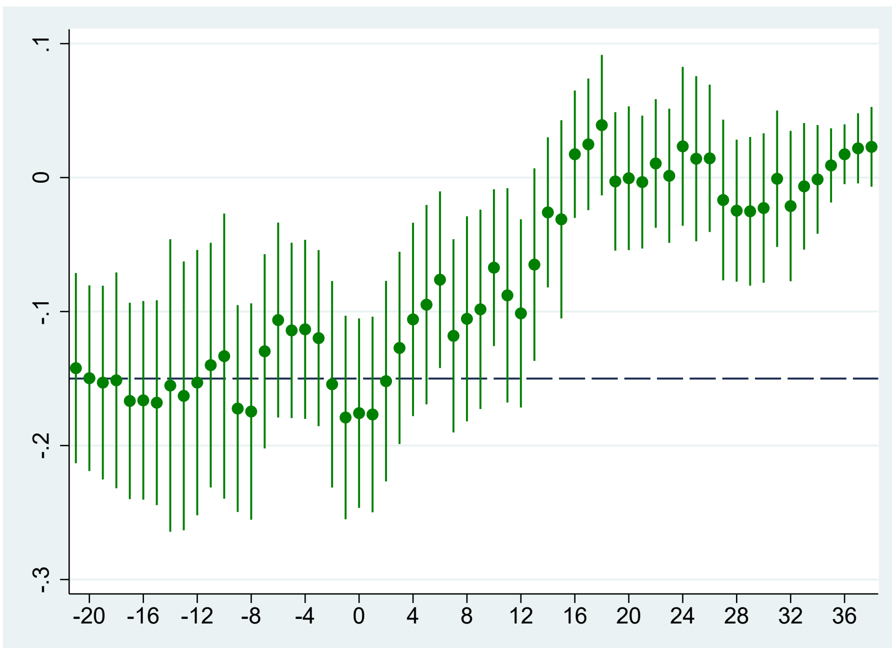


Figure 5: **Dynamics of Total Return Volatility**

The chart plots the estimates of β and the 90% confidence intervals from following ordinary least squares equation:

$$TotalVol_{i,s} = \alpha + \sum_{s=1996Q1}^{2012Q4} \beta_s \times Sticky_j + \sum_{s=1997Q2}^{2012Q4} \gamma_s + X'_{i,t-1} \times \theta + \eta_i + \epsilon_{i,s},$$

which includes a set of leads of the interactions between price stickiness and year-quarter fixed effects for the quarters before and after 2002Q3. The excluded quarter is 1997Q1. Sticky is the frequency of price adjustment multiplied by -1. $Total\ Vol_{i,s}$ is the standard deviation of raw returns (in percent) over the quarter s for firm i. Time 0 is the third quarter of 2002, during which the US Congress passed and implemented the Sarbanes-Oxley Act. Standard errors are clustered at the level of 6-digit NAICS sectors.

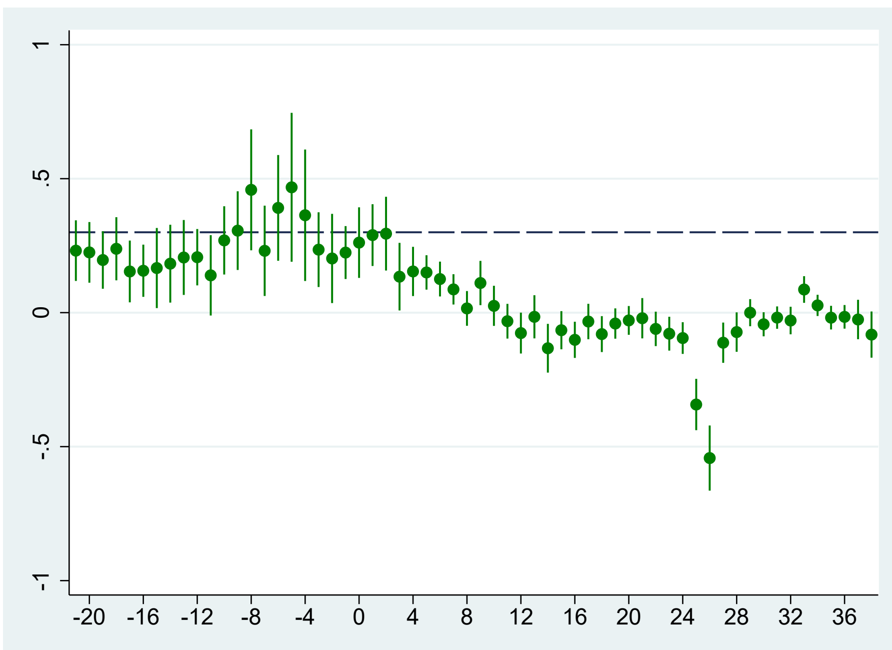
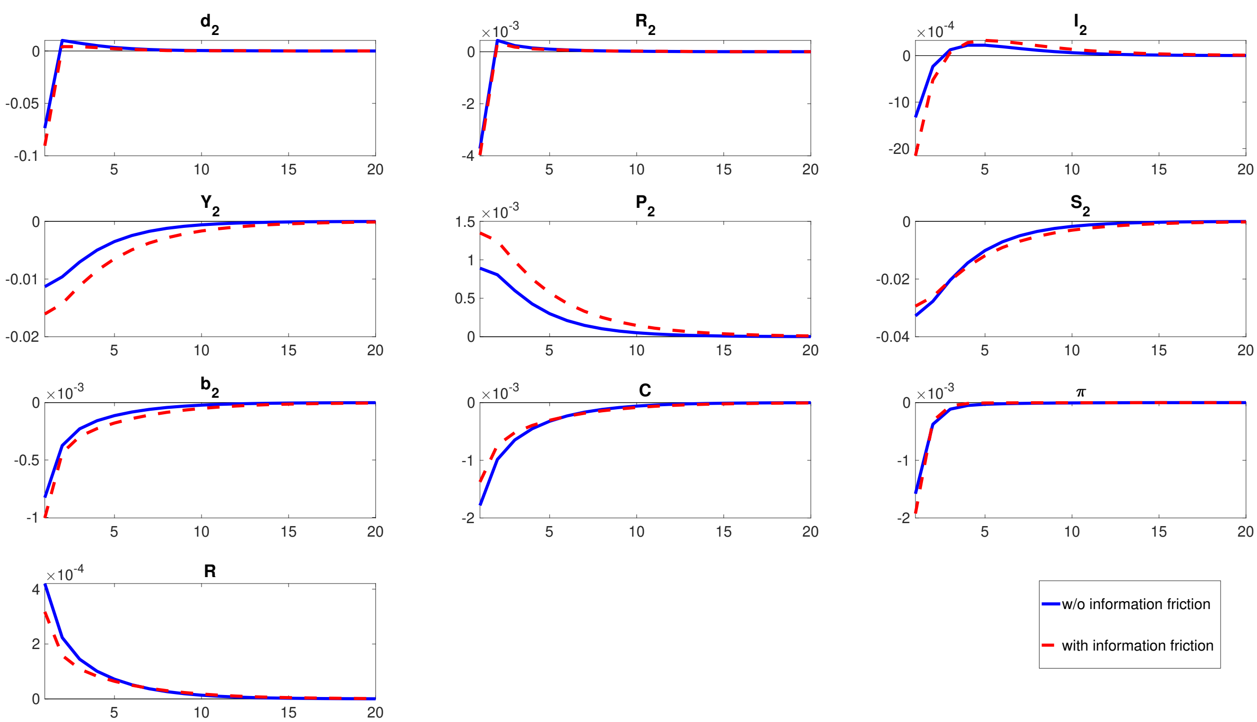


Figure 6: **Impulse Responses**

Figures in the top (bottom) panel are the impulse responses of sticky firms' dividend (d_2)*, stock return* (R_2)*, investment* (I_2)*, output* (Y_2)*, relative product price* ($P_2 \equiv 1/X_2$)*, Sales* ($S_2 \equiv Y_2 P_2$)*, debt financing* (b_2)*, consumption* (C)*, and inflation* (π) *a contractionary monetary policy shock (Panel A) or a positive total factor productivity shock (Panel B).*

Panel A: IRF to a contractionary monetary policy shock



Panel B: IRF to a positive TFP shock

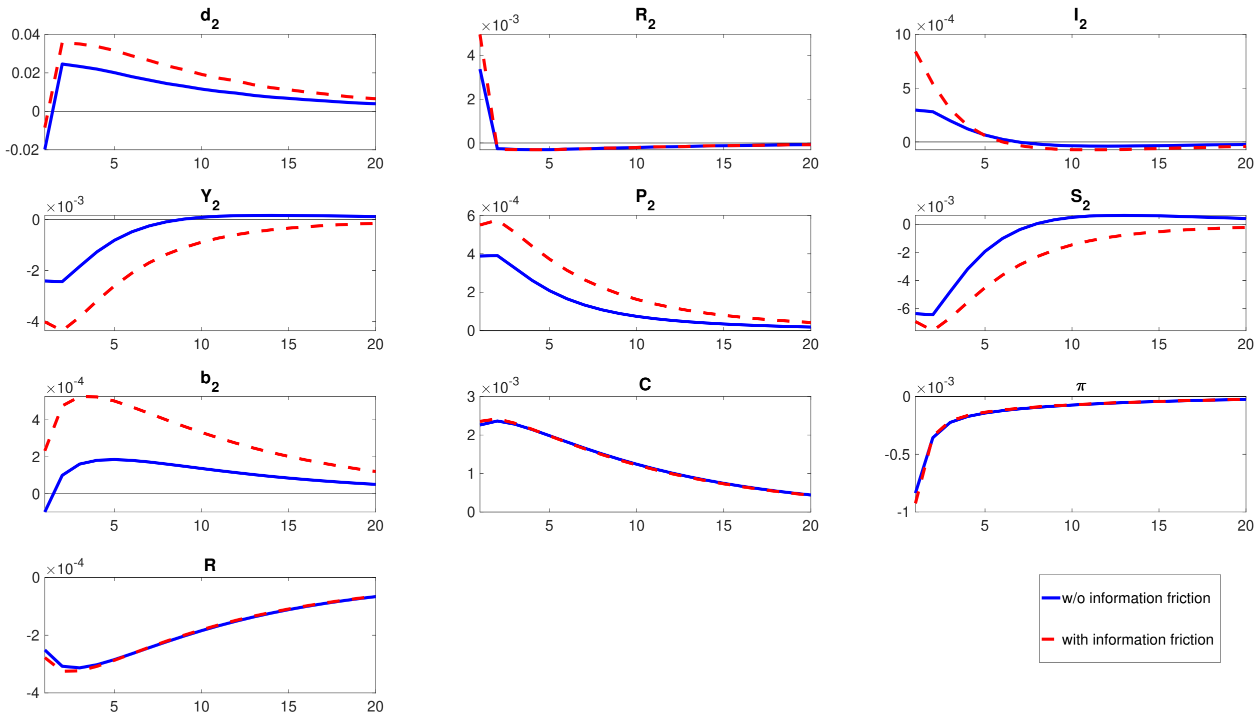


Table 1: **Descriptive Statistics**

The samples are restricted to S&P 500 constituent firms headquartered in the United States. The sample period is 1997Q1 – 2012Q4. Utilities and Financial sectors are excluded. Sticky is the frequency of price adjustment (FPA) multiplied by -1. In the sample period of 2002-2012, the FPA at NAICS sectors of different granularities is calculated by Pasten et al. (2017). Equal-weighted probabilities of price adjustments at the goods level are calculated using the micro-data underlying the Producer Price Index constructed by the BLS. The granularity for FPA is at the 6-digit level. Total Vol is the standard deviation of raw daily returns over quarter s. Idio Vol is the standard deviation of the Fama-French/Carhart four-factor-adjusted daily returns over quarter s. Impl Vol is the weighted average of implied volatility of all near-the-money call options on a given day for a firm over quarter s (Panel A) and on the the Federal Open Market Committee press release (Panel D). Leverage is debt maturing in more than two years to total assets. Profitability is operating income over total assets. Post SOX is an indicator equal to 1 if year-quarter s is after 2002Q3, and 0 otherwise. Post 404 is an indicator equal to 1 if firm i in year-month s complies to SOX Section 404, and 0 otherwise. Firms with fiscal year-ends in November and December complied with the section in their fiscal year of 2004; firms with fiscal year-ends in August, September, and October complied with the section in their fiscal year of 2005. log(Assets) is the natural logarithm of the total assets (in millions) in June of year t. The B-M ratio is the book equity for the fiscal year ending in calendar year t-1 over the market equity as of December t-1. Intangibility is intangible assets defined as total assets minus the sum of net property, plant, and equipment; cash and short-term investments; total receivables; and total inventories to total assets. PCM is the price-to-cost margin. HHI is the Herfindahl-Hirschman Index based on sales of Compustat firms. Loan Spread is the average all-in-drawn spreads (basis point) over the London Interbank Offered Rate. Δlog(Capital is the change in the logarithm of invested capital from quarter s-1 to quarter s. Sales Growth is the growth of sales from quarter s-1 to quarter s. Liquidity is the current assets over total assets. Ret is the raw stock return (in percentage points) on the FOMC announcement date. v (in percent) is the scaled change of the fed funds futures implied rate within a 30 minutes event window around the FOMC press release (-10 min, +20 min). $\overline{v}$ is a moving average of v (in percent) weighted by the number of days in a quarter after the shock occurs.

	Mean	std	p1	p10	p25	p50	p75	p90	p99	N
Panel A. Compustat Sample										
Sticky	-0.24	0.18	-0.88	-0.40	-0.29	-0.19	-0.13	-0.09	-0.06	20,307
Total Vol	0.37	0.21	0.12	0.18	0.24	0.32	0.45	0.62	1.17	20,297
Idio Vol	0.31	0.17	0.10	0.15	0.19	0.27	0.37	0.51	0.95	20,297
Impl Vol	5.88	2.59	2.38	3.33	4.14	5.27	6.88	9.18	15.12	19,679
Leverage	0.20	0.14	0.00	0.00	0.10	0.18	0.28	0.38	0.58	20,307
Post SOX	0.66	0.47	0.00	0.00	0.00	1.00	1.00	1.00	1.00	20,307
Post 404	0.43	0.49	0.00	0.00	0.00	0.00	1.00	1.00	1.00	20,307
Profitability	0.12	0.08	-0.10	0.04	0.07	0.11	0.16	0.21	0.34	20,307
log(Assets)	8.87	1.17	6.59	7.42	8.00	8.78	9.64	10.38	12.03	20,307
B-M ratio	0.42	0.34	0.03	0.12	0.20	0.34	0.54	0.81	1.68	20,307
Intangibility	0.33	0.19	0.03	0.09	0.17	0.31	0.47	0.60	0.82	20,307
PCM	0.42	0.21	0.05	0.17	0.26	0.40	0.56	0.72	0.91	20,307
HHI	0.06	0.06	0.02	0.03	0.03	0.05	0.06	0.10	0.26	20,307
Panel B. DealScan Sample										
Sticky	-0.25	0.19	-0.88	-0.43	-0.29	-0.21	-0.14	-0.10	-0.06	3,764
Loan Spread	91.72	94.44	11.84	19.83	25.00	50.00	125.00	233.10	425.00	3,764
Post SOX	0.58	0.49	0.00	0.00	0.00	1.00	1.00	1.00	1.00	3,764
Post 404	0.38	0.48	0.00	0.00	0.00	0.00	1.00	1.00	1.00	3,764
Leverage	0.22	0.14	0.00	0.06	0.12	0.20	0.30	0.40	0.62	3,764
Profitability	0.12	0.07	-0.05	0.04	0.07	0.11	0.15	0.21	0.33	3,764
log(Assets)	9.12	1.14	6.85	7.73	8.27	9.09	9.82	10.50	12.50	3,764
B-M ratio	0.45	0.41	-0.11	0.13	0.23	0.37	0.59	0.88	1.73	3,764
Intangibility	0.34	0.19	0.03	0.10	0.18	0.32	0.47	0.60	0.83	3,764
PCM	0.19	0.13	0.01	0.07	0.11	0.17	0.25	0.34	0.67	3,764
HHI	0.06	0.07	0.01	0.03	0.03	0.05	0.07	0.12	0.37	3,764
Panel C. Capital Investment and Monetary Policy Shocks										
Δlog(Capital)	0.02	0.14	-0.36	-0.06	-0.01	0.01	0.04	0.09	0.45	21,599
Sticky	-0.24	0.18	-0.88	-0.40	-0.29	-0.19	-0.13	-0.09	-0.06	20,782
Post SOX	0.68	0.47	0.00	0.00	0.00	1.00	1.00	1.00	1.00	21,933
Post 404	0.56	0.50	0.00	0.00	0.00	1.00	1.00	1.00	1.00	16,888
$\overline{v}$	-0.02	0.06	-0.30	-0.10	-0.01	0.00	0.00	0.02	0.05	21,933
log(Assets)	8.88	1.20	6.54	7.43	8.00	8.76	9.65	10.42	12.25	21,933
Sales Growth	0.03	0.19	-0.42	-0.13	-0.04	0.02	0.08	0.18	0.66	21,671
Liquidity	0.41	0.19	0.06	0.15	0.27	0.40	0.53	0.67	0.86	20,931
Panel D. Event Study Sample (FOMC Meeting)										
Ret	0.01	0.03	-0.06	-0.02	-0.01	0.00	0.02	0.03	0.09	43,136
v	-0.02	0.08	-0.44	-0.06	-0.01	0.00	0.01	0.04	0.11	43,136
Sticky	-0.24	0.18	-0.88	-0.41	-0.29	-0.19	-0.14	-0.09	-0.06	43,136
Post SOX	0.65	0.48	0.00	0.00	0.00	1.00	1.00	1.00	1.00	43,136
Post 404	0.52	0.50	0.00	0.00	0.00	1.00	1.00	1.00	1.00	32,784
log(Assets)	8.91	1.14	6.67	7.51	8.07	8.82	9.68	10.42	11.91	43,136
Sales Growth	0.03	0.16	-0.43	-0.13	-0.04	0.02	0.08	0.18	0.69	43,136
Liquidity	0.41	0.19	0.06	0.16	0.27	0.40	0.53	0.67	0.86	43,136

Table 2: **Sticky Output Price and Loan Spread**

This table reports the results for estimating the following linear equation on S&P 500 constituent firms headquartered in the United States over the sample period of 1990 – 2012. Utilities and Financial sectors are excluded:

$$log(Spread)_{n,i,s} = \alpha + \beta \times Sticky_j + \gamma \times Sticky_j \times Post_{i,s} + \delta \times Post_{i,s} + X'_{i,t-1} \times \theta + \eta_t + \eta_i + \epsilon_{n,i,s}.$$

For each loan package n signed by firm i in year-month s, $log(Spread)_{n,i,s}$ *is the logarithm of the average all-in-drawn spreads over the London Interbank Offered Rate. Sticky is the frequency of price adjustment multiplied by -1. In Panel A,* $Post_{i,s}$ *is an indicator equal to 1 if year-month s is after 2002Q3, and 0 otherwise. In Panel B,* $Post_{i,s}$ *is an indicator equal to 1 if firm i in year-month s complies with SOX Section 404, and 0 otherwise. Firms with fiscal year-ends in November and December complied with the section in their fiscal year of 2004; firms with fiscal year-ends in August, September, and October complied with the section in their fiscal year of 2005. Time FE is a set of dummies that capture years. Industry FE is a set of 12 dummies that capture the Fama-French 12-industries. See Table 1 for the definition of control variables. All variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the level of 6-digit NAICS sectors.*

	Panel A. Sarbanes-Oxley Act of 2002				
	(1)	(2)	(3)	(4)	(5)
Sticky	-0.01	0.43**	-0.22		
	(0.26)	(0.20)	(0.21)		
Sticky × Post		-0.73***	-0.68***	-0.47***	-0.41***
		(0.21)	(0.18)	(0.18)	(0.13)
Post		0.22***			
		(0.07)			
N	3,764	3,764	3,764	3,764	3,764
Adjusted R^2	0.18	0.23	0.43	0.71	0.73
	Panel B. Section 404				
	(1)	(2)	(3)	(4)	(5)
Sticky	-0.09	0.31	-0.33		
	(0.24)	(0.21)	(0.20)		
Sticky × Post		-0.76***	-0.65***	-0.33**	-0.25*
		(0.16)	(0.16)	(0.15)	(0.14)
Post		0.22***	0.01	0.01	0.01
		(0.07)	(0.12)	(0.09)	(0.10)
N	3,156	3,156	3,156	3,156	3,156
Adjusted R^2	0.17	0.23	0.41	0.69	0.77
Controls	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	No
Industry FE	No	No	Yes	No	No
Firm FE	No	No	No	Yes	Yes
Industry × Time FE	No	No	No	No	Yes

standard errors in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 3: **Sticky Output Price and Loan Collateralization**

This table reports the results for estimating the following linear equation on S&P 500 constituent firms headquartered in the United States over the sample period of 1990 – 2012. Utilities and Financial sectors are excluded.

$$Collateral_{n,i,s} = \alpha + \beta \times Sticky_j + \gamma \times Sticky_j \times Post_{i,s} + \delta \times Post_{i,s} + X'_{i,t-1} \times \theta + \eta_t + \eta_i + \epsilon_{n,i,s}.$$

For each loan package n signed by firm i in year-month s, $Collateral_{n,i,s}$ is an indicator equal to 1 if lenders require collateral, and 0 otherwise. Sticky is the frequency of price adjustment (FPA) multiplied by -1. In Panel A, $Post_{i,s}$ is an indicator equal to 1 if year-month s is after 2002Q3, and 0 otherwise. In Panel B, $Post_{i,s}$ is an indicator equal to 1 if firm i in year-month s complies with SOX Section 404, and 0 otherwise. Firms with fiscal year-ends in November and December complied with the section in their fiscal year of 2004; firms with fiscal year-ends in August, September, and October complied with the section in their fiscal year of 2005. Time FE is a set of dummies that capture years. Industry FE is a set of 12 dummies that capture the Fama-French 12-industries. See Table 1 for the definition of control variables. All variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the level of 6-digit NAICS sectors.

	Panel A. Sarbanes-Oxley Act of 2002				
	(1)	(2)	(3)	(4)	(5)
Sticky	-0.03	0.05	-0.09		
	(0.08)	(0.06)	(0.08)		
Sticky × Post		-0.16*	-0.11*	-0.15**	-0.07
		(0.08)	(0.06)	(0.07)	(0.05)
Post		0.02			
		(0.02)			
N	4,443	4,443	4,443	4,443	4,443
Adjusted R^2	0.04	0.05	0.09	0.40	0.44
	Panel B. Section 404				
	(1)	(2)	(3)	(4)	(5)
Sticky	-0.05	0.04	-0.06		
	(0.09)	(0.07)	(0.08)		
Sticky × Post		-0.19***	-0.17***	-0.24***	-0.26***
		(0.06)	(0.06)	(0.05)	(0.06)
Post		0.02	0.03	-0.02	-0.01
		(0.02)	(0.04)	(0.03)	(0.04)
N	3,730	3,730	3,730	3,730	3,730
Adjusted R^2	0.04	0.06	0.09	0.41	0.53
Controls	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	No
Industry FE	No	No	Yes	No	No
Firm FE	No	No	No	Yes	Yes
Industry × Time FE	No	No	No	No	Yes

standard errors in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 4: **Event Stock Returns**

This table reports the results for estimating the following ordinary least squares equation on S&P 500 constituent firms headquartered in the United States. Utilities and Financial sectors are excluded:

$$CAR_i = \alpha + \beta \times Sticky_j + X_i' \times \theta + \epsilon_i.$$

Daily abnormal returns are estimated from a four-factor adjusted model. For each firm i, CAR_i is the cumulative abnormal returns estimated over the window of [-1, +1] days relative to November 8, 2001, April 12, 2002, Jun 25, 2002, July 15, 2002, July 25, 2002, and November 4, 2003, respectively. On November 8, 2001, Enron filed an earnings restatement with the SEC; on April 12, 2002, Nasdaq's Executive Committee approved the first round of new corporate governance requirements; on June 25, 2002, WorldCom announced its profits had been inflated by $3.8 billion; on July 15, the Senate passed the bill of Senator Sarbanes to enhance auditing-related procedures, corporate responsibility, and financial disclosure; on July 25, 2002, the House and Senate approved the Sarbanes-Oxley bill; on November 4, 2003, the SEC approved proposals by NYSE and NASDAQ on corporate governance reforms. Sticky is the frequency of price adjustment multiplied by -1. All control variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the level of 6-digit NAICS sectors.

	Nov 8, 2001	Apr 12, 2002	Jun 25, 2002	Jul 15, 2002	Jul 25, 2002	Nov 04, 2003
	(1)	(2)	(3)	(4)	(5)	(6)
Sticky	-0.11***	0.05***	-0.04**	0.02	-0.04	0.05***
	(-6.30)	(4.67)	(-2.37)	(0.87)	(-1.57)	(4.36)
Constant	0.03	0.07**	-0.13**	-0.03	-0.11	-0.02
	(0.47)	(2.00)	(-2.21)	(-0.49)	(-1.41)	(-0.71)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	319	315	314	323	322	316
Adjusted R^2	0.16	0.16	0.07	0.07	0.12	0.10

t-statistics in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 5: **Parameter Values of the Model**

Parameter	Value	Description (Target)
β	0.99	Discount factor, household (target $R = 1.02$)
β_e	0.98	Discount factor, firm
ϕ_L	5	Inverse Frisch elasticity
Π	1	Steady-state trend inflation
δ	0.025	Capital depreciation rate
α	0.35	The labor share of private non-farm business sector is 0.65
μ	0.8	Loan-to-value ratio
ϵ	11	Elasticity of substitution (target markup ten percent)
η	11	Elasticity of substitution between intermediate goods
ϕ_1	36.95	Price-adjustment cost, firm with lower price stickiness (target Calvo parameter = 0.6)
ϕ_2	825	Price-adjustment cost, firm with higher price stickiness (target Calvo parameter = 0.9)
κ_I	66.67	Investment-adjustment cost
ζ	0.5	Size of firms with less stickiness
τ	2	Ratio between the required loan rates for firms with different price stickiness
ϕ_π	1.5	Taylor-rule inflation
ρ_r	0.8	Taylor-rule smoothing
GoY	0.18	Government-spending-to-GDP ratio
ρ_a	0.9	AR productivity
σ_a	6.5×10^{-6}	Standard deviation of technological shock (target $std(C) = 0.007$ in data)
σ_R	8×10^{-7}	Standard deviation of monetary policy shock (target $std(\pi) = 0.002$ in data)

Table 6: **Return Volatility under Different Shocks and Parameter Values in the Model**

This table reports the return volatility of sticky-price firm ($\sigma(R_2)$) and that of flexible-price firms ($\sigma(R_1)$), with different values of ratios between the required loan rates ($\tau = 1$ or 2) for the two types of firms, under different shocks (both shocks, monetary policy shock only, and TFP shock only). The loan rate for flexible-price firms (type 1 firms) is the risk-free rate R_t. The loan rate for sticky-price firms (type 2 firms) is τR.

	Both shocks		MP shock		TFP shock	
	$\tau = 2$	$\tau = 1$	$\tau = 2$	$\tau = 1$	$\tau = 2$	$\tau = 1$
	(1)	(2)	(3)	(4)	(5)	(6)
$\sigma(R_1)$	0.005089	0.005105	0.003722	0.003642	0.003444	0.003551
$\sigma(R_2)$	0.006456	0.005123	0.003843	0.003652	0.005144	0.003555

Table 7: **Sticky Output Price and Leverage**

This table reports the results for estimating the following linear equation on S&P 500 constituent firms headquartered in the United States over the sample period of 1997 – 2012. Utilities and Financial sectors are excluded:

$$Leverage_{i,s} = \alpha + \beta \times Sticky_j + \gamma \times Sticky_j \times Post_{i,s} + \delta \times Post_{i,s} + X'_{i,t-1} \times \theta + \eta_s + \eta_i + \epsilon_{i,s},$$

where $Leverage_{i,s}$ is the long-term debt over assets in quarter s for firm i. Sticky is the frequency of price adjustment multiplied by -1. In Panel A, $Post_{i,s}$ is an indicator equal to 1 if year-month s is after 2002Q3, and 0 otherwise. In Panel B, $Post_{i,s}$ is an indicator equal to 1 if firm i in year-month s complies with SOX Section 404, and 0 otherwise. Firms with fiscal year-ends in November and December complied with the section in their fiscal year of 2004; firms with fiscal year-ends in August, September, and October complied with the section in their fiscal year of 2005. Time FE is a set of dummies that capture year-quarters. Industry FE is a set of 12 dummies that capture the Fama and French 12-industries. See Table 1 for the definition of control variables. All variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the level of 6-digit NAICS sectors.

	Panel A. Sarbanes-Oxley Act of 2002				
	(1)	(2)	(3)	(4)	(5)
Sticky	-0.11***	-0.17***	-0.12**		
	(0.04)	(0.05)	(0.05)		
Sticky × Post		0.09**	0.09**	0.08***	0.07
		(0.04)	(0.04)	(0.03)	(0.05)
Post		0.00			
		(0.01)			
N	20,307	20,307	20,307	20,307	20,307
Adjusted R^2	0.10	0.11	0.20	0.71	0.71
	Panel B. Section 404				
	(1)	(2)	(3)	(4)	(5)
Sticky	-0.10**	-0.15***	-0.15***		
	(0.04)	(0.05)	(0.05)		
Sticky × Post		0.10***	0.10***	0.10***	0.08**
		(0.03)	(0.04)	(0.03)	(0.04)
Post		-0.00	-0.04	0.04***	0.03**
		(0.01)	(0.04)	(0.01)	(0.01)
N	15,397	15,397	15,397	15,397	15,397
Adjusted R^2	0.08	0.10	0.10	0.72	0.73
Controls	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	No
Industry FE	No	No	Yes	No	No
Firm FE	No	No	No	Yes	Yes
Industry × Time FE	No	No	No	No	Yes

standard errors in parentheses
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 8: **Sticky Output Price and Firm Leverage (Errors-in-Variables)**

This table reports the results for estimating the following linear equation on S&P 500 constituent firms headquartered in the United States over the sample period of 1997 – 2012. Utilities and Financial sectors are excluded. We use the linear-cumulant equations methodology of Erickson, Jiang, and Whited (2014). We assume Sticky, B-M ratio, *and* Intangibility *are measured with error:*

$$Leveragei, s = \alpha + \beta \times Sticky_j + \gamma \times Sticky_j \times Post_{i,s} + \delta \times Post_{i,s} + X'_{i,t-1} \times \theta + \epsilon_{i,s}.$$

For each firm i, $Leverage_{i,s}$ is long-term debt in year-quarter s. Sticky is the frequency of price adjustment multiplied by -1. In Panel A, $Post_{i,s}$ is an indicator equal to 1 if year-month s is after 2002Q3, and 0 otherwise. In Panel B, $Post_{i,s}$ is an indicator equal to 1 if firm i in year-month s complies with SOX Section 404, and 0 otherwise. Firms with fiscal year-ends in November and December complied with the section in their fiscal year of 2004; firms with fiscal year-ends in August, September, and October complied with the section in their fiscal year of 2005. See Table 1 for the definition of control variables. All variables are winsorized at the 1% and 99% levels.

	OLS	3rd Cum	4th Cum	5th Cum
	Panel A. Sarbanes-Oxley Act of 2002			
	(1)	(2)	(3)	(4)
Sticky	-0.17***	-0.13***	-0.18***	-0.19***
	(0.05)	(0.04)	(0.03)	(0.01)
Sticky × Post	0.09**	0.08**	0.09***	0.10***
	(0.04)	(0.03)	(0.02)	(0.01)
Post	-0.00	-0.03	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Controls	Yes	Yes	Yes	Yes
N	20,307			
Adjusted R^2	0.11			
	Panel B. Section 404			
	(1)	(2)	(3)	(4)
Sticky	-0.15***	-0.11**	-0.23***	-0.23***
	(0.05)	(0.05)	(0.03)	(0.01)
Sticky × Post	0.10***	0.07**	0.09***	0.13***
	(0.03)	(0.03)	(0.02)	(0.01)
Post	-0.00	-0.04	-0.01	0.00
	(0.01)	(0.02)	(0.01)	(0.01)
Controls	Yes	Yes	Yes	Yes
N	15,397			
Adjusted R^2	0.10			

standard errors in parentheses
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 9: **Sticky Output Price and Return Volatility**

This table reports the results for estimating the following linear equation on S&P 500 constituent firms headquartered in the United States over the sample period of 1997 – 2012. Utilities and Financial sectors are excluded:

$$Total\ Vol_{i,s} = \alpha + \beta \times Sticky_j + \gamma \times Sticky_j \times Post_{i,s} + \delta \times Post_{i,s} + X'_{i,t-1} \times \theta + \eta_s + \eta_i + \epsilon_{i,s},$$

where $Total\ Vol_{i,s}$ *is the standard deviation of raw returns (in percent) in quarter* s *for firm* i*. Sticky is the frequency of price adjustment multiplied by -1. In Panel A,* $Post_{i,s}$ *is an indicator equal to 1 if year-month* s *is after 2002Q3, and 0 otherwise. In Panel B,* $Post_{i,s}$ *is an indicator equal to 1 if firm* i *in year-month* s *complies with SOX Section 404, and 0 otherwise. Firms with fiscal year-ends in November and December complied with the section in their fiscal year of 2004; firms with fiscal year-ends in August, September, and October complied with the section in their fiscal year of 2005. Time FE is a set of dummies that capture year-quarters. Industry FE is a set of 12 dummies that capture the Fama and French 12-industries. See Table 1 for the definition of control variables. All variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the level of 6-digit NAICS sectors.*

	Panel A. Sarbanes-Oxley Act of 2002				
	(1)	(2)	(3)	(4)	(5)
Sticky	0.08***	0.26***	0.16***		
	(0.02)	(0.06)	(0.05)		
Sticky × Post		-0.27***	-0.25***	-0.24***	-0.15***
		(0.06)	(0.06)	(0.07)	(0.05)
Post		-0.15***			
		(0.02)			
N	20,589	20,589	20,589	20,589	20,589
Adjusted R^2	0.11	0.15	0.54	0.68	0.74
	Panel B. Section 404				
	(1)	(2)	(3)	(4)	(5)
Sticky	0.07***	0.22***	0.21***		
	(0.02)	(0.04)	(0.04)		
Sticky × Post		-0.25***	-0.24***	-0.23***	-0.13***
		(0.05)	(0.04)	(0.04)	(0.05)
Post		-0.13***	-0.07***	-0.05***	-0.03*
		(0.02)	(0.02)	(0.01)	(0.02)
N	15,597	15,597	15,597	15,597	15,597
Adjusted R^2	0.11	0.15	0.50	0.69	0.74
Controls	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	No
Industry FE	No	No	Yes	No	No
Firm FE	No	No	No	Yes	Yes
Industry × Time FE	No	No	No	No	Yes

standard errors in parentheses
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 10: **Sticky Output Price and Investment Sensitivity to Monetary Policy**

This table reports the results for estimating the following linear equation on S&P 500 constituent firms headquartered in the United States. The sample period is 1997 – 2009. Utilities and Financial sectors are excluded.

$$\Delta log(Capital)_{i,s} = \alpha + \beta \times Sticky_j \times \overline{v}_s + \gamma \times Sticky_j \times \overline{v}_s \times Post_{i,s} + \delta \times Sticky_j \times Post_{i,s} + Z'_{i,t-1} \times \theta + \eta_i + \eta_s + \epsilon_{i,s}.$$

For each firm i, $\Delta log(Capital)_{i,s}$ is the change in the logarithm of invested capital from quarter $s-1$ to quarter s. $\overline{v}_s$ is a moving average of v_d (in percent) weighted by the number of days in the quarter s after the shock occurs. v_d is the scaled change of the fed funds futures implied rate within a 30-minute event window around the FOMC press release (-10 min, +20 min) on day d. The sign of v_m is flipped so that a positive (negative) shock corresponds to an expansionary (a contractionary) monetary policy shock or a decrease (an increase) in interest rates. Sticky is the frequency of price adjustment multiplied by -1. Panel A, $Post_{i,s}$ is an indicator equal to 1 if year-month s is after 2002Q3, and 0 otherwise. In Panel B, $Post_{i,s}$ is an indicator equal to 1 if firm i in year-month s complies with SOX Section 404, and 0 otherwise. Firms with fiscal year-ends in November and December complied with the section in their fiscal year of 2004; firms with fiscal year-ends in August, September, and October complied with the section in their fiscal year of 2005. Time FE is a set of dummies that capture year-quarters. Industry FE is a set of 12 dummies that capture the Fama-French 12-industries. See Table 1 for the definition of control variables. All variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the level of 6-digit NAICS sectors.

	Panel A. Sarbanes-Oxley Act of 2002				
	(1)	(2)	(3)	(4)	(5)
Sticky $\times\overline{v}$	0.13*	0.24**	0.23**	0.28**	0.34**
	(0.07)	(0.10)	(0.11)	(0.13)	(0.16)
Sticky $\times\overline{v}\times$ Post		-0.29**	-0.31**	-0.30**	-0.47*
		(0.14)	(0.14)	(0.14)	(0.26)
N	19,766	19,766	19,766	19,766	19,766
Adjusted R^2	0.07	0.07	0.07	0.07	0.08
	Panel B. Section 404				
	(1)	(2)	(3)	(4)	(5)
Sticky $\times\overline{v}$	0.11	0.22**	0.22*	0.30**	0.41**
	(0.08)	(0.10)	(0.11)	(0.15)	(0.20)
Sticky $\times\overline{v}\times$ Post		-0.39**	-0.40**	-0.39**	-0.56**
		(0.17)	(0.17)	(0.17)	(0.26)
N	14,973	14,973	14,973	14,973	14,973
Adjusted R^2	0.07	0.07	0.07	0.07	0.07
Controls	Yes	Yes	Yes	Yes	Yes
$\overline{v}\times$ Controls	No	No	Yes	Yes	Yes
$\overline{v}\times$ Industry FE	No	No	No	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	No
Firm FE	Yes	Yes	Yes	Yes	Yes
Industry $\times$ Time FE	No	No	No	No	Yes

standard errors in parentheses
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 11: **Sticky Output Price and Stock-Price Sensitivity to Monetary Policy**

This table reports the results for estimating the following linear equation on S&P 500 constituent firms headquartered in the United States. The sample period is 1997 – 2009. Utilities and Financial sectors are excluded.

$$Ret_{i,d} = \alpha + \beta \times Sticky_j \times v_d + \gamma \times Sticky_j \times v_d \times Post_{i,d} + \delta \times Sticky_j \times Post_{i,d} + Z'_{i,s-1} \times \theta + \eta_i + \eta_d + \epsilon_{i,d}.$$

For each firm i, $Ret_{i,d}$ is the raw stock return (in percentage points) on FOMC announcement date d. v_d is the scaled change of the fed funds futures implied rate within a 30-minute event window around the FOMC press release (-10 min, +20 min) on day d. The sign of v_d is flipped so that a positive (negative) shock corresponds to an expansionary (a contractionary) monetary policy shock or a decrease (an increase) in interest rates. Sticky is the frequency of price adjustment multiplied by -1. Panel A, $Post_{i,s}$ is an indicator equal to 1 if year-month s is after 2002Q3, and 0 otherwise. In Panel B, $Post_{i,s}$ is an indicator equal to 1 if firm i in year-month s complies with SOX Section 404, and 0 otherwise. Firms with fiscal year-ends in November and December complied with the section in their fiscal year of 2004; firms with fiscal year-ends in August, September, and October complied with the section in their fiscal year of 2005. Time FE is a set of dummies that capture year-quarters. Industry FE is a set of 12 dummies that capture the Fama-French 12-industries. See Table 1 for the definition of control variables. All variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the level of 6-digit NAICS sectors.

	Panel A. Sarbanes-Oxley Act of 2002					
	(1)	(2)	(3)	(4)	(5)	(6)
v	5.93***			10.21***		
	(0.73)			(1.18)		
Sticky $\times v$	7.31***	7.45***	7.45***	13.77***	13.85***	7.56**
	(2.40)	(2.10)	(2.10)	(3.13)	(3.10)	(3.75)
Sticky $\times v \times$ Post				-14.56***	-14.45***	-13.64***
				(2.80)	(2.88)	(2.86)
N	43,136	43,136	43,136	43,136	43,136	43,136
Adjusted R^2	0.02	0.28	0.28	0.03	0.29	0.29
	Panel B. Section 404					
	(1)	(2)	(3)	(4)	(5)	(6)
v	5.36***			9.03***		
	(0.80)			(1.15)		
Sticky $\times v$	6.70***	6.72***	6.72***	11.85***	11.84***	6.35*
	(2.51)	(2.21)	(2.21)	(3.11)	(3.24)	(3.70)
Sticky $\times v \times$ Post				-11.82***	-11.63***	-11.06***
				(2.29)	(2.54)	(2.50)
N	32,784	32,784	32,784	32,784	32,784	32,784
Adjusted R^2	0.02	0.28	0.28	0.03	0.29	0.29
Controls	Yes	Yes	Yes	Yes	Yes	Yes
$v\times$ Controls	No	No	Yes	No	No	Yes
Firm FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	Yes	Yes	No	Yes	Yes

standard errors in parentheses
$*p < 0.10, **p < 0.05, ***p < 0.01$

Online Appendix: The Impact of Securities Regulation on New Keynesian Firms

Not for Publication

Figure A.1: **Dynamics of Idiosyncratic Return Volatility**

The chart plots the estimates of β and the 90% confidence intervals from the following ordinary least squares equation:

$$Y_{i,s} = \alpha + \sum_{s=1997Q2}^{2012Q4} \beta_s \times Sticky_j + \sum_{s=1997Q2}^{2012Q4} \gamma_s + X'_{i,t-1} \times \theta + \eta_i + \epsilon_{i,s},$$

which includes a set of leads of the interactions between price stickiness and year-quarter fixed effects for the quarters before and after 2002Q3. The excluded quarter is 1997Q1. In Panel A, $Y_{i,s}$ is the standard deviation of Fama-French/Carhart four-factor-adjusted returns (in percent) over the quarter s for firm i. In Panel B, $Y_{i,s}$ is the average of implied daily volatility of call-option contracts in quarter s for firm i. Time 0 is the third quarter of 2002, during which the US Congress passed and implemented the Sarbanes-Oxley Act. Standard errors are clustered at the level of 6-digit NAICS sectors.

Panel A. Idiosyncratic Volatility

Panel B. Option-Implied Volatility

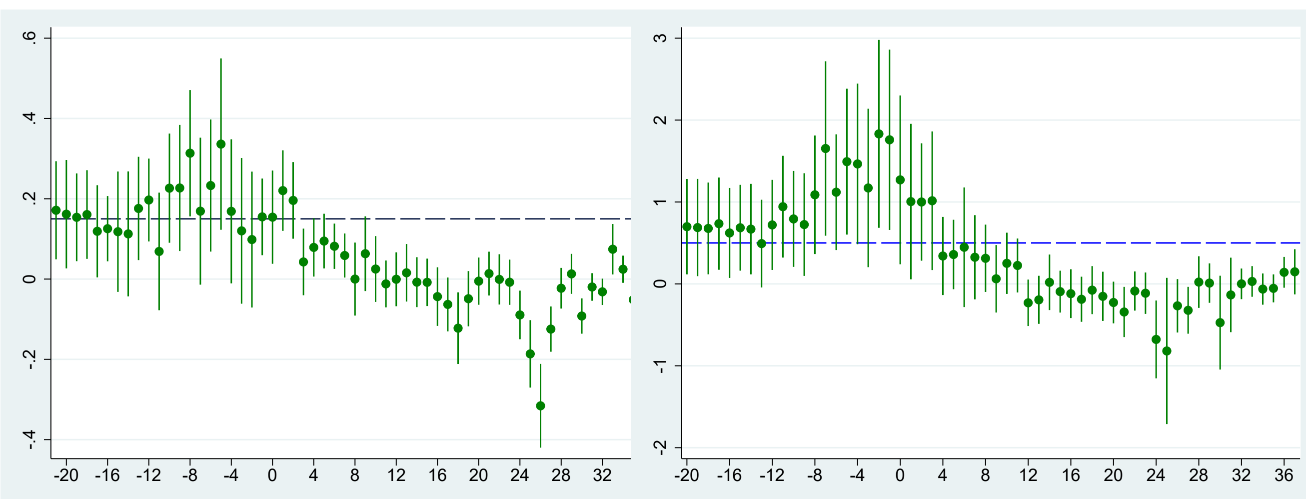


Table A.1: **Sticky Output Price and Capital Investment**

This table reports the results for estimating the following linear equation on S&P 500 constituent firms headquartered in the United States over the sample period of 1997 – 2012. Utilities and Financial sectors are excluded:

$$CAPX_{i,s} = \alpha + \beta \times Sticky_j + \gamma \times Sticky_j \times Post_{i,s} + \delta \times Post_{i,s} + X'_{i,t-1} \times \theta + \eta_s + \eta_i + \epsilon_{i,s},$$

where $CAPX_{i,s}$ is the capital expenditure over assets in quarter s for firm i. Sticky is the frequency of price adjustment multiplied by -1. In Panel A, $Post_{i,s}$ is an indicator equal to 1 if year-month s is after 2002Q3, and 0 otherwise. In Panel B, $Post_{i,s}$ is an indicator equal to 1 if firm i in year-month s complies with SOX Section 404, and 0 otherwise. Firms with fiscal year-ends in November and December complied with the section in their fiscal year of 2004; firms with fiscal year-ends in August, September, and October complied with the section in their fiscal year of 2005. Time FE is a set of dummies that capture year-quarters. Industry FE is a set of 12 dummies that capture the Fama and French 12-industries. See Table 1 for the definition of control variables. All variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the level of 6-digit NAICS sectors.

	Panel A. Sarbanes-Oxley Act of 2002				
	(1)	(2)	(3)	(4)	(5)
Sticky	-0.03***	-0.02***	-0.01***		
	(0.01)	(0.01)	(0.00)		
Sticky × Post		-0.01	-0.00	0.00	0.00
		(0.00)	(0.00)	(0.00)	(0.00)
Post		-0.01***			
		(0.00)			
N	20,307	20,307	20,307	20,307	20,307
AdjustedR^2	0.30	0.32	0.39	0.65	0.66
	Panel B. Section 404				
	(1)	(2)	(3)	(4)	(5)
Sticky	-0.03***	-0.02***	-0.01***		
	(0.01)	(0.01)	(0.00)		
Sticky × Post		-0.01*	-0.01	0.00	0.00
		(0.00)	(0.00)	(0.00)	(0.00)
Post		-0.01***			
		(0.00)			
N	15,394	15,394	15,394	15,394	15,394
AdjustedR^2	0.33	0.35	0.43	0.68	0.69
Controls	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	No
Industry FE	No	No	Yes	No	No
Firm FE	No	No	No	Yes	Yes
Industry × Time FE	No	No	No	No	Yes

standard errors in parentheses
$*p < 0.10, **p < 0.05, ***p < 0.01$

Table A.2: **Return Volatility in the Model with Different Loan-to-value Ratio but without Credit Spread Difference**

This table reports the return volatility of sticky-price firm ($\sigma(R_2)$) and that of flexible-price firms ($\sigma(R_1)$), in the model without credit-spread difference but with lower and higher loan-to-value ratios ($\mu_2 = 0.8$ and $\mu_1 = 0.6$) for sticky-price and flexible-price firms, respectively, under different shocks (both shocks, monetary policy shock only, and TFP shock only).

	Both shocks	MP shock	TFP shock
$\sigma(R_1)$	0.005091	0.003655	0.003523
$\sigma(R_2)$	0.004369	0.003187	0.002965

Table A.3: **Sticky Output Price and Return Volatility: Alternative Measures**

This table reports the results for estimating the following linear equation on S&P 500 constituent firms headquartered in the United States over the sample period of 1997 – 2012. Utilities and Financial sectors are excluded:

$$Y_{i,s} = \alpha + \beta \times Sticky_j + \gamma \times Sticky_j \times Post_{i,s} + \delta \times Post_{i,s} + X'_{i,t-1} \times \theta + \eta_s + \eta_i + \epsilon_{i,s},$$

where $Y_{i,s}$ are the standard deviation of Fama-French/Chart four-factor-adjusted returns (in percent) in quarter s for firm i (columns (1)-(5)) and the average of implied daily volatility of call-option contracts in quarter s for firm i. Sticky is the frequency of price adjustment multiplied by -1. In Panel A, $Post_{i,s}$ is an indicator equal to 1 if year-month s is after 2002Q3, and 0 otherwise. In Panel B, $Post_{i,s}$ is an indicator equal to 1 if firm i in year-month s complies with SOX Section 404, and 0 otherwise. Firms with fiscal year-ends in November and December complied with the section in their fiscal year of 2004; firms with fiscal year-ends in August, September, and October complied with the section in their fiscal year of 2005. Time FE is a set of dummies that capture year-quarters. Industry FE is a set of 12 dummies that capture the Fama-French 12-industries. See Table 1 for the definition of control variables. All variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the level of 6-digit NAICS sectors.

	Idiosyncratic Volatility					Option-Implied Volatility				
	Panel A. Sarbanes–Oxley Act									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sticky	0.05**	0.19***	0.10**			1.20***	3.64***	2.22***		
	(0.02)	(0.05)	(0.05)			(0.33)	(0.80)	(0.66)		
Sticky × Post		-0.18***	-0.17***	-0.16***	-0.14***		-3.51***	-3.19***	-2.94***	-2.11***
		(0.05)	(0.05)	(0.05)	(0.04)		(0.87)	(0.79)	(0.90)	(0.68)
Post		-0.15***					-1.89***			
		(0.02)					(0.32)			
N	20,589	20,589	20,589	20,589	20,589	19,950	19,950	19,950	19,950	19,950
Adjusted R^2	0.14	0.22	0.49	0.63	0.67	0.17	0.21	0.60	0.77	0.83
	Panel B. Section 404									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sticky	0.05**	0.19***	0.10**			1.20***	3.64***	2.22***		
	(0.02)	(0.05)	(0.05)			(0.33)	(0.80)	(0.66)		
Sticky × Post		-0.18***	-0.17***	-0.16***	-0.14***		-3.51***	-3.19***	-2.94***	-2.11***
		(0.05)	(0.05)	(0.05)	(0.04)		(0.87)	(0.79)	(0.90)	(0.68)
Post		-0.15***					-1.89***			
		(0.02)					(0.32)			
N	15,597	15,597	15,597	15,597	15,597	15,125	15,125	15,125	15,125	15,125
Adjusted R^2	0.11	0.15	0.50	0.69	0.74	0.16	0.21	0.54	0.78	0.83
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	No	No	No	Yes	Yes	No
Industry FE	No	No	Yes	No	No	No	No	Yes	No	No
Firm FE	No	No	No	Yes	Yes	No	No	No	Yes	Yes
Industry *times* Time FE	No	No	No	No	Yes	No	No	No	No	Yes

standard errors in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table A.4: **Sticky Output Price and Stock-Price Sensitivity to Monetary Policy: Placebo Test**

This table reports the results for estimating the following linear equation on S&P 500 constituent firms headquartered in the United States. The sample period is 1997 – 2009. Utilities and Financial sectors are excluded.

$$Ret_{i,d-1->d-2} = \alpha + \beta \times Sticky_j \times v_d + \gamma \times Sticky_j \times v_d \times Post_{i,d} + \delta \times Sticky_j \times Post_{i,d} + Z'_{i,s-1} \times \theta + \eta_i + \eta_d + \epsilon_{i,d}.$$

For each firm i, $Ret_{i,d-1->d-2}$ is the raw stock return (in percentage points) in the two days preceding the FOMC announcement date d. v_d is the scaled change of the fed funds futures implied rate within a 30-minute event window around the FOMC press release (-10 min, +20 min) on day d. The sign of v_d is flipped so that a positive (negative) shock corresponds to an expansionary (a contractionary) monetary policy shock or a decrease (an increase) in interest rates. Sticky is the frequency of price adjustment multiplied by -1. Panel A, $Post_{i,s}$ is an indicator equal to 1 if year-month s is after 2002Q3, and 0 otherwise. In Panel B, $Post_{i,s}$ is an indicator equal to 1 if firm i in year-month s complies with SOX Section 404, and 0 otherwise. Firms with fiscal year-ends in November and December complied with the section in their fiscal year of 2004; firms with fiscal year-ends in August, September, and October complied with the section in their fiscal year of 2005. Time FE is a set of dummies that capture year-quarters. Industry FE is a set of 12 dummies that capture the Fama-French 12-industries. See Table 1 for the definition of control variables. All variables are winsorized at the 1% and 99% levels. Standard errors are clustered at the level of 6-digit NAICS sectors.

	Panel A. Sarbanes-Oxley Act of 2002					
	(1)	(2)	(3)	(4)	(5)	(6)
v	-0.78*			-2.03***		
	(0.43)			(0.73)		
Sticky $\times v$	0.64	0.55	0.55	-2.54	-2.66	4.23
	(1.75)	(1.90)	(1.90)	(2.20)	(2.31)	(3.33)
Sticky $\times v \times$ Post				7.10**	6.57**	6.02**
				(2.91)	(2.83)	(2.83)
N	43,136	43,136	43,136	43,136	43,136	43,136
Adjusted R^2	0.00	0.30	0.30	0.00	0.30	0.30
	Panel B. Section 404					
	(1)	(2)	(3)	(4)	(5)	(6)
v	-0.89**			-0.43		
	(0.43)			(0.57)		
Sticky $\times v$	1.29	1.01	1.01	0.95	0.48	7.58***
	(1.60)	(1.74)	(1.74)	(1.75)	(1.98)	(2.75)
Sticky $\times v \times$ Post				1.33	1.37	2.50
				(2.52)	(2.42)	(2.39)
N	32,784	32,784	32,784	32,784	32,784	32,784
Adjusted R^2	0.00	0.30	0.30	0.00	0.30	0.30
Controls	Yes	Yes	Yes	Yes	Yes	Yes
$v \times$ Controls	No	No	Yes	No	No	Yes
Firm FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	Yes	Yes	No	Yes	Yes

standard errors in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$