

Financial Frictions and Reaction of Stock Prices to Monetary Policy Shocks

Ali Ozdagli*

February 15, 2014

*E-mail: ali.ozdagli@bos.frb.org. Address: Federal Reserve Bank of Boston, 600 Atlantic Ave, Boston, MA-02210. The views expressed in this paper do not necessarily reflect those of the Federal Reserve Bank of Boston or the Federal Reserve System.

Abstract

This paper reveals a new theoretical implication of the credit channel of monetary policy: the stock prices of financially more constrained firms are *less* responsive to monetary policy shocks. In order to study this implication, we use Enron scandal as an exogenous variation in the monitoring cost of the Arthur Andersen clients relative to other firms in a difference in differences framework. We find that Arthur Andersen clients have responded about 40 to 50 basis points less than other firms to a 10 basis point surprise reduction in federal funds target rate in the final days of the scandal, which is in line with the new implication of the credit channel.

Keywords: monetary policy, stock market, credit channel, financial constraints

1 Introduction

This paper studies the relationship between financial frictions and the reaction of stock prices to monetary policy shocks. Using the financial accelerator framework of Bernanke, Gertler, and Gilchrist (BGG, 1999), we initially reveal a new theoretical implication of the credit channel of monetary policy: The stock prices of financially more constrained firms, i.e. firms subject to greater monitoring costs, are *less* responsive to monetary policy shocks because monetary policy affects stock prices through external finance and firms with greater monitoring cost rely less on external finance.

Because the main source of financial frictions in BGG framework is monitoring costs, the ideal test of this theoretical result requires an experiment with treatment and control groups where the monitoring cost of the treatment group is increased relative to that of the control group. Due to the absence of these ideal conditions, the papers in the literature usually rely on indirect proxies of financial constraints which might suffer from endogeneity problems. Instead, we recognize that firms' financial statements serve greatly to reduce the monitoring costs of investors and use the ENRON accounting scandal of 2001, the largest

accounting-fraud related corporate bankruptcy in history, and the resulting demise of its auditing firm, Arthur Andersen, as an exogenous large shock to the monitoring cost of other Arthur Andersen clients in comparison to the clients of other auditing companies. We find that the stock price of Arthur Andersen clients have responded about 40 to 50 basis points less than other firms to a 10 basis point surprise reduction in federal funds target rate in the final days of the scandal, in comparison to the initial days of the scandal. This effect is very large, considering that Bernanke and Kuttner (2005) finds that the aggregate U.S. stock market increases by about 45 basis points in response to a 10 basis points surprise decrease in stock prices.

Our paper is closely related to the widely studied topic of monetary policy transmission to the real economy, in particular the credit channel.¹ These implications of credit channel for firms investment and hiring decisions are extensively studied in a long strand of literature pioneered by Gertler and Gilchrist (1994), Kashyap, Lamont, and Stein (1994), and Oliner and Rudebusch (1996) among others. Our paper is also related to an extensive literature on how monetary policy affects stock prices.² However, because these two strands of literature grew separately there are relatively very few papers that study how the credit channel influences the sensitivity of stock prices to monetary policy like we do.

Due to the difficulties in measuring financial constraints, these papers look at indirect proxies, most notably firm size, using the license provided by Gertler and Gilchrist (1994) who argue that "in nearly every study the "likely to be constrained" firms are much smaller on average than the control group". Perez-Quiros and Timmermann (2000) use lagged change in monetary base as a proxy of monetary policy and finds that small firms' stock prices react more strongly to monetary policy. Lamont, Polk, and Saa-Requejo (2001) recognize that

¹More recently, the meaning of credit channel has been blurred due to alternative mechanisms that have been proposed how this channel should work. Here, we refer to the traditional credit channel which is today more widely known as the firm (borrower) balance sheet channel.

²A long but incomplete list includes Geske and Roll (1983), Kaul (1987), Lee (1992), Thorbecke (1997), Patelis(1997), Bomfim and Reinhart (2000), Kuttner (2001), Cochrane and Piazzesi (2002), Bomfim (2003), Fuhrer and Tootell (2003), Dupor and Conley (2004), Rigobon and Sack (2004), Bernanke and Kuttner (2005), Gurkaynak, Sack, and Swanson (2005), Bjørnland and Leitemo (2009). See also Sellin (2001) for an earlier survey.

the modern monetary policy is actually based on interest rates rather than monetary base. Therefore, they study federal funds rate and discount window rate and find no evidence that the relative performance of constrained firms reflects monetary policy, credit conditions, or business cycles. Ehrmann and Fratscher (2004) recognize that investors are not caught totally off-guard when federal funds target rate changes and therefore stock prices should only react to surprise component in the target rate change. They calculate the surprise component of federal funds target rate change using the difference between the actual target rate change and the anticipated change measured by the survey expectations. According to their study on the S&P 500 firms, they find that firms with small size, poor credit ratings, and low debt to capital ratios, or a high Tobin's q are affected significantly more by monetary policy. Subsequent papers in this literature focus on the same problem in a more international setting.³

Our contribution addresses two problems that seem to plague this literature. First, the hypotheses in these papers are not based on an explicit theory which generates a lack of clear definition of financial constraints. We address this problem by providing a clean analysis on the financial accelerator framework of Bernanke, Gertler, and Gilchrist (1999) who define financial frictions as monitoring costs. While the framework is not new, the novel implication of the model is loud and clear: firms subject to greater monitoring costs are less responsive to monetary policy shocks because monetary policy affects firms stock prices through external finance and firms with greater monitoring cost rely less on external finance. While there are myriads of ways to model financial constraints we focus on this particular model with monitoring costs, not only because of its popularity but also because we want to trade the vague definition of financial constraints in previous studies with a more precise and clear one that we can more easily study.

Second, we address the endogeneity problem associated with indirect proxies of financial constraints as this problem has been increasingly recognized in the empirical corporate

³See, for example, Ammer, Vega, and Wongsman (2010) and Laeven and Tong (2012).

finance literature over the last decade.⁴ For this purpose, we use Enron scandal as an exogenous variation in the monitoring cost of the Arthur Andersen clients relative to other firms. This approach alleviates the omitted variable problem because the origin of the accounting scandal is outside of the firms we study, a sample that excludes Enron. Before the scandal Enron was a highly praised firm for its success and the subpar accounting practices of Enron and Arthur Andersen did not come to surface until 2001. This pattern is evident not only in mass media but also in the academic literature on auditor choice that put all the Big N accounting firms into the same category until Enron scandal. Therefore, it is reasonable to assume that the auditor choice did not have any sizable effect on market valuation of the firms before the scandal. Nevertheless, we also address any remaining endogeneity concerns by using intraday returns and also an instrumental variable approach.

2 The Model and a New Empirical Prediction

In this section, we show that the responsiveness of a firm's market value of equity to monetary policy shocks decreases as financial frictions increase. For this purpose, we follow the popular framework in Bernanke, Gertler, Gilchrist (1999), Appendix A in particular.⁵ The only difference is that we normalize price of capital and aggregate return on capital to one, since these variables are the same for all firms and we are interested in cross-sectional comparison.

If we let w be the firm's profitability, K be its capital and B be the face value of debt,

⁴For example, while Ehrmann and Fratscher (2004) aims to solve the endogeneity problem caused by the mismeasurement of monetary policy surprises whereas they ignore the the mismeasurement and omitted variable bias caused by using proxies for vaguely defined financial constraints. To give an example, Ehrmann and Fratscher find that the stock prices of small firms in their sample, consisting of S&P 500 firms, respond more to monetary policy shocks. However, we find that in a more comprehensive sample of the overall stock market smaller firms' stock prices react less to monetary policy shocks even after controlling for liquidity of the stock.

⁵The Bernanke, Gertler, Gilchrist (1999) framework is in essence an application of costly state verification model in Townsend (1979). Due to space constraints, we do not list thousands of citations of these papers here.

we can write the firm's problem subject to costly state verification as

$$V = \max_{K,B} E(wK - B)^+$$

subject to the incentive compatibility constraint of the lender

$$R(K - N) = E(\mathbb{I}_{wK \geq B} B + \mathbb{I}_{wK < B} (1 - \mu) wK)$$

where R is the gross risk-free rate, N is given net worth, or book equity, of the firm, μ is the monitoring cost, and $\mathbb{I}$ denotes the indicator function that is equal to one if the corresponding condition is satisfied and zero otherwise. We are interested in $\partial \ln V / \partial R \partial \mu$ because the interest rate is set by the monetary authority and monitoring cost is the main source of financial frictions.

Defining $v \equiv V/N$, $k \equiv K/N$, and $\bar{w} \equiv B/K$, we can rewrite the firm's problem as

$$v = \max_{k, \bar{w}} E(w - \bar{w})^+ k \tag{1}$$

subject to

$$R(k - 1) = E(\mathbb{I}_{w \geq \bar{w}} \bar{w} + \mathbb{I}_{w < \bar{w}} (1 - \mu) w) k. \tag{2}$$

Because we are interested in how the percentage change in stock prices in response to a change in risk-free rate varies with monitoring costs and because net worth, N , is a state variable independent of interest rate we can directly work with v , instead of V , which reduces our problem's dimension.

We start by showing that firms using more external finance are more responsive to monetary policy shocks.

Proposition 1 *The sensitivity of a firm's stock value to monetary policy shocks, $\partial \ln V / \partial R$ increases as the ratio of total capital to internal funds, K/N , increases.*

Proof. Solving constraint (2) for k and plugging the solution into objective function (1) gives an unconstrained problem in $\bar{w}$. Then, using the envelope theorem, we get $d \ln V / dR = 1/R - 1/[R - E(\mathbb{I}_{w \geq \bar{w}} \bar{w} + \mathbb{I}_{w < \bar{w}} (1 - \mu) w)]$. Using constraint (2), this reduces to $d \ln V / dR = (1 - k)/R$ which is negative because $k > 1$ and moreover $|d \ln V / dR|$ increases in $k \equiv K/N$. ■

Intuitively, monetary policy affects the firm's behavior by changing the premium the firm has to pay on external finance. Therefore, a firm that relies more on external finance will be affected more by the monetary policy shock. The next proposition establishes that firms subject to greater monitoring costs use less external finance.

Proposition 2 *Let $f(w)$ and $F(w)$ denote the pdf and cdf of the firm's productivity, $h(w) \equiv f(w)/(1 - F(w))$ denote the hazard rate, and let $\bar{w}h(\bar{w})$ be increasing in $\bar{w}$. Then, the ratio of total capital to internal funds, K/N , decreases in monitoring costs, μ .*

Proof. See Appendix. ■

Intuitively, firms with greater monitoring costs rely less on external finance as they have to pay a higher premium. The assumption regarding the hazard rate is imposed by Bernanke, Gertler and Gilchrist (1999) to guarantee a non-rationing outcome which is particularly realistic for the publicly listed firms we study. We refer the reader to Appendix A.1 of Bernanke, Gertler and Gilchrist (1999) for details.

Putting these two proposition together, we conclude that firms with higher monitoring costs rely less on external finance which makes them less sensitive to monetary policy shocks. Therefore, the two propositions lead to the following corollary which is the main theoretical result of this paper.

Corollary 3 *The monetary policy sensitivity of stock price is greater for firms that are subject to greater monitoring costs.*

We will test this theoretical result in the next section.

3 Empirical Analysis

3.1 Motivation of Empirical Strategy

There are two main empirical challenges in testing our hypothesis: endogeneity of the monitoring costs and identification of monetary policy actions. In terms of the first challenge, the ideal test of our main theoretical result requires an experiment with treatment and control groups where the monitoring cost of the treatment group is increased and the control group remain constant. Due to the absence of these ideal conditions, the papers in the literature generally rely on indirect proxies of financial constraints which might suffer from endogeneity problems, in particular from omitted variable bias. Instead, our identification approach recognizes that firms' financial statements serves greatly to reduce the monitoring costs of investors and uses the ENRON accounting scandal of 2001 and the resulting demise of its accounting firm, Arthur Andersen, as an exogenous large shock to the monitoring cost of other Arthur Andersen clients in comparison to the clients of other firms.

This approach alleviates the omitted variable problem because the origin of this surprising accounting scandal is outside of the firms we study, a sample that excludes ENRON. Before the scandal ENRON was a highly praised firm for its success and the subpar accounting practices of ENRON and Arthur Andersen did not come to surface until 2001. This pattern is evident not only in mass media but also in the academic literature on auditing quality that put all the Big N accounting firms, including Arthur Andersen, into the same category until ENRON scandal.⁶ Therefore, it is reasonable to assume that the auditor choice did not have any sizable effect on market valuation of the firms before the scandal.

While this assumption is sufficient for our identification, it is not necessary. The necessary and sufficient identification assumption is that the auditor choice is independent of the characteristics that might affect how a firm's stock price sensitivity to monetary policy shocks changes with increasing monitoring costs. This is a weaker assumption than assuming that

⁶See for example, Francis, et. al. (1999).

the auditor choice does not have a material effect on market valuation. Nevertheless, we also hedge against any remaining endogeneity concerns we might have overlooked by using the auditor choice from 5 years ago as an instrument in an IV framework, noting that firms usually establish long-term relationships with their auditor and the characteristics that affect their market valuation varies over time and these changes are unlikely to be correlated by their auditor choice long time ago. Using lagged dependent variables is quite common in the macroeconomics and finance though researchers generally use one year lags. By using a long lag, we try to be as conservative as possible and stack the odds against ourselves although the lag length does not have any qualitative effect on our results.

In order to address the second challenge, the endogeneity of monetary policy actions, we follow the approach of Kuttner (2001) and Bernanke and Kuttner (2005) to dissect the monetary policy actions into the unexpected (*surprise*) component and the anticipated (*expected*) component on FOMC announcement dates because the equity market would have already responded to anticipated policy actions. The identification of the surprise element in the target rate change relies on the price of the current month 30-day federal funds futures contracts, a price which encompasses market expectations of the effective federal funds rate. We follow this method because federal funds futures outperform target rate forecasts based on other financial market instruments or based on alternative methods, such as sophisticated time series specifications and monetary policy rules.⁷ Another advantage of looking at one-day changes in near-dated federal funds futures is that federal funds futures do not exhibit predictable time-varying risk premia (and forecast errors) over daily frequencies.⁸ Similarly, over daily frequencies, the effect of Enron scandal on risk premia of the firms is negligible compared to the effect of the monetary policy surprise on FOMC announcement dates.

The ENRON scandal is not a sudden event but rather a scandal that got unveiled over the course of 2001 and there is no reliable way to figure out investor's belief on the probability

⁷See Evans (1998) and Gürkaynak, Sack and Swanson (2007) for details.

⁸See, for example, Piazzesi and Swanson (2008). Details of this policy surprise measure are given in the data section.

of an accounting scandal. Therefore, we need an FOMC announcement day that is late enough in 2001 to incorporate the full effect of the scandal and also has a sizeable monetary policy surprise. Moreover, we need to avoid the unscheduled FOMC announcements to avoid the effect of timing shocks which would reduce the exogeneity of the measured policy surprise. We choose the scheduled FOMC announcement on 6 November, 2001 because this date includes a sizeable monetary policy surprise (-10 basis points) for the 50 basis points reduction in federal funds target rate on that date and it is very close to 8 November, 2001 when Enron filed the 8-K report announcing that it will restate financial documents dating from 1997 through the second quarter of 2001.⁹

As a comparable "before" date we choose 15 May 2001 because this date shares similar characteristics to the announcement on 6 November 2001. In particular, the change in federal funds target rate on both dates was -50bp, both of them were scheduled announcements and they have a similar size for the monetary policy surprise, -8bp vs -10bp, both of which are negative so that we do not need to worry about asymmetric effects of expansionary and contractionary shocks. The other FOMC dates in early 2001 were either unscheduled which would introduce timing shocks and violate exogeneity of monetary policy surprise or had zero or positive surprises.

Our main analysis is a difference in differences approach implemented as the regression

$$return = \beta_0 + \beta_1 AAClient + \beta_2 After + \delta AAClient * After + controls + error$$

where δ is the parameter of interest. $AAClient$ is a dummy variable equal to one if the firm's

⁹The financial restatement announcement on November 8 has not been a big surprise to the market participants. On October 16, 2002, Enron posted huge losses in shareholder's equity as a nonrecurring item related to the termination of "certain structured finance arrangements". On October 22, 2001, Enron announced that the SEC had requested information regarding certain related party transactions. Following October 16, 2001, Enron's stock price fell almost 75 percent from \$33.84 to \$9.05 by November 7, 2001, the day before it announced that it would restate earnings for 1997 through 2001. In the days surrounding the restatement announcement, its stock price fell from \$9.05 to \$8.63, a drop of less than 5 percent suggesting that the market priced in the financial restatement before the announcement. This suggests that the financial restatement announcement on November 8 has not been a big surprise to the market participants which together justifies our use of 6 November 2001 FOMC announcement as the "after" period.

financial statements for year 2000 is audited by Arthur Andersen and zero otherwise. After is a dummy variable that is equal to one for the observations on 6 November 2001 and zero for observations on 15 May 2001.

For our main analysis, we are not using any time series dimension because the probability of accounting scandal assigned by investors has been changing over time in 2001, which is hard to measure.¹⁰ Moreover, before 2001, in year 2000, there are only three FOMC dates where the federal funds target rate has been changed but these were very early in the year and the surprise component was very small. After November 2001, the surprise in December 11, 2001 meeting was zero and the one in January 30, 2002 meeting was only 1 basis point. The rest of 2002 was riddled with accounting scandals involving other auditing firms, starting in January with Homestore.com whose auditing firm is PricewaterhouseCoopers, and in February with Qwest whose auditing firm is KPMG.¹¹ These properties limit our ability to use time series dimension of the data.

Despite these limitations we can still do a robustness check where we use October 2 as a date between May 15 and November 6 because October 2 has a monetary policy surprise of similar size, -7bp. To the extent that the probability of the accounting scandal on October 2 has been between the probabilities on May 15 on November 6, the differential reaction of Arthur Andersen clients on October 2 should be a number between those in May 15 and November 6. This analysis is also included in a separate robustness section.

3.2 Data Description

Monetary Policy Surprise: Following Bernanke and Kuttner’s analysis, we define an event as either an FOMC meeting or an announced change in the funds target rate. Kuttner (2001) and Bernanke and Kuttner (2005) obtain the corresponding surprise change in the

¹⁰The use of time series would require policy surprise, probability of scandal, and their interaction as regressors. Not knowing the probability of scandal requires that we rely on a dummy variable for each event date which makes identification impossible unless either the value of surprise is similar among the event dates chose (which is our approach) or we ignore time fixed effects (which would bias the estimates).

¹¹See <http://www.forbes.com/2002/07/25/accountingtracker.html>.

target rate by first calculating the change in the rate implied by the corresponding futures contract, given by 100 minus the futures contract price, and then scaling this result by a factor associated with the number of days of the month in which the event occurred because the payoff of the contract is determined by the average realized federal funds effective rate during the month. Accordingly, the unexpected target rate change, for an event taking place on day d of month m , is given by

$$\Delta i^u = \frac{D}{D-d}(f_{m,d}^0 - f_{m,d-1}^0),$$

where $f_{m,d}^0 - f_{m,d-1}^0$ is the change in the current-month implied futures rate, and D is the number of days in the month. To suppress the end-of-month noise in the federal funds rate, the unscaled change in the implied futures rate is used as the measure of target rate surprise when the event occurs on the last three days of a month. If the event happens on the first day of a month, $f_{m-1,D}^1$ is used instead of $f_{m,d-1}^0$. The expected federal funds rate change is defined as the difference between the actual change minus the surprise:

$$\Delta i^e = \Delta i - \Delta i^u,$$

where Δi is the actual federal funds rate change. The data for the decomposition of the federal funds target rate changes can be obtained from Kenneth Kuttner's webpage.¹²

Firm-level data: Our dependent variable, the stock returns on particular FOMC announcement dates, comes from the daily CRSP files. The auditor information in year 2000 and balance sheet variables we use to calculate our control variables come from Compustat annual files and the market values used to calculate control variables come from CRSP. We also use minute-level intraday returns from QuantQuote in our robustness checks. We discard penny stocks, stocks with price less than \$5, following the definition in Amihud (2002). We only use firms that have stock return data on both FOMC announcement dates

¹²<http://econ.williams.edu/people/knk1/research>

of interest and therefore implicitly control for firm-specific fixed effects on returns because, in a balanced panel of two dates, difference in difference regression and fixed effects panel regression provide the same coefficient estimates.¹³

Our control variables are the usual suspects from the cross-sectional asset pricing literature that is related with stock returns. Market Leverage is calculated by dividing book value of debt by the sum of book value of debt and market value of common equity. The market value of common equity is price times shares outstanding from CRSP as of December 31, 2000. The book value of debt is total assets minus book equity where book equity is equal to the sum of common equity and deferred taxes as in Fama and French (1992), (Compustat items CEQ and TXDITC, respectively). Book-to-Market is book value of equity divided by market value of equity. Assets is total assets (Compustat Item AT). Profitability is operating income (Compustat Item OIBDP) divided by total assets.¹⁴

Table 1 provides key statistics for the control variables that we employ in our study, both for the full sample and for the subsamples of clients of different Big 5 accounting firms. A clear pattern in this Table is that the key statistics for our control variables are remarkably similar across different subsamples with the exception of Total Assets where the Total Assets of Arthur Andersen clients exhibit a smaller mean and standard deviation than those of other firms. Nevertheless, a closer look to the distribution of total assets in the last two lines reveals that this difference is only due to the upper 5% of the distribution. Moreover, restricting our subsample to firms with total assets less than \$10 billion leads to quantitatively similar regression results. Therefore, we can safely argue that Arthur Andersen firms have similar characteristics to other firms, at least for the key characteristics we are studying, and study the full sample. We also find that all the Big 5 accounting firms are very diversified in terms of their clientele, further supporting this argument.

[TABLE 1 ABOUT HERE]

¹³In a balanced panel of two dates, difference in difference regression and fixed effects panel regression provides the same coefficient estimate.

¹⁴We ignore CAPM beta because its effect on daily returns is negligible.

3.3 Empirical Results

This section presents the results from the regression

$$return = \beta_0 + \beta_1 AAClient + \beta_2 After + \delta AAClient * After + controls + error$$

where δ is the parameter of interest given in the first line. *AAClient* is a dummy variable equal to one if the firm’s financial statements for year 2000 is audited by Arthur Andersen and zero otherwise. *After* is a dummy variable that is equal to one for the observations on 6 November 2001 and zero for observations on 15 May 2001. Because monetary policy surprise were expansionary on both dates, our theory implies that Arthur Andersen clients’ prices should have reacted relatively less positively to the monetary policy shock on November 6. Therefore, we expect $\delta < 0$.

[TABLE 2 ABOUT HERE]

Column 1 of Table 2 presents the results of this regression without any additional control variable. The first line tells us that following the Enron scandal, the sensitivity of stock prices of Arthur Andersen clients to a 10 basis points reduction in the federal funds target rate decreased by about 50 basis points. This is a very big effect: to put this number in perspective, Bernanke and Kuttner (2005) finds that the aggregate U.S. stock market increases by about 40 basis points in response to a 10 basis points surprise decrease in stock prices.

Column 2 presents the results of the same regression after including control variables. Our controls do not seem to affect average returns on these two dates, with the exception of market leverage which has a negative relationship with returns. More importantly, the coefficient of interest *AAClient*After* practically stays the same, albeit with a higher standard error.

The necessary and sufficient identification assumption for columns 1 and 2 is that the auditor choice is independent of the characteristics that might affect how a firm’s stock price sensitivity to monetary policy shocks changes with increasing monitoring costs. However,

it is possible that the perceived auditing quality between clients of Big 5 auditing firms and the remaining firms might have been different in 2000 which is also evident from the academic accounting literature of that time which studies auditing quality by considering Big N auditing firms and other firms as providing different quality services. Therefore, column 3 repeats the regression by focusing on the subsample of Big 5 auditing firms' clients. Because the firms that prepare clean balance sheets and hence have non-missing control variables tend to be clients of the Big 5 accounting firms the number of observations in column 3 is hardly different from the number of observations in column 2 and the coefficient estimates are very close to each other, as expected.

Despite our best efforts, it is still possible that there may be some endogeneity concerns that we might have overlooked. In order to address any remaining concerns, we use the auditor choice from 5 years ago as an instrument in an IV framework, noting that firms usually establish long-term relationships with their auditor and the characteristics that affect their market valuation varies over time and these changes are unlikely to be correlated with their auditor choice long time ago. Using lagged dependent variables is quite common in the macroeconomics and finance though researchers generally use one year lags. By using a long lag, we try to be as conservative as possible. Column 4 shows that the resulting coefficient for AAClient*After has the same sign and slightly larger magnitude though the Hausman t-statistic is 1.23 suggesting that the difference is statistically not significant.

As discussed in popular textbooks like Angrist and Pischke (2008), the Achilles heel of the difference in differences approach is the non-parallel time trend across firms. We control for this possibility by separating stocks into portfolios by their auditing firms and running a regression of different portfolio returns on a linear trend. In unreported regressions results, we find that the p-value for the hypothesis of equal time trends is 0.3 which suggests that a monotonic time trend is not a primary concern.

Nevertheless, we note that a linear time trend might not be the perfect way to approach this issue. To be more precise, the time trend issue is actually an omitted variable problem.

The concern is that there might be an exogenous force that move the stock returns of Arthur Andersen clients and other firms in different directions on 15 May and 6 November, especially if there has been other Enron related news on those dates. For example, Enron stock price decreased by 3% on 15 May and 13% on 6 November: if one assumes that the larger price decrease of Enron can be attributed to unidentified negative news related to accounting scandal then the lower returns of Arthur Andersen clients (relative to other firms) on 6 November can be attributed to the direct effect of the accounting scandal rather than a reduced reaction to the monetary policy shock.

In order to address this concern, we look at the subsample of most liquid firms, i.e. those that are a member of S&P 500 index and focus on the event window from 2pm (15 minutes before the FOMC announcement) and 4pm (market close) to ensure that most of the stock return movement is attributable to the monetary policy announcement.¹⁵ This choice also stacks the odds against us because the stock price of Enron was flat in this event window on 6 November (9.69 versus 9.67) whereas on 15 May it went down by about 1 percent from 57.45 to 56.99. Therefore, if there were any Enron related news that would depress stock prices of Arthur Andersen clients in this window it is more likely to happen on 15 May rather than 6 November which stacks the odds against our identification method. Column 5 of Table 1 shows that the coefficient changes very little and is still statistically significant when we focus on intraday returns.

3.4 Additional Robustness Checks

So far, we are not using any time series dimension because the probability of accounting scandal assigned by investors has been changing over time in 2001, which is hard to measure and moreover the dummy δ . However, although we cannot observe how the probability of accounting scandal has evolved over time we still can do a robustness check where we

¹⁵This narrow window choice should also address any remaining concerns regarding whether the difference between 6 November and 15 May is due to time varying risk premium because the effect of the risk premium on returns in intraday window is even lower than that in daily window which itself is already negligible.

use October 2 as a date between May 15 and November 6 because this date has a federal funds target rate change and a monetary policy surprise of similar size, -50bp and -7bp respectively. To the extent that the probability of the accounting scandal on October 2 has been between the probabilities on May 15 on November 6, the differential policy reaction of Arthur Andersen clients on October 2 should be a number between those in May 15 and November 6.

Therefore, we extend the regressions in the previous section as

$$return = \beta_0 + \beta_1 AAClient + \beta_2 October + \beta_3 Nov + \delta_1 AAClient * Oct + \delta_2 AAClient * Nov + controls + error$$

where we are interested in δ_1 and δ_2 , the effect of increasing probability of Enron scandal on the differential reaction of Arthur Andersen clients in comparison to other firms on October 2 and November 6 versus 15 May. By the same argument in the previous section, we expect $\delta_1 < \delta_2 < 0$.

[TABLE 3 ABOUT HERE]

Table 3 summarizes the results. Not surprisingly the coefficient of $AAClient * Nov$ is similar in sign and magnitude to our findings in the previous section. Moreover, the coefficient of $AAClient * Oct$ is negative but smaller in magnitude as expected from the conjecture that the probability of Enron scandal has been gradually increasing. However, the coefficient estimate has a very large standard deviation making it statistically insignificant, likely reflecting the fact that the uncertainty on the Enron's accounting practice did not get fully resolved until Enron filed a huge loss in its 2001Q2 financial statement on October 16 and SEC put the final nail on ENRON's coffin on October 22 which eventually led to Enron's restatement of financial document from 1997 to the second quarter of 2001.

4 Conclusion

In this paper, we have studied the relationship between financial frictions and the reaction of stock prices to monetary policy shocks. Following Bernanke, Gertler, and Gilchrist framework we theoretically show that financially more constrained firms' stock prices should react less to monetary policy. We also present strong empirical evidence based on the differential effect of the Enron/Arthur Andersen scandal on the Arthur Andersen clients' sensitivity to monetary policy after the scandal.

An important message of the paper is that any empirical analysis of financial frictions, monetary policy, and stock prices should be based on strong theoretical foundations and a clear definition of the financial friction. In the context of Bernanke, Gertler, and Gilchrist (1999) the financial friction was based on the costly state verification theory of Townsend (1979). This is certainly not the only source of financial friction, neither in the real world nor in our theoretical worlds. While we choose the BGG framework due to its popularity and clean definition of the constraint; it would be also interesting to analyze and test the implications of other types of financial constraints on the relationship between stock prices and monetary policy. We leave the continuation of this ambitious research agenda to future work.

5 References

Amihud, Y. (2002). "Illiquidity and stock returns: cross-section and time-series effects", *Journal of Financial Markets* 5, pp. 31-56

Ammer, Vega, and Wongsman, 2010, International Transmission of U.S. Monetary Policy Shocks: Evidence from Stock Prices, *JMCB*

Bernanke, B. S., M. Gertler, and S. Gilchrist. 1996. "The Financial Accelerator and the Flight to Quality." *Review of Economics and Statistics* 78(1): 1–15.

Bernanke, B. S., M. Gertler, and S. Gilchrist. 1999. "The Financial Accelerator in a Quantitative Business Cycle Framework." In *Handbook of Macroeconomics*, ed. J. B. Taylor and M. Woodford. Vol. 1C, 1341–1393. Amsterdam: North-Holland.

Bernanke, Ben S., and Kenneth N. Kuttner, 2005, What explains the stock market's reaction to Federal Reserve policy?, *Journal of Finance* 60 (3), 1221-1257.

Bjørnland, Hilde C., and Kai Leitemo, 2009, Identifying the interdependence between US monetary policy and the stock market, *Journal of Monetary Economics* 56, 275-282.

Bomfim, A.N., 2003. Pre-announcement effects, news effects, and volatility: monetary policy and the stock market. *Journal of Banking and Finance* 27 (1), 133-151.

Cochrane, J.H., Piazzesi, M., 2002. The fed and interest rates: a high-frequency identification. *American Economic Review Papers and Proceedings* 92, 90-95.

Ehrmann and Fratscher, 2003, Taking Stock: Monetary Policy Transmission to Equity Markets, *JMCB*

Jere R. Francis, Edward L. Maydew, and H. Charles Sparks (1999) The Role of Big 6 Auditors in the Credible Reporting of Accruals. *AUDITING: A Journal of Practice & Theory*: September 1999, Vol. 18, No. 2, pp. 17-34.

Evans, C., 1998. Real-time Taylor rules and the federal funds futures market. *Federal Reserve Bank of Chicago, Economic Perspectives* 2, 44-55.

Fuhrer, Jeff, and Geoffrey Tootell, 2003, Eyes on the prize: How did the Fed respond to the stock market?, *Journal of Monetary Economics* 55,796-805.

Gertler, M., and S. Gilchrist. 1994. Monetary Policy, Business Cycles and the Behavior of Small Manufacturing Firms. *Quarterly Journal of Economics* 109(2): 309-340.

Geske, R., Roll, R., 1983. The fiscal and monetary linkage between stock returns and inflation.

Journal of Finance 38-33.

Gürkaynak, Refet S., Brian Sack, and Eric T. Swanson, 2005, Do actions speak louder than words? The response of asset prices to monetary policy actions and statements, *International Journal of Central Banking* 1(1), 55-93.

Gürkaynak, Refet S., Brian Sack, and Eric T. Swanson, 2007. Market-based measures of monetary policy expectations. *Journal of Business and Economic Statistics* 25 (2), 201-212.

Kashyap, A. K., O. A. Lamont, and J. C. Stein. 1994. Credit Conditions and the Cyclical Behavior of Inventories, *Quarterly Journal of Economics* 109(3): 565-592.

Kuttner, Kenneth N., 2001, Monetary policy surprises and interest rates: Evidence from the Fed funds futures market, *Journal of Monetary Economics* 47 (3), 523-544.

Lamont, Owen, Christopher Polk, and Jesus Sa ´a-Requejo, 2001, Financial constraints and stock returns, *Review of Financial Studies* 14, 529-554.

Laeven and Tong, 2012, U.S. Monetary Shocks and Global Stock Prices, *Journal of Financial Intermediation*.

Oliner, S. D., and G. D. Rudebusch. 1996. “Is There a Broad Credit Channel for Monetary Policy?” *Federal Reserve Bank of San Francisco Economic Review*, Winter, 3–13.

Patelis, A.D., 1997. Stock return predictability and the role of monetary policy. *The Journal of Finance* 52, 1951-1972.

Perez-Quiros, Gabriel, and Allan Timmermann, 2000, Firm Size and Cyclical Variations in Stock Returns, *Journal of Finance*.

Rigobon, Roberto, and Brian Sack, 2004, The impact of monetary policy on asset prices, *Journal of Monetary Economics* 51, 1553–1575.

Townsend, R.M., 1979. Optimal contracts and competitive markets with costly state verification. *Journal of Economic Theory* 21(2), 265–293.

6 Appendix: Proof of Proposition 2

Using constraint (2), we can write

$$R\left(\frac{k-1}{k}\right) = \Gamma(\bar{w}) - \mu G(\bar{w})$$

where

$$\Gamma(\bar{w}) - \mu G(\bar{w}) = \bar{w} + \int_0^{\bar{w}} ((1-\mu)w - \bar{w}) dF(\bar{w})$$

It is clear that for a given value of $\bar{w}$, k is decreasing in μ . Moreover, Bernanke, Gertler, Gilchrist (1999) shows that

$$\begin{aligned} \Gamma'(\bar{w}) - \mu G'(\bar{w}) &= 1 - F(\bar{w}) - \mu \bar{w} f(\bar{w}) \\ &= [1 - F(\bar{w})][1 - \mu \bar{w} h(\bar{w})] > 0 \end{aligned}$$

in equilibrium if $\bar{w}h(\bar{w})$ is increasing in $\bar{w}$. To summarize their argument, because $\bar{w}h(\bar{w})$ is increasing in $\bar{w}$ there exists a $\bar{w}^*$ so that $\Gamma'(\bar{w}) - \mu G'(\bar{w}) \leq 0$ if $\bar{w} \geq \bar{w}^*$, where $\bar{w}^*$ satisfies $1 - \mu \bar{w}^* h(\bar{w}^*) = 0$. Appendix A.1 of Bernanke, Gertler, Gilchrist (1999) shows that $\bar{w} > \bar{w}^*$ cannot be an equilibrium. In particular, if the lender gives the firm $K - N$, its expected payoff from this lending, $E(\mathbb{I}_{wK \geq B}B + \mathbb{I}_{wK < B}(1-\mu)wK) = [\Gamma(\bar{w}) - \mu G(\bar{w})]K$, will decrease in the face value of debt, $B = \bar{w}N$, for $\bar{w} > \bar{w}^*$ because $\Gamma''(\bar{w}) - \mu G''(\bar{w}) < 0$. Therefore, both the firm and the lender would benefit from a lower $\bar{w}$ when $\bar{w} > \bar{w}^*$ and hence the equilibrium value of $\bar{w}$ cannot be in this region.

Therefore, we only need to establish that $d\bar{w}/d\mu < 0$. By substituting the incentive compatibility constraint (2) of the lender into the objective function of the firm (1), we

obtain

$$v = \max_{\bar{w}} \frac{R \int_{\bar{w}}^{\infty} (w - \bar{w}) dF(w)}{R - \left[\bar{w} + \int_0^{\bar{w}} ((1 - \mu) w - \bar{w}) dF(\bar{w}) \right]} = \frac{RP(\bar{w})}{R - [\Gamma(\bar{w}) - \mu G(\bar{w})]}.$$

which has the first order condition

$$\Omega(\bar{w}, \mu) = P'(\bar{w})(R - [\Gamma(\bar{w}) - \mu G(\bar{w})]) + P(\bar{w})[\Gamma'(\bar{w}) - \mu G'(\bar{w})] = 0$$

which should satisfy $\partial \Omega(\bar{w}, \mu) / \partial \bar{w} < 0$ at the equilibrium value of $\bar{w}$ because the second order condition, $d^2 v / d\bar{w}^2 < 0$, dictates that $\Omega(\bar{w} + \varepsilon, \mu) > 0$ and $\Omega(\bar{w} - \varepsilon, \mu) < 0$ for any positive value of ε at the equilibrium value of $\bar{w}$.

Full differentiation of both sides yields

$$\frac{\partial \Omega(\bar{w}, \mu)}{\partial \bar{w}} \frac{d\bar{w}}{d\mu} = P(\bar{w}) G'(\bar{w}) - P'(\bar{w}) G(\bar{w}).$$

It is straight forward to show that the right side is positive which, combined with $\partial \Omega(\bar{w}, \mu) / \partial \bar{w} < 0$, gives $d\bar{w} / d\mu < 0$.

Table 1. Descriptive Statistics

ALL FIRMS						ARTHUR ANDERSEN CLIENTS					
<u>Variable</u>	<u># Obs</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Min</u>	<u>Max</u>	<u>Variable</u>	<u># Obs</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Min</u>	<u>Max</u>
Return %	4424	0.86	3.16	-35.42	46.00	Return %	804	0.84	3.03	-15.71	26.07
Market Lev	3892	0.32	0.25	0.00	0.98	Market Lev	714	0.36	0.25	0.00	0.96
Book-to-Market	3892	0.59	0.66	-15.26	5.91	Book-to-Market	714	0.65	0.61	-0.19	5.91
Total Assets(\$MM)	4424	6566	36396	3	902210	Total Assets(\$MM)	804	3656	11380	8	171532
Profitability	4194	0.13	0.26	-1.58	6.28	Profitability	760	0.13	0.15	-0.87	0.69
ERNST & YOUNG CLIENTS						DELOITTE & TOUCHE CLIENTS					
<u>Variable</u>	<u># Obs</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Min</u>	<u>Max</u>	<u>Variable</u>	<u># Obs</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Min</u>	<u>Max</u>
Return %	960	0.96	3.25	-15.47	24.69	Return %	672	0.64	3.58	-35.42	46.00
Market Lev	860	0.30	0.26	0.00	0.98	Market Lev	600	0.35	0.26	0.00	0.95
Book-to-Market	860	0.55	0.48	-0.23	3.04	Book-to-Market	600	0.63	0.55	-0.26	3.46
Total Assets (\$MM)	960	8004	46675	5	671246	Total Assets (\$MM)	672	7168	31188	6	303100
Profitability	904	0.09	0.20	-1.58	0.56	Profitability	656	0.16	0.37	-0.40	6.27
KPMG CLIENTS						PRICEWATERHOUSECOOPERS CLIENTS					
<u>Variable</u>	<u># Obs</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Min</u>	<u>Max</u>	<u>Variable</u>	<u># Obs</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Min</u>	<u>Max</u>
Return %	692	0.92	2.80	-12.39	16.53	Return %	1070	0.94	2.97	-19.92	24.34
Market Lev	614	0.32	0.25	0.00	0.97	Market Lev	910	0.31	0.25	0.00	0.96
Book-to-Market	614	0.58	0.56	-0.51	3.93	Book-to-Market	910	0.55	0.94	-15.26	5.10
Total Assets (\$MM)	692	8540	56870	3	902210	Total Assets (\$MM)	1070	6776	26357	5	306577
Profitability	654	0.12	0.25	-1.15	3.02	Profitability	1002	0.15	0.31	-0.54	6.28
TOTAL ASSETS										# Obs	
	1%	5%	10%	25%	50%	75%	90%	95%	99%		
AA Clients	17	51	79	204	589	2630	9140	16415	42109		804
Other Firms	16	45	78	190	618	2362	9947	22686	149000		3620

Table 2. The Effect of ENRON Scandal on Stock Price Sensitivity to Monetary Policy
Arthur Andersen (AA) Clients vs Other Firms
15 May 2001 vs 6 November 2001

VARIABLES	(1) No Controls	(2) With Controls	(3) BIG 5	(4) IV	(5) S&P 500 Intraday
AAClient*After	-0.508** (0.239)	-0.491* (0.266)	-0.584** (0.267)	-0.746** (0.337)	-0.544** (0.220)
AAClient	0.227 (0.167)	0.188 (0.191)	0.211 (0.190)	0.309 (0.260)	0.182 (0.133)
After	0.441*** (0.106)	0.444*** (0.119)	0.538*** (0.121)	0.412*** (0.128)	2.000*** (0.112)
Market Lev.		-0.701*** (0.247)	-0.811*** (0.245)	-0.480* (0.273)	-1.217*** (0.353)
Book-to-Market		0.070 (0.087)	0.118 (0.083)	0.023 (0.096)	0.147 (0.129)
Asset		0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)
Profitability		-0.167 (0.161)	-0.185 (0.158)	-0.136 (0.135)	-0.987 (0.685)
Observations	4,424	3,692	3,506	2,528	662
R-squared	0.004	0.006	0.009	0.006	0.380

Heteroskedasticity-robust standard errors are in parentheses. We have also calculated standard errors clustered at the auditor level and block-bootstrapped standard errors which were smaller than heteroskedasticity-robust errors; hence we report heteroskedasticity-robust errors throughout. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. After=1 refers to 15 May 2001 and After=0 refers to 6 November 2001. The dependent variable is the daily stock returns on 15 May 2001 and 6 November 2001 from CRSP. All balance sheet variables used for calculating control variables is from Compustat. Market Leverage is calculated by dividing book value of debt by the sum of book value of debt and market value of common equity. The market value of common equity is price times shares outstanding from CRSP as of December 31, 2000. The book value of debt is total assets minus book equity where book equity is equal to the sum of common equity and deferred taxes as in Fama and French (1992), (Compustat items CEQ and TXDITC, respectively). Book-to-Market is book value of equity divided by market value of equity. Assets is total assets (Compustat Item AT). Profitability is operating income (Compustat Item OIBDP) divided by total assets. Column BIG 5 refers to the subsample of Big 5 auditing firms' clients listed in Table 1. Column IV is the instrumental variable regression with the auditor choice of 1995 as the instrument. Column S&P intraday uses the returns of S&P 500 firms from 2pm to 4pm.

Table 3. The Effect of ENRON Scandal on Stock Price Sensitivity to Monetary Policy
 Arthur Andersen (AA) Clients vs Other Firms
 15 May 2001 vs 2 October 2001 vs 6 November 2001

	(1) No Controls	(2) With Controls	(3) BIG 5	(4) IV
VARIABLES				
AAClient*Oct	-0.248 (0.268)	-0.134 (0.303)	-0.169 (0.304)	-0.181 (0.369)
AAClient*Nov	-0.522** (0.231)	-0.490* (0.259)	-0.570** (0.259)	-0.696** (0.327)
AAClient	0.189 (0.169)	0.172 (0.193)	0.194 (0.192)	0.255 (0.261)
Oct	0.504*** (0.123)	0.607*** (0.140)	0.642*** (0.143)	0.578*** (0.155)
Nov	0.301*** (0.100)	0.293*** (0.112)	0.373*** (0.113)	0.325*** (0.123)
Market Leverage		-0.433* (0.252)	-0.538** (0.254)	-0.099 (0.287)
Book-to-Market		-0.229** (0.116)	-0.159 (0.118)	-0.351*** (0.127)
Asset		-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)
Profitability		-0.455*** (0.171)	-0.438*** (0.167)	-0.351** (0.160)
Observations	6,312	5,271	5,013	3,642
R-squared	0.004	0.010	0.010	0.012

Details for control variables and column descriptions are given in the footnote of Table 2. *Oct* is a dummy variable for observations on 2 October 2001; *Nov* is a dummy variable for observations on 6 November 2001. The dependent variable is the daily stock returns on 15 May 2001 and 6 November 2001 from CRSP.