Federal Reserve Private Information and the Stock Market*

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Abstract

We study the response of stock prices to monetary policy, distinguishing effects of exogenous shocks from "Delphic" shocks that reveal the Federal Reserve's macroeconomic forecasts. To decompose monetary policy surprises into these separate components we construct a measure of Federal Reserve private information that exploits differences in central bank and market forecasts. Contractionary policy shocks of either type lower stock prices with exogenous shocks having a larger negative effect. There is some suggestive evidence of an asymmetry; when FOMC meetings are unscheduled or when the fed funds rate reverses direction, stock prices rise in response to a contractionary Delphic shock.

Keywords: Monetary Policy Shocks, Stock Prices, Federal Reserve Private Information

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1 Introduction

Uncovering the nature of the monetary policy transmission mechanism continues to be an important issue for market participants, policymakers and academics. The large body of literature on this topic has identified a variety of channels through which monetary policy can affect the economy. However recent research has emphasized a new so-called "Fed Information" channel whereby a signal from the central bank that reveals information about economic fundamentals can affect agents' expectations and thus the economy (see for example Campbell, Fisher, Justiniano, and Melosi (2016) and Nakamura and Steinsson (2018)). In this paper we aim to shed light on this Fed information effect through the lens of the stock market. Specifically, we study how the stock market responds to monetary policy by explicitly separating exogenous shocks from shocks that reveal information about economic activity (labeled "Delphic" shocks following Campbell, Evans, Fisher, and Justiniano (2012)). We focus on the stock market reaction as it is an important component of the overall monetary policy transmission mechanism which can drive economic activity by affecting wealth, cost of capital and overall expectations.

We build on the framework of Bernanke and Kuttner (2005) (BK henceforth) and use an identification strategy based on high-frequency futures market data. Since stock prices should not react to policy changes that are already anticipated, changes in short rate futures prices that occur in a narrow window around the Federal Open Market Committee (FOMC) announcements are used to construct a measure of monetary policy surprise. Given the growing importance of Federal Reserve communication,[1] we extend the federal funds target rate based monetary policy surprise used by BK to also include any communication about unexpected future changes in monetary policy.

Our estimation methodology proceeds in two steps. First, we decompose the futures based monetary policy surprise measure into an exogenous component and a Delphic component. In carrying out this decomposition we take the view that Federal Reserve signals about economic

[1]For early work on the importance of Federal Reserve communication see Gürkaynak, Sack, and Swanson (2005). For a more recent study see Feroli, Greenlaw, Hooper, Mishkin, and Sufi (2017).

activity should surprise the futures market only if they reveal any private information that the Federal Reserve possesses. This private information could arise either due to asymmetric information underlying the forecasts or due to a difference in forecasting models. It is important to point out that our framework does not require that the Federal Reserve always has superior information relative to the market (*à* la Romer and Romer (2000)) and that information can also flow from the market to the Federal Reserve.

To capture this private information we construct a measure that combines market survey data with the Federal Reserve's internal forecasts. Specifically, our measure is defined as the difference between the Greenbook forecasts produced by the Federal Reserve Board's staff and the consensus forecast from the market based Blue Chip survey. The first step involves running a regression of monetary policy surprise on our measure of private information. The regression results suggest that monetary policy surprises are "predictable" using the private information variable. Moreover, the estimates imply that when the Greenbook forecast is more optimistic relative to the market's forecast, it is related to a positive monetary policy surprise (i.e. a contractionary surprise). Note that this regression can only be run ex-post and not in real-time as the Greenbook forecasts are publicly released with a five year lag. But the relationship between the monetary policy surprise and Federal Reserve private information suggests that a portion of the futures market reaction is attributable to differences in forecasts.[2]

The second step in our estimation involves studying the stock market response to the fitted value (i.e. Delphic component) and the residual (clean measure of an exogenous monetary policy shock) of the first step regression. We lay out a simple conceptual framework to understand how exogenous and Delphic shocks can affect stock prices differently. Under some simple conditions, the stock response to a contractionary exogenous shock is expected to be negative, while the response to a Delphic shock is ambiguous. Intuitively, a contractionary Delphic shock can lower stock prices through a rise in the discount rate, but it can also raise stock prices by providing

[2] We would like to point out that our measure of private information may not perfectly capture the true underlying information differences. Unfortunately, data at a higher frequency is not available and we believe our measure using the Greenbook and Blue Chip forecasts is the best proxy based on existing data.

good news about future dividends.

Our baseline results using data from 1991 to 2011 find a stock response to the exogenous monetary policy shock that is similar to BK.[3] A hypothetical surprise increase of 100 basis points in the expected path of the fed funds rate over the next 4 quarters results in about a 5.7% fall in the S&P 500 index. On the other hand, a contractionary Delphic shock of the same size reduces stock prices by about 2.1%. Moreover, the difference in the stock price response to exogenous and Delphic shocks is also statistically significant, suggesting that the stock market is indeed reacting differently to these two kinds of monetary policy shocks. Our results imply that for the Delphic shock, on average, the discount rate induced response of stock prices dominates the dividend news induced component. But we also find some suggestive evidence for an asymmetry on certain FOMC meetings. These episodes occur when FOMC policy actions were enacted at unscheduled dates (also called inter-meeting moves) or when there is a reversal in the direction of the change in the fed funds rate target (also called turning points). On these particular FOMC meetings, the stock market falls more in response to a contractionary exogenous monetary policy shock but rises in response to a contractionary Delphic shock.[4] We also investigate the role of these two shocks on stock market volatility. Using the decomposition of Bekaert, Hoerova, and Lo Duca (2013) we find that exogenous shocks have a bigger impact on risk aversion while Delphic shocks mainly affect uncertainty.

To complement our high-frequency analysis and to understand the economic reasons behind the observed stock price response, we perform a decomposition of stock prices using the framework of Campbell and Ammer (1993). This methodology uses a monthly vector autoregression to break down current excess stock returns into revisions of the expectation of discounted future dividends, the real interest rate, and future excess returns. We find some suggestive evidence that on average the response of excess returns to exogenous shocks is mostly due to changes in expected future excess returns and dividends, while the excess return response to a Delphic

[3]The end date of the sample is restricted by the most recently available Greenbook data.

[4]A caveat to the asymmetry results is that they are identified from a small number of observations due to the historical infrequency of the unscheduled and turning point meetings.

shock is primarily attributed to changes in expected dividends. These vector autoregression results confirm the asymmetric effects of monetary policy actions on unscheduled and turning point FOMC meetings.

This paper is related to a few different strands of the literature. First, there is a long line of work that builds on the high frequency approach of BK to study the effect of monetary policy on stock prices. Gürkaynak, Sack, and Swanson (2005) and more recently Kurov (2012) expands on this work by separately estimating the stock response to surprises to the federal funds rate and surprises in forward guidance. While our analysis focuses exclusively on a narrow window around FOMC meetings, there is intriguing new evidence that discusses other occasions on which the Federal Reserve communicates to the public (for example in speeches made by FOMC members). These are explored in more detail by Cieslak, Morse, and Vissing-Jorgensen (2016), Lucca and Moench (2015) and Neuhierl and Weber (2017). However, all these papers use the composite monetary policy surprise measure, while the focus of our paper is to separate the effect of Delphic shocks from exogenous monetary policy shocks.

This paper is also related to the growing literature on how central bank signals about fundamentals can affect economic activity. Campbell, Fisher, Justiniano, and Melosi (2016) and Nakamura and Steinsson (2018) empirically highlight the role of Delphic signals and their effect on survey expectations. Cieslak and Schrimpf (2018) and Andrade and Ferroni (2018) use high-frequency stock and bond prices to study these information effects. Melosi (2017) and Tang (2015) provide evidence of this channel using a dynamic stochastic general equilibrium model while Lakdawala (2017), Miranda-Agrippino and Ricco (2018) and Jarocinski and Karadi (2018) use a structural vector autoregression framework. The stock market response results in this paper are consistent with this literature.

2 Stock Prices and Monetary Policy

To identify the effect of monetary policy on stock prices, one cannot directly regress stock prices on the central bank's policy instrument (for example the short-term interest rate). The endogenous reaction of both stock prices and the central bank's policy instrument to common economic conditions leads to the classic simultaneous equation bias. Thus the literature has tried to isolate exogenous variation in the policy instrument to overcome this problem. Following the work of BK, an important strategy involves high-frequency identification using federal funds futures contracts. In this section we first outline a simple framework to understand futures based identification, with a special emphasis on why central bank private information can matter. This treatment is closely related to the framework laid out in Miranda-Agrippino (2016). Next we extend the framework and discuss how stock prices may respond differently to an interest rate change by the central bank depending on if the change reflects an exogenous monetary policy shock or if it reflects a signal about the central bank's private information.

2.1 Monetary Policy Surprise from Futures Data

Let $p_t^{(h)}$ be the price of a futures contract at time t that matures in $t+h$. The underlying asset for this futures contract is the federal funds rate.[5] Thus we can write

$$p_t^{(h)} = i_{t+h|t} + \zeta_t^{(h)} \tag{2.1}$$

where $i_{t+h|t} = E_t i_{t+h}$ is the expected fed funds rate at $t+h$ and $\zeta_t^{(h)}$ is the risk-premium. There is an ongoing debate in the literature about the relevance of risk-premia in fed funds futures markets, but they are not crucial to our analysis and we will set them to zero in the illustrative model.[6]

The next step is to consider a general monetary policy rule where the central bank changes the short-term interest rate i_t in response to current, lagged and forecasts of certain indicators of economic activity.

$$i_t = g^{CB}\left(\widehat{\Omega}_{t|t}^{CB}\right) + e_t \tag{2.2}$$

[5] Note that technically the fed funds futures contract trades as 100 - the average effective fed funds rate, but we are omitting the "100 -" component for simplicity.

[6] Piazzesi and Swanson (2008) find that fed funds futures risk-premia are slow-moving and do not change much around FOMC announcements. On the other hand, Miranda-Agrippino (2016) finds a bigger role for risk-premia.

where e_t represents a monetary policy shock and $g^{CB}(.)$ is the central bank's reaction function. $\widehat{\Omega}^{CB}_{t|t}$ contains the central bank information set available at time t, including any current information that is used to form forecasts. The hat denotes the fact that the central bank estimates the values of the relevant variables based on their information set.[7]

An important convention in the monetary policy literature is that e_t is assumed to be an exogenous shock, i.e. it is unrelated to economic activity. Thus if we can estimate e_t, then we can regress stock prices on e_t to identify the effects of monetary policy. One strategy for identification is to study changes in fed funds futures data around FOMC announcements, following BK.

Consider the futures contract maturing at the end of the current month (i.e. $h = 0$). Specifically, consider the futures prices of this contract measured just before the FOMC announcement

$$p^{(0)}_{t-\varepsilon} = i_{t|t-\varepsilon} = g\left(\widehat{\Omega}^{M}_{t|t}\right) \tag{2.3}$$

The M superscript denotes the fact that the futures price will reflect expectations based on the market's information set, $\widehat{\Omega}^{M}_{t|t}$. We are making the assumption that the market has full knowledge of the central bank's reaction function, i.e. $g^{CB}(.) = g^{M}(.) = g(.)$. Below, we provide an alternate derivation of our estimating equation where we relax this assumption.

The key assumption in the futures based identification is that no other macro news announcements are released in the window between $t - \varepsilon$ and t. Thus we have that $\widehat{\Omega}_{t|t-\varepsilon} = \widehat{\Omega}_{t|t}$. Now consider the futures price after the FOMC announcement.

$$p^{(0)}_{t} = i_{t|t} = g\left(\widehat{\Omega}^{CB}_{t|t}\right) + e_t \tag{2.4}$$

Note that the information set that is relevant to the short rate set by the central bank is its own

[7] In general $\Omega^{j}_{k|t}$ denotes the period k estimates of the fundamentals in the monetary policy reaction function based on the information available to j in period t.

information set. The monetary policy surprise is measured as the change in the futures contract

$$
\begin{aligned}
mps_t &= p_t^{(0)} - p_{t-\varepsilon}^{(0)} \\
&= g\left(\widehat{\Omega}_{t|t}^{CB}\right) - g\left(\widehat{\Omega}_{t|t}^{M}\right) + e_t \\
&= g\left(\widehat{\Omega}_{t|t}^{CB} - \widehat{\Omega}_{t|t}^{M}\right) + e_t \qquad (2.5)
\end{aligned}
$$

where the last equality holds if we assume a linear reaction function $g(.)$ for the central bank. There is an alternative way to derive equation 2.5 without resorting to the assumption that the market has full knowledge of the central bank's reaction function. In this case we will assume $g^{CB}(.)$ to represent the central bank's actual monetary policy stance given its estimates of the relevant fundamentals, rather than just the reaction function component of its rule, i.e. $p_t^{(0)} = i_{t|t} = g^{CB}\left(\widehat{\Omega}_{t|t}^{CB}\right)$. The price of the futures contract just before the FOMC announcement is given by $p_{t-\varepsilon}^{(0)} = i_{t|t-\varepsilon} = g^{M}\left(\widehat{\Omega}_{t|t}^{M}\right)$ where $g^M(.)$ is not assumed to be the same as $g^{CB}(.)$. Then if $g^{CB}(.)$ and $g^M(.)$ are linear we can write the monetary policy surprise as

$$
\begin{aligned}
mps_t &= p_t^{(0)} - p_{t-\varepsilon}^{(0)} = g^{CB}\left(\widehat{\Omega}_{t|t}^{CB}\right) - g^{M}\left(\widehat{\Omega}_{t|t}^{M}\right) \\
&= g^{CB}\left(\widehat{\Omega}_{t|t}^{CB}\right) - g^{M}\left(\widehat{\Omega}_{t|t}^{M}\right) - g^{CB}\left(\widehat{\Omega}_{t|t}^{M}\right) + g^{CB}\left(\widehat{\Omega}_{t|t}^{M}\right) \\
&= g^{CB}\left(\widehat{\Omega}_{t|t}^{CB} - \widehat{\Omega}_{t|t}^{M}\right) + g^{CB}\left(\widehat{\Omega}_{t|t}^{M}\right) - g^{M}\left(\widehat{\Omega}_{t|t}^{M}\right) \\
&= g^{CB}\left(\widehat{\Omega}_{t|t}^{CB} - \widehat{\Omega}_{t|t}^{M}\right) + e_t \qquad (2.6)
\end{aligned}
$$

In this case the exogenous monetary policy shock $e_t \equiv g^{CB}\left(\widehat{\Omega}_{t|t}^{M}\right) - g^{M}\left(\widehat{\Omega}_{t|t}^{M}\right)$ has a specific interpretation and represents the central bank and the market translating the same fundamentals into different monetary policy stances. On the other hand, the exogenous monetary policy shock from 2.5 represented a broader and more conventional measure of an exogenous monetary policy shock. Regardless of the approach taken to derive equation 2.5 (or 2.6), it is clear that in the special case that the information set of the central bank and the market coincide, the monetary policy surprise recovers the exogenous monetary policy shock. However the assumption of no asymmetric information may not be tenable. As mentioned in the introduction there is a growing body of literature suggesting a role for central bank signals about macro fundamentals.

While the derivation presented above used the futures contract expiring in the current month, we can show more generally that the analysis used to derive equation 2.5 (or 2.6) also applies to futures contracts that expire not in the current month, but in the future. In the first step of the estimation procedure we separate the monetary policy surprises into i) exogenous component and ii) private information component. Equation 2.5 suggests that a simple linear regression will suffice as long as we can construct a variable that measures the difference in the information set of the central bank relative to the market. Essentially we need a private information variable that captures $\widehat{\Omega}_{t|t}^{CB} - \widehat{\Omega}_{t|t}^{M}$. In Section 3.2 below we discuss in detail how we create this variable using forecast data. With this variable in hand, we run the following regression.

$$mps_t = c + \gamma \left(\widehat{\Omega}_{t|t}^{CB} - \widehat{\Omega}_{t|t}^{M} \right) + e_t \tag{2.7}$$

Using this equation we construct the residual $\widehat{e}_t$ and the fitted value $\widehat{\gamma} \left(\widehat{\Omega}_{t|t}^{CB} - \widehat{\Omega}_{t|t}^{M} \right)$. In the next step of the estimation procedure we regress the change in the stock price on the residual and fitted value.

$$\Delta S_t = \alpha + \beta_1 \widehat{e}_t + \beta_2 \widehat{\gamma} \left(\widehat{\Omega}_{t|t}^{CB} - \widehat{\Omega}_{t|t}^{M} \right) + u_t \tag{2.8}$$

where S_t is the stock price and Δ represents the change in a narrow window around the FOMC announcement.

In a related paper Jarocinski and Karadi (2018) also decompose a monetary policy surprise into an exogenous and Delphic (or information) shock. Empirically, they use the response of the stock market to monetary policy announcements to isolate the two components. The monetary policy shock dominates when the co-movement between the policy surprise and stock response is negative, whereas the Delphic shock dominates when the co-movement is positive. While this is an appealing and complementary approach, it cannot be used when the stock market response is itself the outcome of interest. Instead, we disentangle monetary policy shocks from Delphic shocks by directly proxying for the Fed's private information set.[8]

What should we expect for the sign of the two coefficients β_1 and β_2 in our framework? Next, we layout a simple conceptual framework that can help us understand the related issues.

2.2 Stock Price Response to Exogenous and Delphic Shocks

This section provides some context for understanding our empirical analysis. The discussion draws on basic insights from rational asset pricing models and standard New Keynesian models. Based on these frameworks we first argue that the sign of the stock response to exogenous monetary shocks is quite likely to be negative. On the other hand, the response to Delphic shocks is ambiguous because there are distinct and potentially opposing effects. Intuitively, a contractionary Delphic shock can work through discount rates to lower stock prices but it may also provide a signal that could lead the market to revise upwards their expectations of economic activity (and thus revise upwards expectations of future cash flows) leading to higher stock prices.

Next we flesh this out in a little more detail. Consider the stock price S_t that depends on the discount rate r_t (composed of a risk-free rate and an equity premium) and expected future cash flows X_t. Both r_t and X_t in turn depend on (among other things) the exogenous monetary policy shock (e_t) and the interest rate surprise related to revelation of private information by the central bank ($\widehat{\gamma} g(\widehat{\Omega}^{CB}_{t|t} - \widehat{\Omega}^{M}_{t|t})$), what we have labeled the Delphic component. Using the shorthand notation $\widetilde{g}_t \equiv \widehat{\gamma} g(\widehat{\Omega}^{CB}_{t|t} - \widehat{\Omega}^{M}_{t|t})$ we have

$$S_t\left(r_t\left(e_t, \widetilde{g}_t\right), X_t\left(e_t, \widetilde{g}_t\right)\right)$$

Without loss of generality we assume the following: A positive value for e_t and $\widetilde{g}_t$ represents a contractionary monetary policy shock, an increase in X_t represents higher expected future cash flows and a positive value for $(\widehat{\Omega}^{CB}_{t|t} - \widehat{\Omega}^{M}_{t|t})$ implies that the Fed's forecast of economic activity is more optimistic than the market's. Consider the total derivative of the stock price to the

[8] It is also worth mentioning the complementary approaches of Cieslak and Schrimpf (2018) and Andrade and Ferroni (2018). The former use co-movement of stocks and interest rates along with monotonicity restrictions to isolate shocks to growth expectations and risk premia, while the latter use the joint reaction of interest rates and inflation swaps to isolate a Delphic shock for the ECB.

exogenous monetary policy shock

$$\frac{dS_t}{de_t} = \frac{\partial S_t}{\partial r_t}\frac{dr_t}{de_t} + \frac{\partial S_t}{\partial X_t}\frac{dX_t}{de_t}$$

From basic asset pricing theory we have that $\frac{\partial S_t}{\partial r_t} < 0$ and $\frac{\partial S_t}{\partial X_t} > 0$, i.e. a higher discount rate lowers stock prices and higher expected future cash flows raises stock prices. In canonical macro models with real effects of monetary policy (e.g. New Keynesian models) we have that an increase in interest rates results in a economic slowdown which is bad news about future cash flows, i.e. $\frac{dX_t}{de_t} < 0$. Finally, the typical asset pricing model would imply that an increase in interest rates raises discount rates, i.e. $\frac{dr_t}{de_t} > 0$.[9] This means that the total response of the stock market to an exogenous shock is the sum of two negative components and thus we expect β_1 in our regression from equation 2.8 to be negative.

Next consider the total derivative of the stock price to a Delphic shock.

$$\frac{dS_t}{d\widetilde{g}_t} = \frac{\partial S_t}{\partial r_t}\frac{dr_t}{d\widetilde{g}_t} + \frac{\partial S_t}{\partial X_t}\frac{dX_t}{d\widetilde{g}_t}$$

As discussed above, $\frac{\partial S_t}{\partial r_t} < 0$ and $\frac{\partial S_t}{\partial X_t} > 0$. Relying on the same argument above, an increase in interest rates (driven now by the Delphic component) is likely associated with an increase in discount rates, i.e. $\frac{dr_t}{d\widetilde{g}_t} > 0$.

Finally, what is the sign of $\frac{\partial X_t}{\partial \widetilde{g}_t}$? An increase in $\widetilde{g}_t$ reflects a signal of higher rates driven by the Fed's (more optimistic) private information. This has two distinct effects on X_t. Through the conventional monetary transmission channel, an increase in the Fed's policy instrument will translate into a contractionary effect on the economy, i.e., lower expected future cash flows. However, if the signal about rosier Fed forecasts can directly affect private sector beliefs about future economic activity, it can have an expansionary effect on the economy. As discussed in the introduction there is a growing strand of the literature which provides evidence for this latter

[9] Note that there is some work that has shown that increases in interest rates are associated with lower equity premiums. Even in this case we would get that $\frac{dr_t}{de_t} > 0$ as long as equity premiums do not fall enough to outweigh the rise in the risk-free rate.

channel dominating, i.e that $\frac{dX_t}{d\widetilde{g}_t}$ is positive. Thus the two components of the overall derivative $\frac{dS_t}{d\widetilde{g}_t}$ are likely to be of the opposite sign. The overall sign of the derivative will depend on the relative strength of the two competing effects.

To summarize the main takeaway from this section, the conceptual framework suggests that we should have a strong prior for β_1 to be negative but there is uncertainty about the sign of β_2 as it can reasonably be expected to be either positive or negative.

3 Data

We use the S&P 500 index to measure the response of the stock market. The prices are measured in a 30 minute window around FOMC announcements, starting at 10 minutes before the announcement and ending 20 minutes after the announcement.[10] For our baseline results, we use the sample period 1991-2011. There are 188 total FOMC policy decisions over this time frame. We drop a total of five data points. We exclude 8/17/2007, 11/25/2008, and 4/27/2011 due to data unavailability for those dates. We also drop 9/17/2001 and 3/18/2009 following Campbell, Fisher, Justiniano, and Melosi (2016). This leaves 183 observations in our sample. In the next subsection we detail the construction of the monetary policy surprise and conclude this section by discussing the private information variables constructed from Greenbook and Blue Chip forecasts.

3.1 Monetary policy surprise Our measure of the surprise change in monetary policy is constructed from interest rate futures contracts, as in Kuttner (2001). Federal funds rate and Eurodollar futures contracts capture the market's expectations about future Federal Reserve actions. Changes in these futures contracts around FOMC announcements therefore serve as a measure of the change in policy that is unanticipated by the market. Since any expected change in policy will already be priced into financial assets, the reaction of asset prices to monetary policy should be entirely due to this surprise component.

[10] We use S&P 500 futures returns until 2004, as in Gürkaynak, Sack, and Swanson (2005), and spot S&P 500 index returns for the remainder of the sample.

We want the monetary policy surprise measure to capture surprises to expectations about future fed funds rate changes, in addition to any surprise to the current month's fed funds rate target. Thus to construct our measure of the monetary policy surprise, we follow Gürkaynak, Sack, and Swanson (2005) and use five futures contracts expiring up to one year ahead.[11] For the baseline results, the surprise in each contract is measured as the change in the futures rate in a 30 minute window (10 minutes before to 20 minutes after) around FOMC policy decisions as in Gürkaynak, Sack, and Swanson (2005). But we also discuss results obtained using a broader daily window. Taken together, the five contracts contain rich information about the short and medium term path of expected interest rates. To summarize this information in a parsimonious way we perform a principal components analysis. The first principal component of F explains more than 80% of the total variation across all the contracts. We therefore use this first principal component as our baseline measure of monetary policy surprises.[12] Figure 1 plots this monetary policy surprise measure using both the 30 minute and daily window. The two series display a high degree of correlation with some minor discrepancies around the financial crisis in 2008 and in the early 1990s. To facilitate interpretation of our results below, we normalize the policy surprise such that its effect on the four quarter ahead Eurodollar futures contract is equal to unity. Thus the coefficient from a regression of stocks on the monetary policy surprise will measure the effect on the stock market of a 1 percentage point surprise rise in the expected path of the fed funds rate over the next 4 quarters.

3.2 Federal Reserve Private Information Our measure of Federal Reserve private information is constructed using the FOMC Greenbook forecasts and the private sector Blue Chip forecasts, and is similar to the approach used in Barakchian and Crowe (2013) and Campbell, Fisher, Justiniano, and Melosi (2016).

[11]Specifically, we use the current month's fed funds futures (scaled for timing of meeting within the month), the 3-month ahead fed funds futures, and the 2-quarter, 3-quarter, and 4-quarter ahead Eurodollar futures. For comparison, Bernanke and Kuttner (2005) use only the current month fed funds futures contract in their baseline results.

[12]This is essentially identical to the measure used in Nakamura and Steinsson (2018) which they call the "policy news shock". We should note that this does involve leaving out some information relative to the approach of Gürkaynak, Sack, and Swanson (2005) who use the first two principal components.

The Fed's Greenbook forecasts represent the information set of the central bank $\widehat{\Omega}^{CB}_{t|t}$ from equation 2.7, while the Blue Chip forecasts proxy for the market's information set $\widehat{\Omega}^{M}_{t|t}$. Greenbook forecasts are constructed by the Federal Reserve Board's staff a week prior to every scheduled FOMC policy meeting and are released to the public following a roughly five year lag. Blue Chip forecasts are compiled from market professionals on a monthly basis and released on the 10th of every month. For each FOMC policy decision, the corresponding measure of Fed private information is calculated as the most recent Greenbook forecast minus the last Blue Chip forecast prior to the policy decision that is of the same forecast horizon as the relevant Greenbook forecast. For example, for a scheduled FOMC meeting occurring on the 22nd of a month we use the Greenbook forecast constructed a week prior to that meeting (the 15th) and the Blue Chip forecast released on the 10th of that month.[13] Greenbook forecasts are not constructed for unscheduled FOMC meetings. On unscheduled dates we therefore use the Greenbook and Blue Chip forecasts associated with the previous scheduled FOMC meeting.[14] While there is an asynchronicity regarding when the Fed and private forecasts are collected, we show below that it turns out not to be crucial for our results. In the online appendix, for each FOMC meeting we list the corresponding Greenbook and Blue Chip forecast dates.

Each set of forecasts predicts the values of macroeconomic variables on a quarterly basis. For the 1991-2011 sample we use the following four variables: real GDP, CPI, industrial production, and the civilian unemployment rate. For each variable, both sets of forecasts contain at least five different forecast horizons: the current quarter forecast, the quarter ahead forecast, two quarter ahead forecast, three quarter ahead forecast, and four quarter ahead forecast. Our measure of private information for variable i at forecast horizon j is:

$$\widehat{\Omega}^{CB}_{i,t+j|t} - \widehat{\Omega}^{M}_{i,t+j|t} \tag{3.1}$$

[13]For a scheduled FOMC meeting occurring before the 10th of a month we use the Blue Chip forecast released on the 10th of the previous month.

[14]The only exception is the 2/1/1991 unscheduled meeting. The Greenbook forecast for the scheduled 2/7/1991 meeting was constructed on 1/30/1991. Thus, we use the 1/30/1991 Greenbook forecast and the 1/10/1991 Blue Chip forecast for the 2/1/1991 meeting.

These variables are plotted in Figure 2. A few interesting points stand out. These variables are persistent and for each variable as the forecast horizon increases, the persistence rises. This suggests that the Federal Reserve's internal forecasts are not completely inferred by the market based on FOMC meeting actions and announcements. This is especially true for the longer-horizon forecasts. For a given variable, in addition to the autocorrelation for each individual forecast horizon, the private information variables for different horizons are also correlated with one another. Forecast horizons that are "closer" to each other are more highly correlated. For example, the 4 quarter ahead forecast is quite highly correlated with the 3 quarter ahead forecast but not with the nowcast.

These patterns guide us in choosing the private information measures that will be used in the regression analysis below. First, given the high cross-correlation among the private information variables of different horizons (for a given variable) we use only the nowcast and the 4 quarter ahead forecast. Next, given the high persistence of the private information variables, we include the first lag in our regression. Thus our baseline specification will have the contemporaneous and first lag of the nowcast (0 quarter ahead forecast) and 4 quarter ahead forecast for four macro variables: GDP, CPI, industrial production and unemployment. Thus we have a total of 16 private information variables that capture the relevant information. A potential alternative is to follow the approach of Campbell, Fisher, Justiniano, and Melosi (2016) and construct a short and long factor for each variable using principal component analysis. We found that the short factors and long factors correlate very highly with the nowcast and the 4 quarter ahead forecasts.

4 Results

4.1 Stock prices and monetary policy surprise We start by exploring the relationship between returns on the S&P 500 index (ΔS_t) and our measure of monetary policy surprise (mps_t) detailed in the previous section. Table 1 reports the summary statistics for these two measures using both a tight window and broad window around FOMC announcements. The tight window measures the change from 10 minute before to 20 minutes after the announcement. The broad window is just the daily change. The correlation between the tight and broad measures of the monetary policy surprise is high (0.81), while the correlation is lower for stock returns (0.47). For the policy surprise, moving to a broader window increases the standard deviation slightly, but it does so considerably more for the stock return. Thus stock returns in the broad window appear to have more noise relative to the tight window. The table also provides information separated by unscheduled FOMC meetings and meetings that correspond to "turning points" (which are instances when the federal funds rate target is changed in the direction opposite to previous changes). There has been some discussion in the literature that FOMC meetings of these two types are "unusual" relative to the other meetings. BK document that stock price reactions are much larger on turning point FOMC meetings. Faust, Swanson, and Wright (2004) find that monetary policy surprises on unscheduled FOMC meetings are more likely to reveal information about the state of the economy, i.e. suggesting a role for Delphic shocks (using our terminology). We will discuss the importance of these particular episodes for stock prices in more detail below and in Section 4.3. For now, we want to point out that both papers use data up to the early 2000s (2002 for BK and 2003 for Faust, Swanson, and Wright (2004)). Extending the data up to 2011, we notice that both monetary policy surprises and stock returns are substantially more volatile on unscheduled and turning point days, consistent with the idea that these meetings are somewhat different.

Table 2 presents the results from the regression of ΔS_t on mps_t using the 30 minute window with robust standard errors in parentheses. $R^2 > 0.3$ provides support for the assumption that monetary policy surprises are major drivers of stock prices in this narrow window. Consistent with BK, the specification in column (1) reports a significant decline in the S&P 500 following a positive monetary policy surprise (i.e. an unexpected tightening of monetary policy). A 1 percentage point surprise rise in the expected path of the fed funds rate over the next 4 quarters results in a 5.1% fall in stock prices.[15] This coefficient is precisely estimated with statistical

[15]Notice from Table 1 that the standard deviation of the policy surprise is 7 basis points. This implies that a one standard deviation increase in the policy surprise leads to a 0.36% fall in stock prices.

significance at the 1% level.[16] Column 2 presents regression results where the monetary policy surprise is interacted with a dummy variable that jointly represents FOMC meetings that are unscheduled and those associated with turning points. Column 3 and 4 presents the interaction results where the dummy variable is separated into unscheduled meetings and turning point meetings. The stock response to a monetary policy surprise is slightly lower in columns 2-4. The interaction coefficients are all negative but none of them are statistically significant. These negative point estimates suggest that if there is any evidence of asymmetry in the response of stock prices, it points to a larger negative response on unscheduled and turning point FOMC meetings. Since the standard errors are relatively large, it is reasonable to conclude that the response of stock prices to monetary policy surprises is stable across these different types of FOMC meetings.

Table 3 shows the regression results using the wider daily window. Column 1 shows that the response of stock prices is now statistically insignificant and much lower in magnitude relative to the tight window (-2.4% vs -5.1%). The R^2 is also substantially lower at .03. The daily stock response in Table 3 is also lower relative to the findings in BK. There are two main reasons why our daily results are different from BK's daily results. First, we use a broader measure of monetary policy surprise that captures forward guidance shocks, while BK just used federal funds rate surprises. And second, we extend the sample end date from 2002 to 2011. Similar to Table 2, columns 2-4 show the regression results with dummy interactions for unscheduled and turning point FOMC meetings. The coefficients on the interactions are negative and two out of the three are not significant. Thus the daily data regressions confirm that the stock market response to monetary policy surprises is stable across the different FOMC meetings and if anything more likely to be negative in these episodes.

Taken together, it is an indication that stock returns in the broad window have a lot more noise relative to the tight window. The underlying identifying assumption in this paper is that the relevant window around FOMC announcements does not contain any other important

[16] Our results are more strongly significant compared to studies that only use the current month federal funds futures contract in calculating their monetary policy surprise (see for example Gorodnichenko and Weber (2016)).

macroeconomic news event. In light of the above results, this identifying assumption is more credible with the tight window and motivates us to use the tight window for our benchmark results below in Section 4.3. This is also consistent with the recommendation of Gürkaynak, Sack, and Swanson (2005) among others.[17] To conclude this section, Figure 3 shows a scatter plot of the stock return and the monetary policy surprise in the tight 30 minute window (which is our preferred measure that is used in the results below). There is a clear negative relationship. The black triangles mark the Unscheduled FOMC meetings while the red squares represent turning points, highlighting that the bigger monetary policy surprises occur at these two types of meetings.

4.2 Monetary Policy Surprise and Private Information In Section 3.2 we discussed the properties of the private information variables constructed from forecast data. An important implication was that the Federal Reserve does not seem to completely reveal all of its private information through the FOMC announcement. Thus we would like to use only the component of private information that is inferred by the market from the FOMC announcements. As discussed above, we proceed by first regressing the monetary policy surprise measure on the private information variables. The estimating equation is reproduced below

$$mps_t = c + \gamma_{i,j} \left(\widehat{\Omega}^{CB}_{i,t+j|t} - \widehat{\Omega}^{M}_{i,t+j|t} \right) + e_t \tag{4.1}$$

Table 4 shows the results from this regression using the nowcast and 4 quarter ahead forecasts for the GDP, CPI, unemployment and industrial production private information variables. Given the persistent nature of the private information variables, we also include the first lag. The R^2 from the regression is 0.16, which is substantial but also highlights the fact that a major part of the monetary policy surprise is exogenous with respect to the Fed's private information.

In the conceptual framework sketched out in Section 2.2, we emphasized that the response of stock prices to private information depends on how forecast differences are related to interest

[17] For instance, Kurov and Gu (2016) show that using a daily window is likely to produce estimates which suffer from bias due to omitted variables, particularly in times of market turbulence.

rate changes. The regression coefficients from Table 4 can inform us about the sign. Note that a positive value for the private information variable for GDP, CPI and IP means that the Fed has a relatively optimistic forecast for the economy. For unemployment a positive sign implies the opposite. The first step regression is reported in Table 4, where 0Q refers to the nowcast and 4Q refers to the four quarter ahead forecast. The sign of all the coefficients on the private information nowcast variables suggest that an optimistic forecast results in a positive value for $\widetilde{g}_t \equiv \widehat{\gamma}(\widehat{\Omega}^{CB}_{t|t} - \widehat{\Omega}^{M}_{t|t})$, i.e. a contractionary policy surprise. But not all the signs on the lagged variables have the signs consistent with this interpretation. For example, the coefficient on the lagged 4 quarter ahead forecast of IP implies that if the Fed has a more positive outlook for IP, that is related to an expansionary policy surprise. This is most likely a combination of some noise and the fact that there is a high amount of correlation in the content of the different private information variables. We have also run the first step regression with different combinations of private information variables (including using principal component analysis) and find that most of the coefficients are consistent with $\widetilde{g}_t$ being positive.

Figure 4 displays the exogenous monetary policy shock (residual) and Delphic shock (fitted value) over time, with summary statistics reported in Table 5. The Delphic shock is typically of a smaller magnitude with a standard deviation roughly half that of the exogenous monetary policy shock. The standard deviation of the Delphic shock is roughly stable even when we narrow down to unscheduled or turning point FOMC meetings. On the other hand, the standard deviation of the exogenous monetary policy shock is much larger in these particular episodes. The Delphic shock displays a few notable episodes, with relatively large contractionary shocks in the late 90s and expansionary ones in the early 2000s and 2008-2009. The overall pattern of the exogenous monetary policy shock is similar to the monetary policy surprise, which is unsurprising given that the exogenous monetary policy shock explains around 80% of the variation of the monetary policy surprise.

4.3 Stock Price Response to Exogenous and Delphic Shocks

Now we are ready to run our second step regression. We regress the return on the S&P 500 index in the 30 minute window on the exogenous and Delphic shocks obtained from the first step discussed above. The estimating equation is

$$\Delta S_t = \alpha + \beta_1 \widehat{e}_t + \beta_2 \widehat{\gamma}_{i,j} \left(\widehat{\Omega}^{CB}_{i,t+j|t} - \widehat{\Omega}^{M}_{i,t+j|t} \right) + u_t \tag{4.2}$$

Since the regressors in this second step are generated in the first step, we have to account for the added sampling uncertainty. We use a non-parametric bootstrap to compute the standard errors. Specifically, for each bootstrap simulation, we resample observations from the data (with replacement) and then estimate equations 4.1 and 4.2. We use 10,000 replications in the procedure.

The results are presented in Table 6 with the bootstrapped standard errors in parentheses. Column 1 shows that the exogenous shock has a negative and significant effect on stock returns with a slightly larger magnitude than the monetary policy surprise. Specifically, a 1 percentage point surprise rise in the expected path of the fed funds rate over the next 4 quarters results in a precisely estimated 5.7% fall in stock prices (relative to the 5.1% fall for the monetary policy surprise).[18] The effect of the Delphic shock is also negative but much lower at -2.1%. While this coefficient by itself is not statistically significant, it is significantly different from the coefficient on the exogenous monetary policy shock (with a p-value for the difference of 0.05). As shown in Table 5, exogenous monetary policy shocks are more volatile than Delphic shocks and we reinterpret the coefficients to get a better gauge of the size of the effects. Specifically, stock prices fall 0.34% and 0.06% in response to a one standard deviation exogenous monetary policy and Delphic shock, respectively. An important implication is that, on average, surprise Federal Reserve decisions and announcements that are related to revelation of their private information have a lower effect (in terms of both economic and statistical significance) on the stock market as compared to actions that are exogenous shocks.[19]

[18]The standard deviation of the exogenous shock is slightly lower relative to the monetary policy surprise. Thus the stock response to a one standard deviation exogenous monetary policy shock is essentially identical to the monetary policy surprise response.

[19]In a related paper, Nakamura and Steinsson (2018) use a calibrated New Keynesian model to conclude that on average a Delphic shock raises stock prices. Their estimates imply that the information content of monetary

However, there is some suggestive evidence of an asymmetry in the effect of these shocks. The second column shows the results where the exogenous monetary policy and Delphic shocks are interacted with a dummy variable that jointly represents FOMC meetings that are either unscheduled or are associated with turning points. When the dummy variable is set to zero, i.e., for scheduled meetings where policy is not reversed, the overall stock response is lower in magnitude for the exogenous monetary policy shock and higher in magnitude for the Delphic shock by about a percentage point. The interaction coefficient on the exogenous component is -3.6 implying that the total response of stock prices to exogenous monetary policy shocks on unscheduled or turning point FOMC meetings is substantially larger in magnitude at -8.2. With a higher variance of exogenous monetary policy shocks on these particular meetings, stock prices fall by 0.9% in response to a one standard deviation exogenous monetary policy shock. The interaction coefficient on the Delphic component is also large but *positive* at 14.6 (with a p-value of 0.04). The total response of stock prices to a Delphic shock on these particular FOMC meetings is 11.7 (with a p-value of 0.08). Even with a lower variance of Delphic shocks on these FOMC meetings, it implies a 0.35% *rise* in stock prices in response to a one standard deviation Delphic shock. Moreover, the difference between the total effect of exogenous monetary policy and Delphic shocks for these days is large and strongly significant (p-value < 0.01). Thus there appears to be a clear distinction in how the stock market interprets exogenous vs. Delphic monetary policy actions on these particular FOMC meetings.[20]

The third and fourth columns show the results where the interaction for unscheduled FOMC meetings and turning point FOMC meetings is done separately. The same pattern is obtained with the interaction coefficients. Clearly, the standard errors are larger as there are a total of 17 observations for the unscheduled dates and only 8 for the turning point dates. Nevertheless the sign of the interaction coefficients on these particular dates continue to show a larger negative response to the exogenous monetary policy shock and a positive response to the Delphic shock.

surprises is around 70%, compared to the roughly 15% that we find in Section 4.2. Investigating the source of this difference appears to be a fruitful area for future research.

[20] These results are consistent with Paul (2018) who also emphasizes the importance of unscheduled FOMC meetings when studying revisions of survey expectations to target rate surprises.

One potential issue is that the forecasts of the public (Blue Chip) and those of the Fed (Greenbook) are not recorded on the exact same day. While this is a constraint due to the nature of the forecast data that is available, we assess whether this timing mismatch issue is important for our results. We construct a variable measuring the timing mismatch between the relevant Blue Chip and Greenbook forecasts for each observation in the sample. This variable is calculated as the absolute value of the number of days between the Greenbook forecast and Blue Chip forecast for a given FOMC meeting. To check the robustness of our results, we re-estimate the coefficients from the baseline specification while dropping observations for which the mismatch between Blue Chip and Greenbook forecasts is particularly large. We choose two cutoff points: the 90th percentile of the mismatch variable, which is 20 days, and the 75th percentile of the date mismatch variable, which is 15 days. These results are presented in Table 7. In columns (1a) and (1b) we drop all observations for which the Blue Chip and Greenbook forecasts are more than 20 days apart, and in columns (2a) and (2b) we drop all observations for which the forecasts are more than 15 days apart. Doing so decreases our sample size considerably, particularly in columns (2a) and (2b). However our main results hold up, as we still find a significant difference between the stock market response to exogenous and Delphic shocks on average, as well as a significant and positive response to contractionary Delphic shocks on unscheduled or turning point meetings. Moreover, the magnitudes of the key coefficient estimates are quite similar to the baseline case.

Next we check the robustness of the results to sample selection. First, we consider the zero lower bound episode. Since late 2008, in our sample the fed funds rate is stuck around zero and all the variation in our monetary policy surprise measure is driven by forward guidance surprises rather than any target rate change surprise. However, Swanson and Williams (2014) argue that the effective lower bound on the 1 year Treasury rate was not binding until late 2011 (which coincides with the end of our sample). But after hitting the zero lower bound, the Federal Reserve also engaged in the unconventional policy of large scale asset purchases (i.e. quantitative easing (QE)), with the first announcement coming in late 2008. To check whether our results are driven by this period, we rerun our estimation excluding the zero lower bound episode. The first two columns of Table 8 present these results. Column 1a shows that the overall response to exogenous monetary policy shocks and Delphic shocks is similar to the baseline case reported in Table 6, with similar standard errors as well. The interaction terms with the unscheduled and turning point FOMC meetings also paint a similar picture. Relative to the baseline results, on these particular FOMC meetings, the stock response to exogenous monetary policy shocks is slightly more negative and the response to Delphic shocks is slightly less positive.[21] Both the interaction terms are significant with p-values of 0.05 and 0.05 respectively.

Next we focus on the FOMC meetings in the early 1990s. Starting with February 1994, the FOMC started releasing a statement to accompany its monetary policy decision. To check if our results are driven by the 1991-1993 sample, we rerun the second step regressions using data starting with the February 1994 FOMC meeting. Columns 2a and 2b report these results. The overall response to both exogenous monetary policy and Delphic shocks is slightly larger for the post-1994 sample. For the interaction coefficients we find that the sign of the responses is similar to the baseline case. The magnitude of the effects is a little larger for the exogenous monetary policy shock and a little smaller for the Delphic shock on these particular FOMC meetings. However, the standard errors are somewhat larger in this case.

Finally, we control for the employment report when running our regressions. Recall that the underlying identifying assumption is that no other important macroeconomic event or announcement is occurring in the relevant window around the FOMC announcement. However, as pointed out by Gürkaynak, Sack, and Swanson (2005) there are a handful of FOMC meetings that coincide with macro news releases. Specifically, in the early 1990s there are 7 FOMC meetings that occur on the same day as the release of the employment report. Of special concern are 5 of these meetings that are unscheduled because if the Federal Reserve and the stock market are both responding to the employment report then our estimates will be mistakenly picking up that relationship. As discussed above, in constructing the stock price change and monetary pol-

[21] We also tried truncating the sample in late 2007 to coincide with the beginning of turmoil in the financial markets. The results are very similar to the ones presented here.

icy surprises the narrow 30 minute window was preferred precisely to avoid this particular issue. Gürkaynak, Sack, and Swanson (2005) show that using the narrow 30 minute window does indeed help in circumventing this identification issue. Here we confirm that our main results are not affected by excluding the 7 FOMC meetings that coincide with the employment report. Column 3a of Table 8 shows that the coefficients on the exogenous monetary policy and Delphic shocks are very similar to the baseline results in Table 6. Column 3b shows that on the unscheduled and turning point FOMC meetings, the stock price response is in the same direction as the baseline results with the p-value on the interaction term for the exogenous monetary policy shock and the Delphic shock being 0.04 and 0.03 respectively. Excluding the employment report in fact makes the magnitude of these effects a little larger. We conclude that our results are robust to sample selection.

4.4 Stock Market Volatility Response to Exogenous and Delphic Shocks

Bekaert, Hoerova, and Lo Duca (2013) show that monetary policy decisions have important effects on stock market implied volatility. Here, we investigate whether exogenous and Delphic shocks have differential effects. Bekaert, Hoerova, and Lo Duca (2013) decompose the VIX index into the conditional variance of the stock market, which reflects uncertainty surrounding stock prices, and the variance risk premium, which is supposed to capture risk aversion. Using a high frequency framework, they find that a contractionary monetary policy shock increases both uncertainty and risk aversion, with a bigger effect on risk aversion. First, we estimate the effect of the composite measure of monetary policy surprise on uncertainty (measured as the log of the implied conditional variance of the S&P 500) and risk aversion (measured as log of the variance risk premium). We use the uncertainty and risk aversion measures from Bekaert and Hoerova (2014). The regression results are for the sample 1991-2007 following Bekaert, Hoerova, and Lo Duca (2013). Panel A of Table 9 confirms their result that overall contractionary policy raises uncertainty and risk aversion with a bigger effect on the latter.

Panel B shows the response of uncertainty and risk aversion to exogenous and Delphic shocks. Contractionary shocks of either type increase both uncertainty and risk aversion but there are important differences relative to using the composite monetary policy surprise. The response to an exogenous shock is similar to the composite monetary policy surprise, but with a quantitative difference. Specifically, the response of risk aversion is larger while that of uncertainty is smaller. For the Delphic shock the response of risk aversion is essentially zero, while the response of uncertainty is substantial and strongly significant. This implies that a Delphic shock that reveals the Federal Reserve's private information about underlying macro fundamentals also affects the market's perceived uncertainty about the future. Overall, these results further highlight that exogenous and Delphic shocks capture different dimensions of monetary policy transmission to the stock market.

4.5 VAR Based Decomposition Here we try to understand in more depth the reason behind the observed reaction of the stock market to monetary policy. In Section 2.2 we discussed a broad but abstract framework where stock price movements can be broadly attributed to two main components: i) news about discount rates and ii) news about dividends (or cash flow news). In this section we use a more concrete decomposition of stock prices based on the work of Campbell and Shiller (1988) which calculates how much of the excess stock return can be attributed to expectations of future interest rates, excess returns and dividends. In this framework we can evaluate if the Delphic shock differentially affects the three components of the total excess stock return relative to the exogenous shock. Additionally we can investigate the decomposition effects of the asymmetry on turning point and unscheduled FOMC meetings.

The exact methodology used here follows the work of Bernanke and Kuttner (2005) and Campbell and Ammer (1993). The key idea is to decompose the current period's unexpected excess returns (e^y_{t+1}) into revisions of expectations of discounted future dividends ($\widetilde{e}^d_{t+1}$), future excess returns ($\widetilde{e}^y_{t+1}$) and the real interest rate ($\widetilde{e}^r_{t+1}$)[22]

$$e^y_{t+1} = \widetilde{e}^d_{t+1} - \widetilde{e}^r_{t+1} - \widetilde{e}^y_{t+1} \tag{4.3}$$

[22]The details of the derivation can be found in Bernanke and Kuttner (2005) and Campbell and Ammer (1993).

where

$$
\begin{aligned}
\widetilde{e}^{d}_{t+1} &= (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta d_{t+1+j} \\
\widetilde{e}^{r}_{t+1} &= (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta r_{t+1+j} \\
\widetilde{e}^{y}_{t+1} &= (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \Delta y_{t+1+j}
\end{aligned}
\tag{4.4}
$$

ρ is the steady state level of the price to dividend ratio and is set to .9962 following BK. The expectations terms in 4.4 need to be estimated to evaluate the decomposition in equation 4.3. A vector autoregression is used to construct these expectations. Campbell and Ammer (1993) show how this relationship can be modeled using the variables of interest and any other variables that might be helpful in forecasting excess returns. The resulting model is a six variable VAR with one lag.

$$z_t = Az_{t-1} + w_t$$

The endogenous variables (z_t) include the excess stock return, real interest rate, relative 3-month T-bill rate, change in the 3-month T-bill rate, the dividend-price ratio, and the spread between the 10-year and 1-month Treasury yields.[23] From this VAR we can estimate the variables of interest in equation 4.3 using the following equations

$$
\begin{aligned}
e^{y}_{t+1} &= s_y w_{t+1} \\
\widetilde{e}^{y}_{t+1} &= s_y \rho A \left(I - \rho A\right)^{-1} w_{t+1} \\
\widetilde{e}^{r}_{t+1} &= s_r \left(I - \rho A\right)^{-1} w_{t+1} \\
\widetilde{e}^{d}_{t+1} &= e^{y}_{t+1} + \widetilde{e}^{r}_{t+1} + \widetilde{e}^{y}_{t+1}
\end{aligned}
\tag{4.5}
$$

[23]The excess stock return is defined as the monthly CRSP value-weighted return minus the 1-month T-bill rate, the real interest rate is defined as the 1-month T-bill rate minus the log difference in nonseasonally adjusted CPI, and the relative 3-month T-bill rate is defined as the 3-month T-bill rate minus its 12-month lagged moving average.

where s_y and s_r are vectors with zeros and ones to pick out the relevant variables. The variance of the current excess equity return can be decomposed into the sum of the three variances and covariances.

$$Var(e^y_{t+1}) = Var(\widetilde{e}^d_{t+1}) + Var(\widetilde{e}^r_{t+1}) + Var(\widetilde{e}^y_{t+1})$$
$$-2Cov(\widetilde{e}^d_{t+1}, \widetilde{e}^r_{t+1}) - 2Cov(\widetilde{e}^d_{t+1}, \widetilde{e}^y_{t+1}) + 2Cov(\widetilde{e}^y_{t+1}, \widetilde{e}^r_{t+1}) \quad (4.6)$$

Using monthly data from 1991 to 2011 (to match our baseline estimation sample), we report the variance decomposition of excess equity returns in Table 10. For ease of comparison, the first two columns present the results from BK where they use data from 1989 to 2002. The left column shows the total contribution to the variance while the second column shows the shares (divided by Var(e^y_{t+1})). The majority of variation in excess returns is accounted for by the variance in expected dividends and expected future excess returns. Relative to the BK results, our data suggest a slightly bigger role for dividends (42% vs. 32%) and a smaller role for future excess returns (28% vs. 38%). At this stage, we should mention that there is recent work that points out some potential issues with this framework. These concerns are primarily related to the residual based nature of the decomposition, see for example the work of Chen and Zhao (2009). In the online appendix we show that our results are robust to including a measure of variance risk premium in the VAR (we use the measure from Bekaert, Hoerova, and Lo Duca (2013)). However, we still do not want to place too much emphasis on how our results compare to BK because of the differences in the sample dates and how the monetary policy surprises are constructed. Rather, the main purpose of the analysis in this section is to compare how the decomposition varies between the exogenous and Delphic shocks. We can more reasonably expect that the shortcomings of this residual based decomposition are not systematically related to the manner in which we construct the exogenous and Delphic shocks. Thus our emphasis will be on the *difference* in the decomposition between the exogenous shock and Delphic shock rather than on the level of the effects themselves.

In this framework, a natural way to evaluate the effect of monetary policy is to include the exogenous and Delphic shock directly in the VAR. Denoting the estimated exogenous shock by $\widehat{e_t}$ and the estimated Delpic shock $\left[\widehat{\gamma_{i,j}}\left(\widehat{\Omega}^{CB}_{i,t+j|t} - \widehat{\Omega}^{M}_{i,t+j|t}\right)\right]$ by $\widetilde{g_t}$ we get

$$z_t = Az_{t-1} + \phi_1 \widehat{e_t} + \phi_2 \widetilde{g_t} + \widetilde{w_t} \tag{4.7}$$

The VAR is estimated at a monthly frequency which requires aggregating the monetary policy shocks from the FOMC meeting frequency to a monthly frequency. We follow a simple rule of summing up any monetary policy shocks in a given month to get the monthly number. We have also tried aggregating the monetary policy shocks following the methodology of Gertler and Karadi (2015). The results from this alternative aggregation procedure are very similar to our baseline case.

Having estimated the VAR, we want to calculate the effect of the two monetary policy shocks on the discounted sums in equation 4.4. We can use the relationship outlined above in equation 4.5 together with the orthogonality of the monetary policy shocks. For example, consider the equation for the real interest rate

$$\widetilde{e}^r_{t+1} \quad = \quad s_r \left(I - \rho A\right)^{-1} w_{t+1} = s_r \left(I - \rho A\right)^{-1} \left(\phi_1 \widehat{e_t} + \phi_2 \widetilde{g_t} + \widetilde{w_t}\right) \tag{4.8}$$

From this equation the effect of the exogenous shock on the present value of current and expected future real rates is given by

$$s_r \left(I - \rho A\right)^{-1} \phi_1 \tag{4.9}$$

and the effect of the Delphic shock on the present value of current and expected future real rates is given by

$$s_r \left(I - \rho A\right)^{-1} \phi_2 \tag{4.10}$$

The response of the present value of current and expected future excess returns and dividends is calculated in a similar way. To account for the parameter uncertainty of the VAR coefficients in A, standard errors are calculated using the delta method following Campbell and Ammer (1993) and Bernanke and Kuttner (2005). Table 11 shows the response of the discounted sums to i) the composite monetary policy surprise, ii) the exogenous shock and iii) the Delphic shock. For ease of comparison we reproduce the results from BK in the first column where the sample runs from 1989 to 2002. In the next 3 columns we present the results where both the VAR and the monetary policy shocks are estimated using the 1991 to 2011 sample. For the second column we replace the exogenous and Delphic shocks with the composite monetary policy surprise in the VAR (equation 4.7). Relative to BK, the monetary policy surprise has a larger effect on current excess equity return. Note this is not surprising as our monetary policy surprise measure contains forward guidance surprises in addition to the federal funds rate surprises used in BK. However as found in BK, the current excess return is explained mostly by discounted sums of dividends and future excess returns.[24]

Relative to the composite monetary policy surprise, the exogenous shock (shown in the third column) has a very similar effect on current excess returns. The size of the impact is slightly larger (-17.5 vs. -16.7), which is consistent with the regressions from Section 4.3. This larger negative response is driven mostly by a larger positive response of future excess returns (4.0 vs 3.6). The response to the Delphic shock are quite different, although the standard errors are substantially larger. The overall effect on current excess returns is smaller at -12.0. The most interesting aspect is the composition of this response. The share of the dividend response is much bigger at -9.7, accounting for 81% of the total effect on current excess returns (relative to 66% for the exogenous shock).

Next we extend the above analysis to account for the differential effects on unscheduled and turning point FOMC meetings. This can be done in a straightforward manner using the framework of equation 4.7. Denote the unscheduled and turning point dummy by D_t.

$$z_t = Az_{t-1} + \widetilde{\phi}_1 \widehat{e}_t + \widetilde{\phi}_2 \widetilde{g}_t + \widetilde{\phi}_3 D_t + \widetilde{\phi}_4 \widehat{e}_t D_t + \widetilde{\phi}_5 \widetilde{g}_t D_t + \widetilde{w}_t \tag{4.11}$$

[24] In recent work Maio (2013) and Weber (2015) similarly find that the effect of monetary policy is primarily driven by the response of expected future dividends.

Using this equation the effect on the various components can be calculated as above. For example, on unscheduled and turning point FOMC meetings the effect of the exogenous shock on the present value of current and expected future real rates is given by

$$s_r (I - \rho A)^{-1} \left(\widetilde{\phi}_1 + \widetilde{\phi}_4\right) \tag{4.12}$$

and the effect of the Delphic shock is given by

$$s_r (I - \rho A)^{-1} \left(\widetilde{\phi}_2 + \widetilde{\phi}_5\right) \tag{4.13}$$

Table 12 shows theses estimates. The response of current excess returns and its components to the exogenous shock ($\widetilde{\phi}_1$) is similar to that reported in Table 11. The interaction effects of exogenous shocks ($\widetilde{\phi}_4$) are small as well. The overall response of current excess returns to a Delphic shock is more negative once we allow for the interaction (-21.1 vs. -12.0). This larger negative response on regular FOMC days is counteracted by a large *positive* response on unscheduled and turning point FOMC meetings. Specifically the total effect on these meetings ($\widetilde{\phi}_2 + \widetilde{\phi}_5 = 13.5$) is roughly the same size as the baseline effect from Table 11 but with the opposite sign. This positive response is mainly driven by a large fall in the future excess return and to a lesser extent by a rise in dividends in response to contractionary Delphic shocks. The VAR decomposition exercise confirms that the stock market responds very differently to Delphic shocks that occur on unscheduled or turning point FOMC meetings. Moreover, the results point to a change in the risk premium as a major driver of this asymmetric response.[25] In recent work Hanson and Stein (2015) and Gertler and Karadi (2015) find that monetary policy shocks have substantial effects on bond interest rate term premia. Our results show that, at least on certain FOMC dates, the stock risk premium also seems to respond to monetary policy shocks. We view our results as providing complementary evidence to this active area of research.

[25] While the response of future excess returns is precisely estimated (p-value < 0.01), standard errors in general are somewhat large and thus these results should be interpreted with some caution.

5 Conclusion

What are the effects of monetary policy on the economy? In this paper we aim to shed light on the relatively unexplored information (or signalling) channel of the monetary transmission mechanism. We conduct our analysis using the reaction of the stock market as a laboratory. By exploiting differences in central bank and private sector forecasts we construct a measure of Federal Reserve private information. We use this measure to separate monetary policy surprises into exogenous and Delphic shocks. Exogenous shocks are surprise changes in monetary policy which are unrelated to macroeconomic fundamentals whereas Delphic shocks are surprise changes in policy attributable to the Federal Reserve's private information about the state of the economy.

We find that, on average, stock prices fall more in response to contractionary exogenous shocks relative to Delphic ones. However, on unscheduled and turning point FOMC meetings, contractionary Delphic shocks actually result in an increase in stock prices. The results highlight an unconventional channel of monetary transmission where contractionary policy actions can stimulate the economy.

A promising possibility for future work includes analyzing firm and industry level responses to the exogenous monetary policy and Delphic shocks. Heterogeneous firm-level responses may be informative about which kind of firms or industries are particularly sensitive to the revelation of Federal Reserve private information.

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	All FOMC days		Turning points		Unscheduled	
	30 Minute	Daily	30 Minute	Daily	30 Minute	Daily
Monetary Policy Surprise						
Mean	0.00	0.00	-0.04	-0.03	-0.10	-0.14
Median	0.01	0.01	-0.03	-0.08	-0.10	-0.14
Standard Deviation	0.07	0.09	0.13	0.12	0.12	0.15
Min	-0.34	-0.44	-0.19	-0.17	-0.34	-0.44
Max	0.15	0.24	0.15	0.16	0.13	0.22
Correlation	0.81		0.95		0.82	
Observations	183		8		17	
S&P 500 Return						
Mean	-0.24	0.34	0.69	1.08	0.53	0.60
Median	-0.06	0.24	0.30	0.82	0.03	0.38
Standard Deviation	0.63	1.23	1.64	2.19	1.25	1.69
Min	-1.88	-2.94	-0.75	-2.27	-0.92	-1.13
Max	4.08	5.14	4.08	5.01	4.08	5.01
Correlation	0.47		0.93		0.90	
Observations	183		8		17	

Table 1: This table reports the summary statistics calculated using a tight 30 minute window and a broad daily window. The monetary policy surprise measure reported in percentage points is constructed using a principal component analysis of futures data, see Section 3.1 for details. The S&P 500 return is also reported in percentage points.

VARIABLES	S&P 500 (30 Minute Window)			
	(1)	(2)	(3)	(4)
MP Surprise	-5.14	-4.24	-4.62	-4.34
	(0.93)	(0.98)	(0.84)	(0.83)
Unscheduled/Turning Point Dummy		0.05		
		(0.13)		
MP Surprise x Unscheduled/Turning Point		-1.37		
		(1.60)		
Unscheduled FOMC Dummy			-0.01	
			(0.17)	
MP Surprise x Unscheduled			-1.15	
			(1.74)	
Turning Point Dummy				0.38
				(0.28)
MP Surprise x Turning Point				-4.70
				(3.81)
Constant	-0.02	-0.04	-0.03	-0.05
	(0.04)	(0.04)	(0.04)	(0.03)
Observations	183	183	183	183
R-squared	0.32	0.33	0.32	0.38
Adjusted R-squared	0.32	0.32	0.31	0.37

Table 2: The table reports the regression of the S&P 500 return on the monetary policy surprise, both measured in a 30 minute window around FOMC announcements. The Unscheduled dummy is set to 1 for FOMC meetings occurring outside the regularly scheduled dates. The Turning Point dummy is set to 1 if the policy decision changed the fed funds rate in the opposite direction of the previous change. The Unscheduled/Turning Point dummy is set to 1 for either occurrence. Robust standard errors are in the parentheses.

VARIABLES	S&P 500 (Daily Window)			
	(1)	(2)	(3)	(4)
MP Surprise	-2.42	-1.55	-2.68	-1.57
	(1.45)	(2.27)	(2.10)	(1.45)
Unscheduled/Turning Point Dummy		-0.15		
		(0.34)		
MP Surprise x Unscheduled/Turning Point		-2.21		
		(3.23)		
Unscheduled FOMC Dummy			-0.08	
			(0.47)	
MP Surprise x Unscheduled			0.30	
			(3.25)	
Turning Point Dummy				0.31
				(0.42)
MP Surprise x Turning Point				-12.16
				(3.84)
Constant	0.34	0.33	0.35	0.31
	(0.09)	(0.10)	(0.10)	(0.09)
Observations	183	183	183	183
R-squared	0.03	0.04	0.03	0.10
Adjusted R-squared	0.02	0.02	0.02	0.08

Table 3: The table reports the regression of the S&P 500 return on the monetary policy surprise, both measured using a daily window around FOMC announcements. The Unscheduled dummy is set to 1 for FOMC meetings occurring outside the regularly scheduled dates. The Turning Point dummy is set to 1 if the policy decision changed the fed funds rate in the opposite direction of the previous change. The Unscheduled/Turning Point dummy is set to 1 for either occurrence. Robust standard errors are in the parentheses.

VARIABLES	MP Surprise
CPI0Q	0.008
	(0.004)
U0Q	-0.005
	(0.051)
GDP0Q	0.018
	(0.009)
IP0Q	0.003
	(0.003)
CPI4Q	0.013
	(0.020)
U4Q	0.025
	(0.028)
GDP4Q	0.014
	(0.016)
IP4Q	0.006
	(0.011)
CPI0Q Lag	-0.003
	(0.007)
U0Q Lag	0.030
	(0.044)
GDP0Q Lag	-0.007
	(0.009)
IP0Q Lag	0.002
	(0.003)
CPI4Q Lag	0.002
	(0.020)
U4Q Lag	-0.048
	(0.027)
GDP4Q Lag	0.014
	(0.017)
IP4Q Lag	-0.018
	(0.010)
Constant	0.012
	(0.009)
Observations	182
R-squared	0.16
Adjusted R-squared	0.08

Table 4: The table reports the regression of the monetary policy surprise on the private information variables (constructed as the difference between the Greenbook forecasts and Blue Chip forecasts). "0Q" and "4Q" refer to the nowcast and 4 quarter ahead forecast, see the main text for more details. Robust standard errors are in parentheses.

	All	Unscheduled/TP	Pre-ZLB	Post-1994	No Report
Exogenous Shock					
Mean	0.00	-0.07	0.00	0.00	0.00
Median	0.01	-0.04	0.01	0.00	0.01
Standard Deviation	0.06	0.11	0.06	0.06	0.06
Min	-0.30	-0.30	-0.30	-0.30	-0.30
Max	0.16	0.11	0.16	0.16	0.16
Correlation with MP surprise	0.92	0.98	0.92	0.90	0.91
Observations	182	23	159	139	175
Delphic Shock					
Mean	0.00	-0.01	0.00	0.00	0.00
Median	0.00	-0.01	0.00	0.01	0.01
Standard Deviation	0.03	0.03	0.03	0.03	0.03
Min	-0.09	-0.06	-0.09	-0.09	-0.09
Max	0.08	0.05	0.08	0.08	0.08
Correlation with MP surprise	0.40	0.61	0.40	0.41	0.39
Observations	182	23	159	139	175

Table 5: This table reports the summary statistics calculated using a tight 30 minute window. Both shocks, reported in percentage points, are retrieved from the regression of monetary policy surprises on Fed private information. The exogenous monetary policy (MP) shock is the residual and the Delphic shock is the fitted value, see Section 4.2 for details. The first column includes all FOMC dates in our sample, the second includes only unscheduled and turning point dates, the third includes all dates prior to the fed funds rate hitting the zero lower bound, the fourth column includes all dates following 1994, and the fifth includes all dates that did not coincide with the release of an unemployment report.

VARIABLES	S&P 500 (30 minute window)			
	(1)	(2)	(3)	(4)
Exogenous Shock	-5.72	-4.62	-5.19	-4.74
	(0.99)	(0.90)	(0.86)	(0.84)
Delphic Shock	-2.12	-2.93	-2.49	-2.13
	(1.87)	(1.97)	(1.80)	(1.91)
Unscheduled/Turning Point Dummy		-0.01		
		(0.18)		
Exogenous x Unscheduled/Turning Point		-3.59		
		(2.16)		
Delphic x Unscheduled/Turning Point		14.62		
		(7.08)		
Unscheduled FOMC Dummy			0.15	
			(0.29)	
Exogenous x Unscheduled			-2.48	
			(2.84)	
Delphic x Unscheduled			18.4	
			(14.85)	
Turning Point Dummy				0.06
				(1.59)
Exogenous x Turning Point				-8.67
				(12.57)
Delphic x Turning Point				10.47
				(59.07)
Constant	-0.03	-0.04	-0.03	-0.05
	(0.04)	(0.04)	(0.04)	(0.04)
Observations	182	182	182	182
R-squared	0.34	0.39	0.37	0.42
Adjusted R-squared	0.33	0.37	0.35	0.40

Table 6: The table reports the regression of the S&P 500 return on the residual and fitted value of the policy surprise from the first step, both measured in a 30 minute window around FOMC announcements. The Unscheduled dummy is set to 1 for FOMC meetings occurring outside the regularly scheduled dates. The Turning Point dummy is set to 1 if the policy decision changed the fed funds rate in the opposite direction of the previous change. The Unscheduled/Turning Point dummy is set to 1 for either occurrence. Bootstrapped standard errors are in the parentheses.

	S&P 500 (30 minute window)			
	(1a)	(1b)	(2a)	(2b)
Exogenous Shock	-5.78	-4.62	-6.16	-5.15
	(1.04)	(0.98)	(1.16)	(0.95)
Delphic Shock	-1.63	-2.72	-2.45	-3.61
	(1.97)	(2.17)	(2.30)	(2.35)
Unscheduled/Turning Point Dummy		0.00		-0.09
		(0.19)		(0.26)
Exogenous x Unscheduled/Turning Point		-4.12		-4.05
		(2.29)		(2.89)
Delphic x Unscheduled/Turning Point		19.02		20.71
		(7.73)		(11.98)
Constant	-0.01	-0.03	-0.00	-0.01
	(0.04)	(0.04)	(0.05)	(0.05)
Observations	173	173	140	140
R-squared	0.35	0.41	0.38	0.44
Adjusted R-squared	0.34	0.40	0.37	0.42

Table 7: The table reports the regression of the S&P 500 return on the residual and fitted value of the policy surprise from the first step, both measured in a 30 minute window around FOMC announcements. Columns (1a) and (1b) drop observations for which the timing mismatch between Blue Chip and Greenbook forecasts is greater than 20 days (the 90th percentile). Columns (2a) and (2b) drop observations for which the timing mismatch between Blue Chip and Greenbook forecasts is greater than 15 days (the 75th percentile). The Unscheduled/Turning Point dummy is set to 1 for either FOMC meetings occurring outside the regularly scheduled dates or if the policy decision changed the fed funds rate in the opposite direction of the previous change. Bootstrapped standard errors are in the parentheses.

VARIABLES	Pre-ZLB		Post-1994		No Employment Report	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
Exogenous Shock	-5.87	-4.11	-6.87	-5.25	-5.74	-4.56
	(1.09)	(1.03)	(1.17)	(0.93)	(1.05)	(0.90)
Delphic Shock	-1.27	-1.71	-2.24	-2.33	-2.31	-3.14
	(1.83)	(1.97)	(1.98)	(2.09)	(1.87)	(2.01)
Unscheduled/Turning Point Dummy		-0.03		-0.11		-0.13
		(0.18)		(0.44)		(0.24)
Exogenous x Unscheduled/Turning Point		-4.70		-4.46		-5.10
		(2.34)		(4.45)		(2.54)
Delphic x Unscheduled/Turning Point		11.83		8.67		20.85
		(6.00)		(11.78)		(9.61)
Constant	-0.04	-0.07	-0.04	-0.06	-0.03	-0.04
	(0.05)	(0.04)	(0.05)	(0.05)	(0.04)	(0.04)
Observations	159	159	148	148	175	175
R-squared	0.35	0.41	0.38	0.41	0.34	0.41
Adjusted R-squared	0.34	0.39	0.37	0.39	0.33	0.39

Table 8: The table reports the regression of the S&P 500 return on the residual and fitted value of the policy surprise from the first step, both measured in a 30 minute window around FOMC announcements. The Unscheduled dummy is set to 1 for FOMC meetings occurring outside the regularly scheduled dates. The Turning Point dummy is set to 1 if the policy decision changed the fed funds rate in the opposite direction of the previous change. The Unscheduled/Turning Point dummy is set to 1 for either occurrence. Bootstrapped standard errors are in the parentheses.

Panel A	UC	RA
MP Surprise	0.40	0.99
	(0.19)	(0.66)
Unscheduled Dummy	0.09	0.16
	(0.03)	(0.10)
MP Surprise x Unscheduled	-0.46	-0.94
	(0.37)	(0.71)
Constant	0.03	-0.19
	(0.01)	(0.03)
Observations	147	147
R-squared	0.09	0.04
Adjusted R-squared	0.07	0.02

Panel B	UC	RA
Exogenous Shock	0.27	1.26
	(0.23)	(0.71)
Delphic Shock	0.84	0.05
	(0.29)	(1.13)
Unscheduled Dummy	0.08	0.18
	(0.04)	(0.11)
Exogenous x Unscheduled	-0.08	-1.63
	(0.72)	(1.10)
Delphic x Unscheduled	-3.73	4.89
	(2.98)	(4.59)
Constant	0.03	-0.19
	(0.01)	(0.03)
Observations	146	146
R-squared	0.12	0.05
Adjusted R-squared	0.09	0.02

Table 9: The table reports the regression of uncertainty (UC) and risk aversion (RA) measures (see Section 4.4 for details) on the monetary policy surprise in Panel A, and on the exogenous and Delphic shocks in Panel B. The Unscheduled dummy is set to 1 for FOMC meetings occurring outside the regularly scheduled dates. Bootstrapped standard errors are in the parentheses.

	BK 1989 - 2002		1991 - 2011	
	Total	Share (%)	Total	Share (%)
Var(Excess Return)	19.00		19.59	
Var(Dividends)	6.10	31.90	8.31	42.43
Var(Real Rate)	0.10	0.60	0.29	1.50
Var(Future Returns)	7.20	38.00	5.45	27.82
-2*Cov(Dividends, Real Rate)	-0.60	-3.20	0.55	2.80
-2*Cov(Dividends, Future Excess Returns)	7.20	37.70	4.85	24.77
2*Cov(Future Excess Returns, Real Rate)	1.00	5.10	0.13	0.68

Table 10: The table reports the variance decomposition of current excess equity returns into the variances of revisions in expectations of dividends, real interest rates, future excess returns, and the covariances between them.

	BK 1989 - 2002	MP Surprise	Exog Shock	Delphic Shock
Current Excess Ret.	-11.01	-16.65	-17.45	-12.07
	(3.72)	(5.09)	(5.47)	(12.52)
Future Excess Ret.	3.29	3.61	4.02	1.24
	(1.10)	(2.75)	(2.94)	(4.63)
Real Interest Rate	0.77	1.72	1.82	1.10
	(1.87)	(0.63)	(0.68)	(1.54)
Dividends	-6.96	-11.32	-11.60	-9.73
	(2.35)	(4.93)	(5.42)	(11.47)

Table 11: This table reports the response of current excess equity returns and its components to monetary policy shocks. The first column reproduces the BK results estimated on the sample 5/1989 to 12/2002. The remaining three columns use the baseline data sample of 2/1991 to 12/2011. Delta method standard errors are in parentheses

	Exog	Delphic	Unsch/TP Dum	Exog x Unsch/TP	Delphic x Unsch/TP
	$\widetilde{\phi}_1$	$\widetilde{\phi}_2$	$\widetilde{\phi}_3$	$\widetilde{\phi}_4$	$\widetilde{\phi}_5$
Current Excess Ret.	-19.05	-21.13	0.35	3.61	34.67
	(6.13)	(14.19)	(1.09)	(14.02)	(27.94)
Future Excess Ret.	5.35	9.66	-0.01	-1.89	-31.14
	(2.98)	(5.15)	(0.34)	(4.47)	(8.72)
Real Interest Rate	1.17	0.44	0.12	3.21	1.70
	(0.74)	(1.73)	(0.13)	(1.65)	(3.29)
Dividends	-12.52	-11.03	0.45	4.93	5.23
	(5.98)	(13.00)	(1.01)	(13.06)	(25.83)

Table 12: This table reports the response of current excess equity returns and its components to monetary policy shocks interacted with the unscheduled/turning point dummy. The dummy equals 1 on dates for which the FOMC decision was unscheduled or reversed the previous direction of policy. Delta method standard errors are in parentheses.

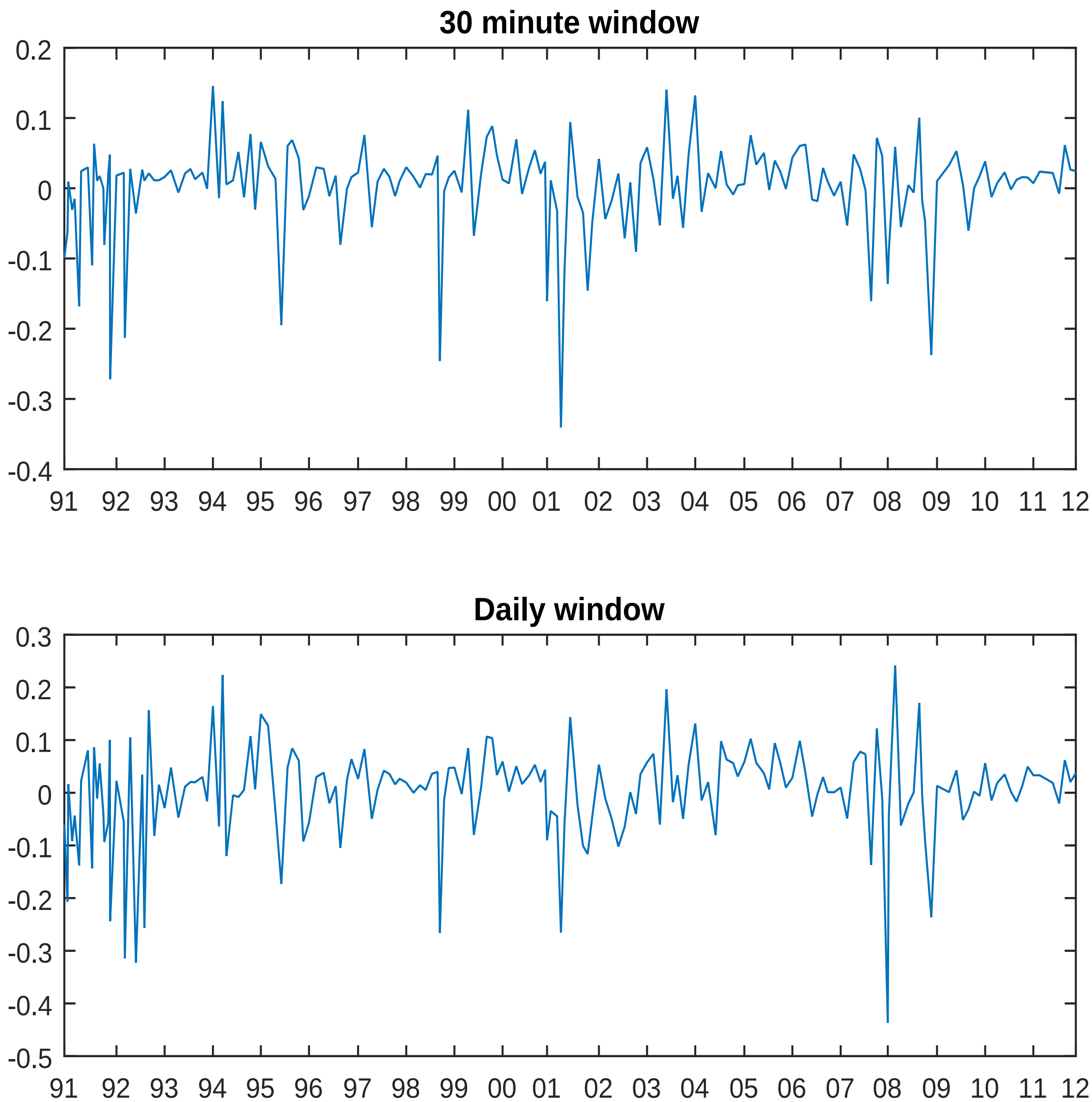

Figure 1: This figure plots the monetary policy surprise constructed from the futures data around FOMC announcements. The top panel uses a tight 30 minute window, whereas the bottom panel uses a broad daily window, see Section 3.1 for more details.

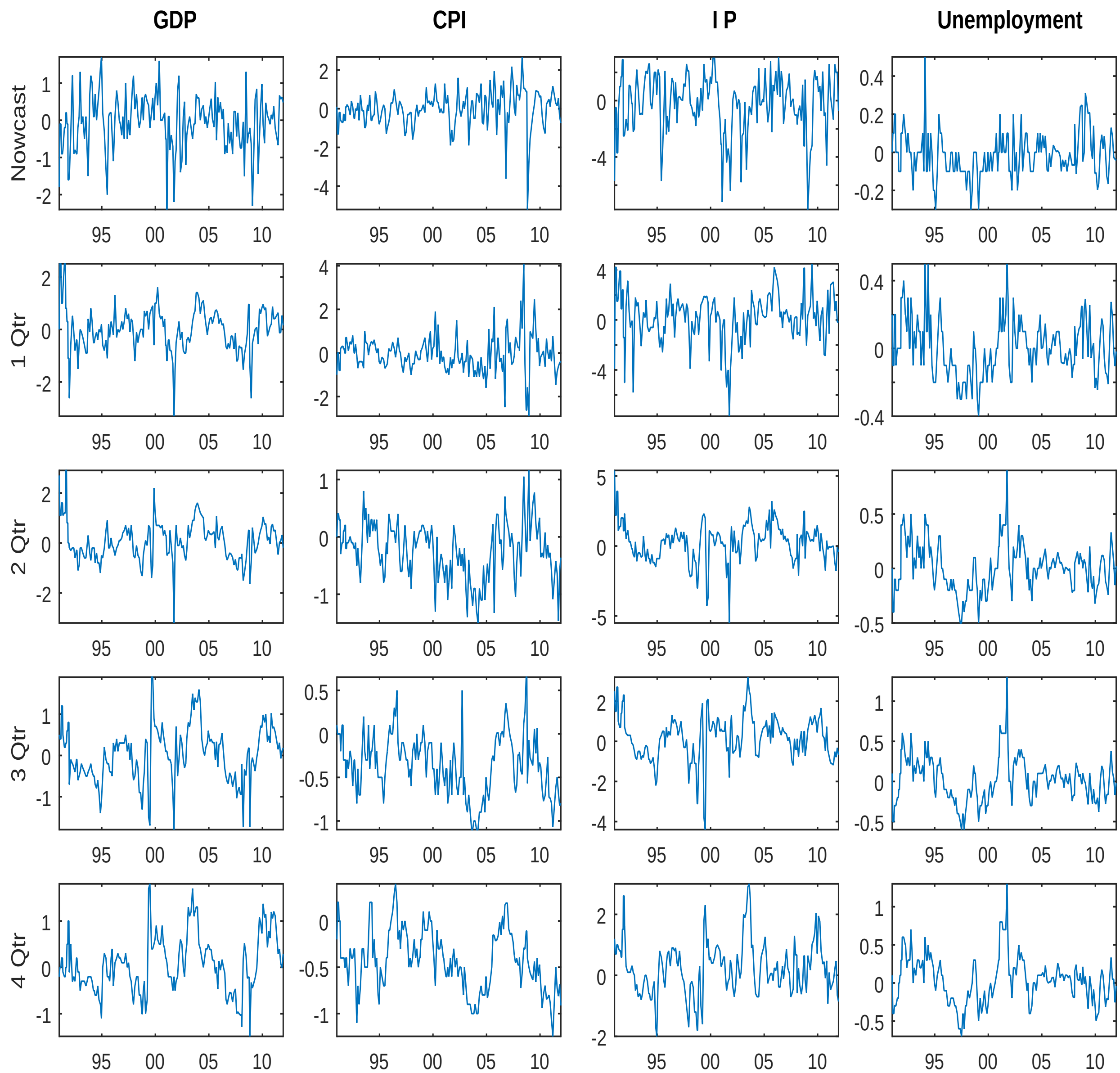

Figure 2: Private information variables for GDP, CPI, IP and unemployment, representing the difference between the Greenbook and Blue Chip forecasts. See the main text for more details.

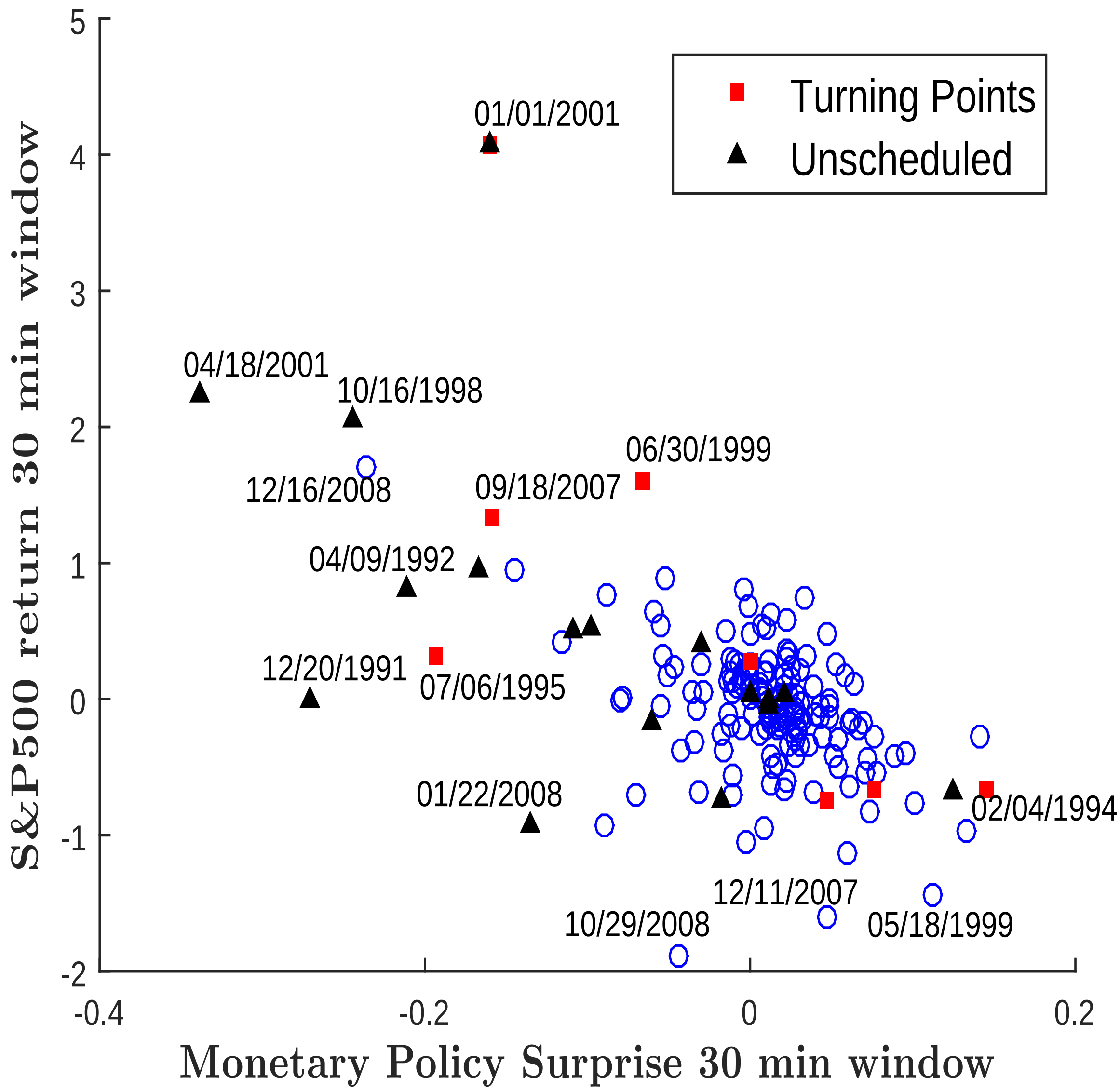

Figure 3: Stock Returns vs Monetary Policy Surprises

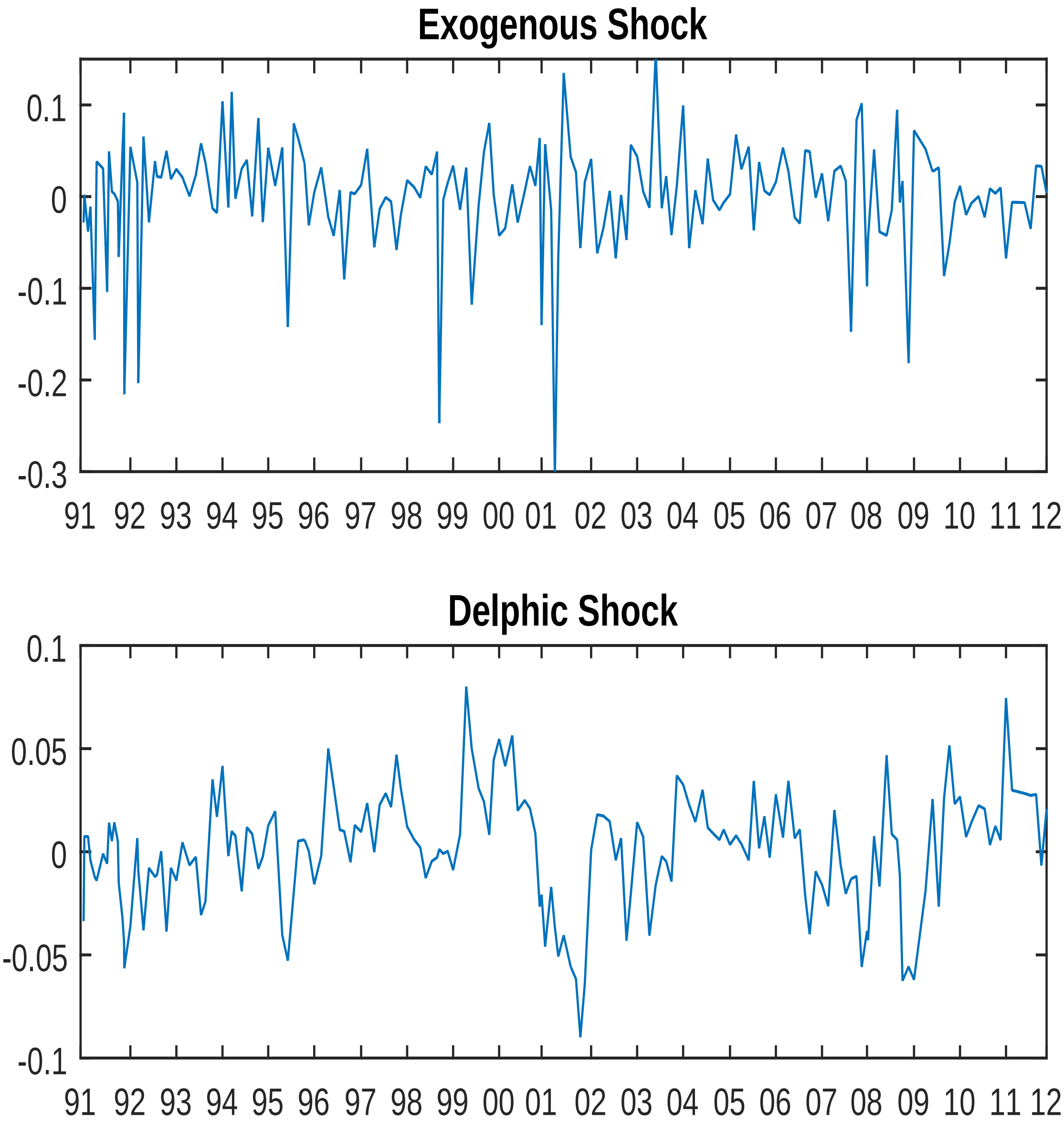

Figure 4: This figure shows the decomposition of the futures based monetary policy surprise into an exogenous component and a Delphic component which is related to the Federal Reserve's private information, see 4.2 for more details.