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What determines the stock market's reaction to monetary policy statements?☆

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ABSTRACT

We find that information communicated through monetary policy statements has important business cycle dependent implications for stock prices. For example, during periods of economic expansion, stocks tend to respond negatively to announcements of higher rates ahead. In recessions, however, we find a strong positive reaction of stocks to seemingly similar signals of future monetary tightening. We provide evidence that the state dependence in the stock market's response is explained by information about the expected equity premium and future corporate cash flows contained in monetary policy statements. We also show state dependence in the average stock returns on days of scheduled FOMC meetings and in the impact of monetary policy statements on stock and bond return volatility.

1. Introduction

At a media dinner in April 2006, the Fed Chairman Ben Bernanke told CNBC reporter Maria Bartiromo that investors underestimated his willingness to use monetary policy to fight inflation. Immediately after Ms. Bartiromo reported it on her program, the S&P 500 index dropped by about 0.8% and Treasury bond yields jumped to four-year highs. Investors interpreted Mr. Bernanke's remark as a sign that the Fed may continue its interest-rate boosting campaign longer than previously thought. That casual remark became the biggest business news story of the day, if not the whole week.[1] Speaking at a conference a few weeks later, the Fed Chairman reiterated his concern about inflation. The reaction of the stock market was summarized in a New York Times headline the following morning: “Bernanke Speaks, and Shares Tumble.”

Market participants analyze every word of Fed officials for clues of possible directions of monetary policy because monetary policy affects asset prices, particularly stock prices. Monetary policymakers are also mindful of the effects of their words on financial asset prices because monetary policy influences the real economy primarily through financial markets, including the stock market.[2] Therefore, it is important for central bankers to understand what determines the market's reaction to their statements.

Most recent studies looking at the effect of monetary policy on the stock market (e.g., Bernanke & Kuttner, 2005; Ehrmann & Fratzscher, 2004) measure monetary policy shocks by estimating unexpected changes in the current federal funds target rate. Gürkaynak, Sack, and Swanson (2005) demonstrate, however, that the reactions of asset prices to monetary news are determined by two factors. The first factor can be interpreted as the unexpected change in the current target rate. The structural interpretation of the second factor, called the path factor, relates to the information about the future path of

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[1] *The Financial Times* reported two days later: “Traders are calling it “The Bartiromo Affair.” Comments made by Ben Bernanke, Federal Reserve chairman, to a reporter at the weekend continued to reverberate yesterday after moving the markets on Monday.” (Hughes, 2006).

[2] For example, Blinder, Ehrmann, Fratzcher, De Haan, and Jansen (2008, p. 913) state: “… it is widely accepted that the ability of a central bank to affect the economy depends critically on its ability to influence market expectations about the futures path of overnight interest rates.” Also, consider this statement made by Alan Greenspan during an FOMC meeting: “The problem that we have here is that monetary policy works through its effects on overall financial markets. … The only way to eliminate the wealth effect, which has to be eliminated, is for the discount rate—the market interest rate used by investors to calculate the present value of expected earnings—to rise. … The question is how we can facilitate that rise.” (Transcript of February 1–2, 2000 FOMC Meeting, p. 124–125.).

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monetary policy communicated to the market, for example, through policy statements of the Federal Open Market Committee (FOMC). An alternative and complementary view of information conveyed by monetary policy statements is informed by Kohn and Sack (2004), who show that such statements affect Treasury yields largely by communicating the Fed's assessment of economic outlook.

Gürkaynak et al. (2005) show that FOMC statements have a large effect on long-term Treasury yields but almost no effect on U.S. stocks. Hausman and Wongswan (2006) report similar results for international markets. This finding seems counterintuitive and contradicts anecdotal evidence that the stock market often responds strongly to statements of Fed officials. Gürkaynak et al. (2005) argue that the weak effect of the path factor on stock prices may be related to information about the future economic conditions contained in FOMC statements. For example, if the Fed signals that monetary policy is likely to stay accommodative for an extended period, market participants are likely to revise downwards their forecasts of corporate earnings. This revision of expectations will tend to mute the positive effect of the lower expected interest rates on stocks.

We argue that the information content of FOMC statements varies with business conditions, leading to an asymmetric stock market response. Once we allow for business cycle variation in the effect of monetary policy statements on stocks, the stock market response becomes both economically and statistically significant. For example, during periods of economic expansion stocks tend to rise following the Fed's indications of lower rates ahead. When the economy is in recession, however, stock prices tend to fall in response to similar signals, which are frequently motivated by the Fed's downbeat assessments of the economic outlook. These results indicate that the Fed's assessment of the future economic conditions made during recessions is more important to equity investors than the future stance of monetary policy.

We also examine expected stock returns on scheduled FOMC meeting days, as well as state dependence in the effect of monetary policy statements on volatility of stock and bond returns. The results show that the equity premium earned on policy announcement days is much higher in recessions than in good economic times. We also find that monetary policy statements are associated with higher conditional volatility of stock and bond returns in recessions but not in expansions. Taken together, these results support the conclusion that information about the economy contained in monetary policy statements is particularly important to investors in recessionary periods, which are characterized by high economic uncertainty.

In further analysis, we investigate possible explanations for the state dependence in the stock market's response to monetary policy statements, including information about the future risk-free interest rate, expected equity risk premium and revisions in expectations of future corporate cash flows. The results show that the state dependence is explained by the effect of FOMC statements on cash flow expectations and the equity premium in recessionary periods.

Our paper makes several contributions to the literature. First, we provide evidence consistent with the notion that the Federal Reserve has important information about future economic conditions that is unknown to market participants. We show that this information moves stock prices when it is revealed through monetary policy statements. This finding contributes to the literature on central bank communication. Second, we show that the information content of monetary policy statements, and therefore the response of equity investors to such statements, depends on the stage of the business cycle. This finding adds to the literature on state dependence in the response of financial markets to macroeconomic news and should help Fed policymakers implement an effective monetary policy. Our third contribution is to show that the expected stock returns on days of scheduled FOMC meetings and the impact of monetary policy statements on asset return volatility also depend on the state of the economy. These results contribute to the literature on the effect of macroeconomic risk on asset returns.

2. Related literature and hypothesis development

2.1. Do central banks have superior information about the economy?

The research literature on central bank communication is large and rapidly growing. Blinder et al. (2008) provide an excellent survey of this literature. They conclude that the existing evidence strongly suggests that central bank communications often move financial markets, making such communications a potentially important tool for achieving monetary policy objectives. Discussing issues for future research, Blinder et al. (2008) note that there has been relatively little research on the directional impact of central bank messages on financial markets. Our paper contributes to filling this gap in the literature.

According to Blinder et al. (2008), one of the conditions under which central bank communications will influence market expectations is if the central bank is believed to have superior information on the economic outlook. The issue of asymmetric information between the central bank and the public remains relatively unexplored. The present subsection briefly reviews several studies in this area.

Kohn and Sack (2004) provide evidence that the effect of FOMC statements about the future direction of monetary policy on one- and two-year ahead Treasury forward rates is driven primarily by information about the economic outlook, rather than by the expected policy actions themselves. The evidence in Kohn and Sack (2004) is consistent with Romer and Romer (2000), who show that the Federal Reserve has information about future economic conditions that is not reflected in commercial forecasts. Romer and Romer (2000) find that some of the Fed's information is communicated to market participants through the Fed's monetary policy actions. However, Faust, Swanson, and Wright (2004) examine a more recent sample period and find little evidence that the Fed's target rate surprises reveal superior information about the current state of the economy.

Monetary policy actions may not be a very effective communication tool. On the other hand, FOMC statements are designed to convey the Fed's view about the economic outlook, and one would expect them to be a more effective means of communicating such information. We add to the literature on central bank communication by providing evidence that information about the Fed's view of the economic outlook determines the stock market's reaction to monetary policy statements. This finding is consistent with the notion that the central bank is perceived to have superior information about the economy.

2.2. State dependence in the reaction of stock returns to economic news

Studies that do not account for the economic state often find little reaction of stocks to macroeconomic news, implying that stock market investors may not process such information efficiently. The literature on state dependence in the response of markets to macroeconomic news shows that the true impact of news on the stock market becomes apparent only when the effect of business conditions is incorporated into the empirical model. In a pioneering study, McQueen and Roley (1993) find a stronger relation between macroeconomic news and stock prices after allowing for business cycle variation in the stock market response. Boyd, Hu, and Jagannathan (2005) show that news of rising unemployment is viewed by the stock market as good news in economic expansions and bad news in recessions. Andersen, Bollerslev, Diebold, and Vega (2007) find similar results for a wide range of macroeconomic announcements. Similarly, Basistha and Kurov (2008) show that the reaction of stock returns to unexpected changes in the fed funds target is much stronger in recessions and in tight credit conditions than in good economic times. We contribute to this literature by examining state dependence in the stock market's reaction to monetary policy statements.

2.3. The effect of economic news on return volatility and expected returns

Several studies have looked at how macroeconomic news affects volatility of financial asset returns. Lobo (2002) and Bomfim (2003) show that unexpected changes in the fed funds target rate increase stock market volatility on FOMC announcement days. Flannery and Protopapadakis (2002) identify several other macro variables that affect equity return volatility. Similarly, Jones, Lamont, and Lumsdaine (1998) show an increase in volatility of Treasury bond returns on days of two major macroeconomic announcements. They also find higher average bond returns on announcement days, implying the presence of an announcement risk premium. Savor and Wilson (in press) find evidence of an announcement risk premium in the stock market. Our contribution to this literature is to examine the effect of monetary policy statements on stock and bond return volatility and to provide evidence that macroeconomic risk associated with such statements increases in recessions, leading to higher expected stock returns on announcement days.

2.4. Hypothesis development

Reflecting the goal of communicating to the public the Fed's policy inclinations and its view of the economic outlook, the FOMC's policy statements have commonly included an assessment of main risks to satisfactory economic performance. Such assessments are likely to be especially important to market participants in periods of economic weakness because bad economic times are characterized by elevated economic uncertainty.[3]

In addition to the time-varying degree of uncertainty, the nature of uncertainty also differs over the business cycle. In an expansion, economic uncertainty revolves around the issue of growth sustainability and inflationary pressures. The key question is whether economic growth is driven primarily by demand shocks or by productivity shocks. Growth driven by demand shocks occurs without a sufficient increase in potential output, ultimately implying higher inflation. An economic expansion driven by productivity shocks occurs with an increase in potential output, thereby implying little inflation.[4] If an FOMC statement signals an unexpected increase in inflationary pressures, implying that monetary policy will have to tighten, the discount rate for stocks will increase and the stock market will respond negatively.

In a recession, the key question is when the adverse demand pressures holding back economic activity are likely to lift. Investors are uncertain about when businesses start investing and hiring again, when consumer confidence recovers and households increase their spending, etc. In other words, once a recession starts, the key question is when it will end. Corporate earnings are strongly procyclical, and the equity risk premium tends to increase in recessions and decline in good economic times.[5] Since monetary policy statements include the Fed's assessment of the economic outlook, and this information is particularly important in recessions, monetary statements are likely to contain information about future corporate cash flows and the equity risk premium. For example, if an increase in the expected path of policy communicated by the Fed signals improving prospects for economic recovery, the stock market will respond positively due to higher expected corporate earnings and lower risk premium. On the other hand, news of lower expected path of policy signals continued economic weakness, implying lower expected earnings growth rates and higher risk premium and leading to a negative response of the stock market.[6] Therefore, we expect a state-dependent relation between monetary policy statements and stock returns. We test the following hypothesis stated in null form:

Hypothesis 1. The response of stock returns to monetary policy statements does not depend on the business cycle.

Birru and Figlewski (2010) use risk neutral probability density for future stock prices extracted from prices of S&P 500 options to examine how the market impounds new information in FOMC announcements. They show that the price adjustment to the news is not instantaneous. Instead, prices continue to adjust and volatility remains elevated well after the time of the announcement. They argue that the price adjustment takes time because the market reaction itself generates additional information that investors have to process and trade upon. Birru and Figlewski (2010) do not attempt to distinguish between the effect of monetary policy changes and FOMC statements. They also do not examine the effect of the state of the economy on the process of price adjustment. However, there are two reasons why it may be more difficult for the market to digest information in monetary policy statements in bad economic times. First, as mentioned above, the degree of economic uncertainty is higher in recessions. Second, the information content of policy statements is likely to be “richer” and more difficult to interpret in recessions because the same statement may contain important information about future risk-free rates, expected corporate earnings and the equity risk premium. Return volatility is driven by information flow (e.g., Andersen, 1996). Therefore, we propose the following null hypothesis:

Hypothesis 2. Monetary policy statements are not associated with higher stock return volatility in recessions.

3. Sample selection and key variables

3.1. Sample selection

We use an event study approach and examine a sample period that extends from January 1994 to September 2008 and includes 126 FOMC announcements. Eight of these announcements occurred after unscheduled FOMC meetings. Our sample period begins in 1994 for two reasons. First, prior to 1994, the decisions of the FOMC were not explicitly announced to the public and had to be inferred from the subsequent open market operations. We use futures market data to estimate monetary news. Swanson (2006) and Gürkaynak et al. (2007) argue that the fed funds futures rate became a better predictor of the future target rate in 1994, when the FOMC began announcing policy decisions immediately after the meeting. Second, the path factor has a clear structural interpretation in the post-1994 period, since the FOMC started releasing statements immediately after policy decisions in February 1994, and Gürkaynak et al. (2005) show that the path factor reflects information contained in FOMC statements.

Similar to Bernanke and Kuttner (2005), we omit the target rate announcement made at the unscheduled FOMC meeting of September 17, 2001. We also omit the three FOMC announcements made in the last quarter of 2008 because of the unprecedented volatility in the fed funds and Eurodollar rates caused by massive disruptions in credit markets during the recent financial crisis. In particular, the effective fed funds rate fluctuated wildly above and below the target

[3] Bloom, Floetotto, Jaimovich, Saporta-Eksten, and Terry (2011) show that economic uncertainty increases sharply in recessions.

[4] For example, from the mid-1990s to 2000 there was considerable uncertainty as to the relative roles of productivity shocks and demand shocks in driving economic growth (e.g., Meyer, 2000). Consequently, market participants were often uncertain about the near-term monetary policy inclinations of the FOMC.

[5] Fama and French (1989) show that expected returns of stocks increase in periods of economic weakness and decline when economic conditions are strong. Campbell and Cochrane (1999) develop a consumption-based model that explains such countercyclical variation in risk premiums by changes in investor risk aversion.

[6] Investor psychology may contribute to the effect of policy statements on the equity premium and the expected earnings growth. For example, Benartzi and Thaler (1995) show that a combination of loss aversion and frequent evaluation of portfolio performance can explain much of the historical equity premium. Investor irrationality may also affect earnings growth expectations or pricing of expected growth (Gao, 2011). Kurov (2010) provides evidence that investor sentiment plays a significant role in the effect of monetary policy decisions on the stock market.

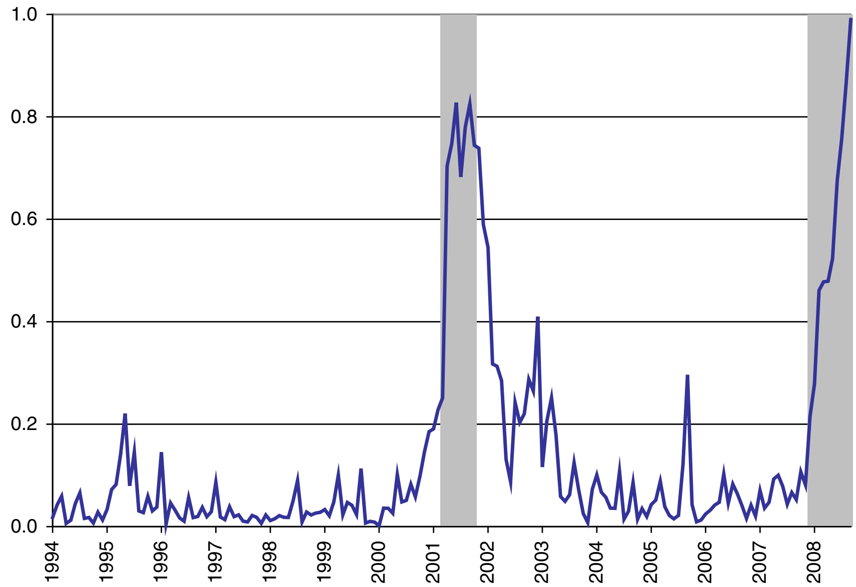

Fig. 1. Filtered recession probabilities. Shaded areas indicate NBER recession dating.

in the last quarter of 2008, making it difficult to accurately estimate the unexpected changes in the target rate using fed funds futures prices. In the more recent period, the fed funds target rate has remained near zero. With the conventional monetary policy tools unavailable to the Fed, the two-factor representation of policy shocks used in this paper may be problematic. Therefore, we do not examine the post-2008 period.

3.2. Business cycle measures

To test our hypotheses concerning the state dependence in the stock market reaction to monetary policy statements, we need to proxy for the state of the economy. We use the recession probability estimated using the Markov-switching dynamic-factor model of Chauvet and Piger (2008). The model estimates probability of the mean shift in the common component of four monthly variables: nonfarm payroll employment (EMP), industrial production (IP), real manufacturing and trade sales (MTS), and real personal income excluding transfer payments (PIX). These variables are also used by the National Bureau of Economic Research (NBER) in establishing business cycle turning points. Chauvet and Piger (2008) use real-time data on these variables, i.e., the data that would have been available in real time, rather than the subsequently released values representing final data revisions. For each month, Chauvet and Piger (2008) create a data set that would have been available at the end of that month.[7]

We use the filtered probability of recession, which is estimated at time t using time t information.[8] The main advantage of this business cycle measure compared, for example, to a dummy variable based on the NBER business cycle chronology is that the filtered recession probabilities are based on information available to market participants in real time, whereas the NBER business cycle turning points are often announced with a substantial lag. The recession probability is highly correlated to the experimental coincident recession index (XRIC) constructed by Stock and Watson (1989) and used by Boyd et al. (2005) to examine the stock market's reaction to unemployment news.[9] The filtered recession probabilities in our sample period are shown in Fig. 1. To check if our results are similar with alternative definitions of the recession proxy, we also use the NBER recession dummy in place of the recession probability.

3.3. Monetary surprises

Following Kuttner (2001), we use the prices of fed funds futures on the day of the Fed policy decision to compute the unexpected change in the federal funds target rate:

$$\Delta i_t^u = \frac{D}{D-d}\left(f_t^0 - f_{t-1}^0\right), \tag{1}$$

where f_t^0 is the fed funds rate implied in the settlement price of the current-month fed funds futures contract, d is the day of the current FOMC meeting and D is the number of days in the month. The settlement price of the fed funds futures is based on the average fed funds rate during the contract's month, rather than the fed funds rate on the settlement date. The first term in Eq. (1) is a scaling factor that accounts for the timing of the announcement within a month.[10]

Gürkaynak et al. (2005) estimate the two factors characterizing the response of asset prices to monetary policy using principal components of price changes in the fed funds futures and Eurodollar futures contracts at the time of the policy decision. Specifically, they use the current target rate surprise in Eq. (1), the change in three-month-ahead fed funds futures and changes in three Eurodollar futures contracts with maturity of up to four quarters.[11] The two principal component factors are linearly transformed so that one of the factors drives the current target rate surprises. This factor is called the target factor. The second factor, called the path factor, is orthogonal to current-month fed funds futures surprises and moves the longer-term funds rate expectations reflected in futures rates for the

[7] EMP, IP and MTS data included in the data set for month t would have been available at the end month $t-1$.

[8] We thank Marcelle Chauvet for making the recession probabilities available to us.

[9] The XRIC is available only until the end of 2003. The correlation between the XRIC and the filtered recession probability during the period from 1994 to 2003 is about 0.89.

[10] As the scaling factor increases at the end of the month, it amplifies the measurement error induced by discreteness of futures prices. To alleviate this problem, when the rate change occurs in the last seven days of the month we use the change in the rate implied in next-month's contract as the measure of the unexpected target change.

[11] Piazzesi and Swanson (2008) show that fed funds futures and Eurodollar futures reflect not only expectations of monetary policy but also time-varying risk premia. Ignoring these risk premia biases forecasts of the future path of monetary policy. Piazzesi and Swanson (2008) also show that measuring monetary policy shocks based on the one-day change in the interest rate futures prices around FOMC announcements is much more robust to the presence of risk premia.

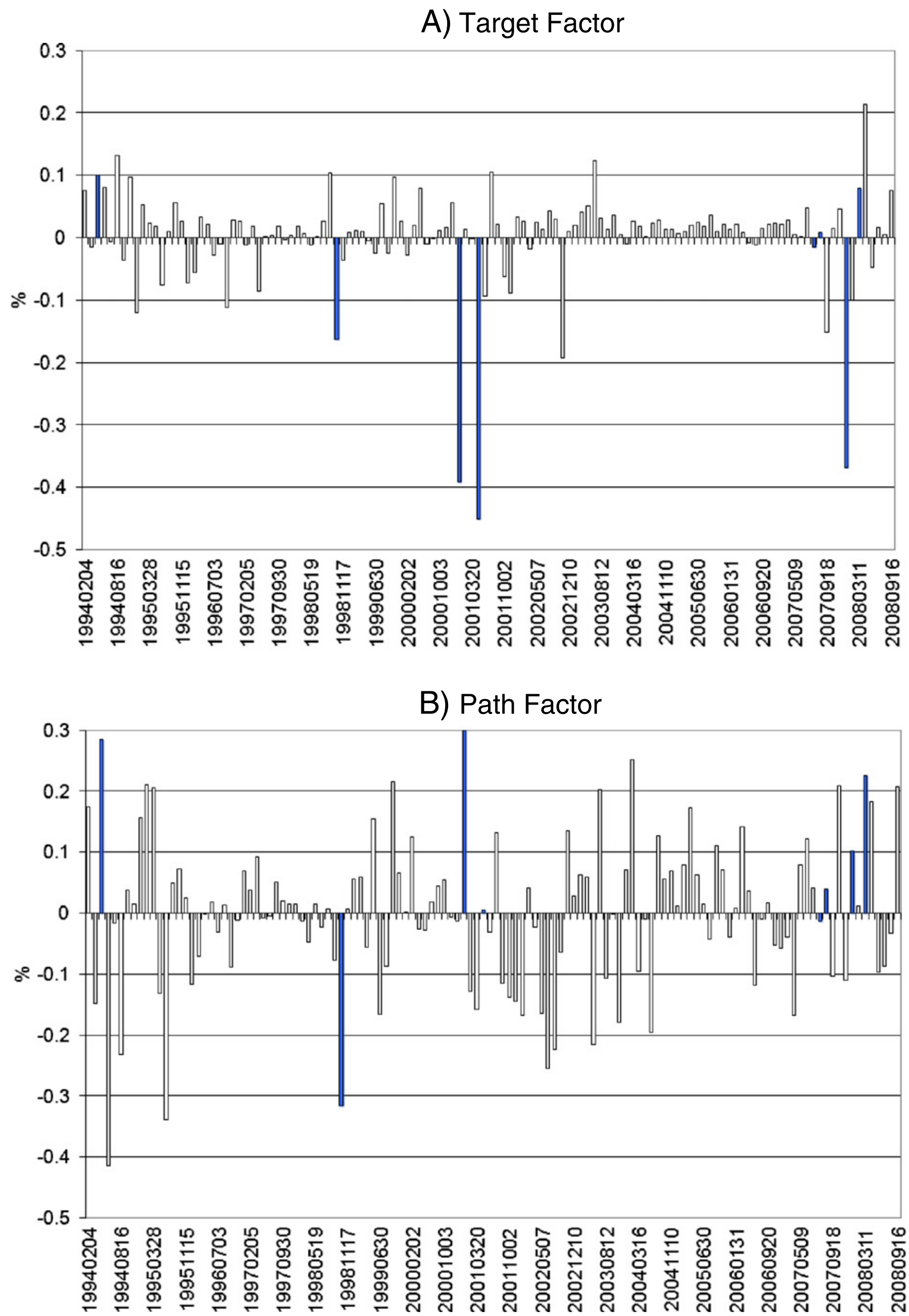

Fig. 2. Monetary policy factors. Panel A. Target factor. Panel B. Path factor. Shaded bars represent unscheduled FOMC meetings.

upcoming year.[12] Gürkaynak et al. (2005) show that the path factor is associated with FOMC statements.

We follow the factor estimation procedure of Gürkaynak et al. (2005) using daily futures market data and making one modification to the scaling of the path factor.[13] After the principal component decomposition, the estimated policy factors have zero mean and unit variance. Therefore, they need to be rescaled appropriately. Gürkaynak et al. (2005) rescale the target and path factors so that the target factor moves the current target rate surprise one-for-one and both factors have the same average effect on one-year-ahead Eurodollar futures rate. Arguably, the path factor should have a larger effect on the Eurodollar rates four quarters ahead than does the target factor because the target factor contains a "timing" surprise that has no effect on rates beyond the current month. Changes in the three-month-ahead fed funds futures rate are unaffected by the timing surprises. Therefore, we rescale the path factor so that it has the same effect on the one-year-ahead Eurodollar futures rate as the three-month-ahead fed funds futures rate has on that rate. After rescaling, a hypothetical 100-basis-point path factor surprise increases the one-year-ahead Eurodollar futures rate by about 73 basis points.

Information in Fed communications leading up to an FOMC meeting is likely to affect the market expectations in the run-up to the meeting. The target and path factor surprises, which are extracted from changes in interest rate futures prices on the day of the meeting,

[12] See Gürkaynak et al. (2005) for a detailed description of the factor estimation procedure.

[13] The fed funds and Eurodollar futures data are obtained from Genesis Financial Technologies.

Table 1
Summary statistics.

Panel A. Monetary policy factors (%)

	Full sample (126 FOMC meetings)			Expansion (111 FOMC meetings)			Recession (15 FOMC meetings)		
	Mean	Median	St. Dev.	Mean	Median	St. Dev.	Mean	Median	St. Dev.
Target factor	0.000	0.014	0.084	−0.005	0.014	0.063	−0.037	0.005	0.172
Path factor	0.000	0.008	0.125	−0.009	0.012	0.125	0.006	−0.031	0.132

Panel B. Stock and bond returns (%)

	Full sample period			Expansion			Recession		
	Mean	Median	St. Dev.	Mean	Median	St. Dev.	Mean	Median	St. Dev.
All trading days									
S&P 500 index	0.026	0.058	1.093	0.039	0.061	1.024	−0.092	0.003	1.570
One-year treasury	0.0004	0	0.050	−0.0005	0	0.046	0.009	0.010	0.077
Ten-year treasury	0.004	0	0.420	0.003	0	0.407	0.009	0	0.517
Event days									
S&P 500 index	0.434	0.310	1.294	0.363	0.303	1.087	0.964	0.583	2.305
One-year treasury	0.013	0.009	0.070	0.008	0.009	0.055	0.046	0.038	0.136
Ten-year treasury	0.002	0	0.453	−0.0002	0	0.424	0.018	−0.072	0.651
Non-event days									
S&P 500 index	0.012	0.052	1.082	0.028	0.057	1.020	−0.136	−0.001	1.521
One-year treasury	−0.0001	0	0.049	−0.0001	0	0.045	0.007	0.010	0.073
Ten-year treasury	0.004	0	0.419	0.003	0	0.407	0.009	0	0.511

The sample period is from January 1994 through September 2008. The recession and expansion sub-periods are based on the NBER recession dating. The sample of asset returns contains 3714 daily observations, including 3338 observations in expansion and 376 observations in recession.

reflect new information in the monetary policy decisions and statements.

The daily target and path factors are shown in Fig. 2. The summary statistics for the monetary policy factors are provided in Panel A of Table 1. The standard deviations of the target and path factor surprises in our sample are about 8 and 13 basis points, respectively. The standard deviation of the target factor surprises increases substantially in recession, whereas volatility of the path factor surprises is about the same in good and bad economic times.

Table 2 provides summary information on content of ten FOMC statements associated with the largest path factor surprises in our sample. The table includes five observations each in expansions and recessions. Daily target and path factor surprises, as well S&P 500 index returns, are also provided in the table. The news content of the statements depends on market expectations at the time of the announcement, and the expectations are not directly observable. Nevertheless, a visual inspection of this subset of the data seems to show that the relation between path factor surprises and stock returns tends to be negative in expansions and positive in bad economic times. For example, the FOMC statement after the March 20, 2001 FOMC meeting stated that "the risks are weighted mainly toward conditions that may generate economic weakness in the foreseeable future." The path factor surprise that day was about −16 basis points, indicating a negative revision in expectations of future policy moves. The S&P 500 index fell by about 2.44% on the same day.

4. Empirical results

4.1. Market response to FOMC statements

To examine the average effect of the two monetary policy factors on stocks, we estimate the following regression for S&P 500 index returns on FOMC announcement days:

$$R_t = \alpha + \gamma_1 Z_{1t} + \gamma_2 Z_{2t} + \varepsilon_t, \tag{2}$$

where Z_1 and Z_2 are the target and path factors, respectively. Since OLS estimation could be sensitive to the presence of outliers, we also estimate the regression in Eq. (2) using the MM weighted least squares procedure introduced by Yohai (1987). This procedure maintains robustness in the presence of a large number of outliers.

The regression results are shown in Table 3. The estimate of the intercept, representing the average stock returns on the FOMC days, is about 0.43% for OLS estimation, or about 0.36% when robust regression is used. In comparison, the unconditional mean of daily S&P 500 index returns during this sample period is a statistically insignificant 0.026%. The intercept estimates are strongly statistically significant. This announcement day effect is consistent with the argument of Savor and Wilson (in press) that higher returns on announcement days represent a risk premium for macroeconomic risk. The robust regression coefficient of the path factor is a statistically insignificant −1.19, whereas the coefficient of the target factor is a substantial −7.78. In other words, consistent Gürkaynak et al. (2005), the path factor seems to have little effect on stocks on average.

Basistha and Kurov (2008) find a much stronger response of stock returns to unexpected changes in the fed funds target rate in recession. We also expect the stock market's reaction to monetary policy statements to depend on the state of the economy. To account for state dependence in the stock market's response to the target and path surprises, we estimate the following regression:

$$R_t = \alpha + \gamma_1 Z_{1t} RM_t + \gamma_2 Z_{1t}(1-RM_t) + \gamma_3 Z_{2t} RM_t + \gamma_4 Z_{2t}(1-RM_t) + \varepsilon_t, \tag{3}$$

where RM_t is the filtered recession probability estimated using the model of Chauvet and Piger (2008) or the NBER recession dummy.[14] Our primary interest is in the coefficients γ_3 and γ_4, which measure the stock market response to monetary policy statements in recession and expansion, respectively.

The regression results are reported in Table 4. The regression has a much better fit compared to the fit of the base model in Table 3. There is a strong evidence of state dependence in the response of stocks to

[14] One could argue that the FOMC decisions affect the state of the economy and are also a direct response to such state. However, the recession probabilities are estimated using past information that is unaffected by current policy decisions and, presumably, has been incorporated into interest rate futures prices by the time of the FOMC meeting. In our sample, there is no significant correlation between the filtered recession probabilities and the two monetary policy factors.

Table 2
Large observations of the path factor.

Date	Target factor (%)	Path factor (%)	S&P 500 return (%)	Information in the FOMC statement
Panel A. Expansion				
May 17, 1994	0.08	−0.41	1.09	After increasing the target rate by another 0.5%, the Fed signals that its rate boosting campaign is essentially over.
July 6, 1995	−0.08	−0.34	1.22	Statement notes receding inflationary pressures.
October 15, 1998	−0.16	−0.32	4.09	After an intermeeting conference call, the Fed justifies a 0.25% target rate cut by "unsettled conditions in financial markets." The move is perceived as a positive by equity and credit markets.
June 26, 2002	0.01	−0.26	−0.27	Statement discusses declining effect of inventory investment and final demand on growth in economic activity. The FOMC mentions continuing uncertainty regarding the rate of economic recovery.
January 28, 2004	−0.01	0.25	−1.37	Statement omits reference to maintaining accommodative policy for "a considerable period." The markets interpret this wording change as an indication that the Fed will raise rates sooner than previously expected.
Panel B. Recession				
January 3, 2001	−0.39	0.30	4.89	The FOMC makes a surprise intermeeting target rate cut of 0.5%. Statement discusses weakening economic activity and consumer confidence. The move is seen by market participants as an attempt of the Fed to provide an immediate boost to the economy, reducing the need for further policy easing.
March 11, 2008	0.08	0.23	3.65	Intermeeting FOMC statement notes increasing liquidity pressures in credit markets and announces measures to address those pressures.
September 16, 2008	0.08	0.21	1.74	Statement notes increasing strains in financial markets and slowing economic growth and mentions "ongoing measures to foster market liquidity."
March 18, 2008	0.21	0.18	4.15	Statement notes weakening outlook for economic activity and uncertain inflation outlook. The Fed reiterates its commitment to supporting market liquidity.
March 20, 2001	0.00	−0.16	−2.44	Statement discusses continuing weakness of demand and production.

Periods with smoothed recession probability above (below) 0.5 are classified as recession (expansion).

changes in the path factor. Rejecting Hypothesis 1, the effect of the path factor on the stock market is negative during expansions and large and positive in recessions. When the recession probability is one, a ten-basis-point positive surprise in the path factor causes an increase in the overall stock market of approximately 96.4 basis points (or about 1%). In contrast, a similar path factor shock in expansion results in a drop in the overall stock prices of approximately 29.2 basis points (or about 0.3%). This difference between the stock market responses to the path factor in recession and expansion is both statistically and economically significant.[15] The regression results are very similar when the NBER recession dummy is used as the business cycle proxy.

Because economic expansion accounts for most of our sample period, the average effect of the path factor on stocks is negative but statistically insignificant as shown in Table 3. The positive effect of the path factor on stocks in recession suggests that the Fed's assessment of the future path of the economy made during a recession may be more important to equity investors than the expected stance of monetary policy.

To test Hypothesis 2, relating to the effect of policy statements on return volatility, we use a Threshold GARCH (TARCH) model. In addition to this hypothesis test, estimating this model complements the results shown in Table 4 for several reasons. First, using all daily returns during the sample periods rather than only returns on FOMC announcement days allows for a better test of the effect of scheduled FOMC meetings on expected returns. Second, the model is estimated for both stock and Treasury bond returns in order to test whether information about the risk-free interest rate contained in FOMC statements can explain the state dependence in the stock market's response to the path factor. Finally, modeling return volatility improves estimation efficiency. The model specification is as follows:

$$R_t = E_{t-1}(R_t) + \gamma_1 Z_{1t} RP_t + \gamma_2 Z_{1t}(1-RP)_t + \gamma_3 Z_{2t} RP_t + \gamma_4 Z_{2t}(1-RP_t) + u_t, \quad (4)$$

$$E_{t-1}(R_t) = \beta_0 + \beta_1 RP_t + \beta_2 I_t^{FOMC} RP_t + \beta_3 I_t^{FOMC}(1-RP_t), \quad (5)$$

$u_t = h_t \varepsilon_t$, where $\varepsilon_t \sim i.i.d.N(0,1)$,

$$h_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 u_{t-1}^2 I_{t-1}^- + \alpha_3 h_{t-1}^2 + \delta_1 |Z_{1t}| RP_t + \delta_2 |Z_{1t}|(1-RP_t) + \delta_3 |Z_{2t}| RP_t + \delta_4 |Z_{2t}|(1-RP_t) + \sum_{i=1}^{4} \phi_i DW_{it} + \phi_{h1} PRE_t + \phi_{h2} POST_t, \quad (6)$$

Table 3
Response of stock prices to target and path factors.
The table reports coefficients for the following regression: $R_t = \alpha + \gamma_1 Z_{1t} + \gamma_2 Z_{2t} + \varepsilon_t$, where R_t is the announcement day return on the S&P 500 index and Z_1 and Z_2 are target and path factors, respectively.

	OLS	Robust regression
Intercept	0.43 (0.11)***	0.36 (0.09)***
Target factor (γ_1)	−6.01 (1.92)***	−7.78 (1.16)***
Path factor (γ_2)	**−0.19 (1.11)**	**−1.19 (0.77)**
R^2	0.151	0.088

The sample period is from January 1994 through September 2008. The sample contains 126 observations. Only FOMC announcement days are used in estimation. The regression is estimated using (1) OLS with the White (1980) heteroskedasticity consistent covariance matrix and (2) MM weighted least squares procedure introduced by Yohai (1987). The coefficients of primary interest are shown in bold. Standard errors are shown in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

[15] To examine the time variation in the effect of policy factors in a cross-section of stocks, we also estimated the regressions in Eqs. (2) and (3) for stocks in the S&P 500 index. The pooled OLS regression results were qualitatively similar to the results for the aggregate returns. These results are not tabulated to save space.

Table 4
Effect of the business cycle on the response of stock prices to target and path factors.
The table reports coefficients for the following regression: $R_t = \alpha + \gamma_1 Z_{1t} RM_t + \gamma_2 Z_{1t}(1-RM_t) + \gamma_3 Z_{2t} RM_t + \gamma_4 Z_{2t}(1-RM_t) + \varepsilon_t$, where R_t is the announcement day return on the S&P 500 index, Z_1 and Z_2 are target and path factors, respectively, and RM_t is the filtered recession probability estimated using the model of Chauvet and Piger (2008) or the NBER recession dummy.

	With recession probability		With NBER recession dummy	
	OLS	Robust regression	OLS	Robust regression
Intercept	0.44 (0.10)***	0.37 (0.09)***	0.43 (0.09)***	0.36 (0.08)***
Target factor ×				
Recession (γ_1)	−7.90 (2.52)***	−10.02 (3.13)***	−5.69 (1.51)***	−7.25 (1.47)***
Expansion (γ_2)	−6.02 (2.18)***	−6.97 (1.78)***	−8.09 (2.15)***	−4.54 (1.74)***
0 γ_1–γ_2	−1.88	−3.05	2.40	−2.71
Path factor ×				
Recession (γ_3)	**14.69 (4.44)*** **	**9.64 (3.22)*** **	**12.67 (2.78)*** **	**10.90 (1.99)*** **
Expansion (γ_4)	**−2.87 (0.85)*** **	**−2.92 (0.89)*** **	**−2.08 (0.80)*** **	**−3.01 (0.72)*** **
γ_3–γ_4	**17.56*** **	**12.56*** **	**14.75*** **	**13.91*** **
R^2	0.282	0.144	0.383	0.178

The sample period is from January 1994 through September 2008. The sample contains 126 observations. Only FOMC announcement days are used in estimation. The regression is estimated using (1) OLS with the White (1980) heteroskedasticity consistent covariance matrix and (2) MM weighted least squares procedure introduced by Yohai (1987). The coefficients of primary interest are shown in bold. Standard errors are shown in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

where R_t is the one-day return on the S&P 500 index or on one- or ten-year Treasury bonds,[16] Z_1 and Z_2 are the target and path factors, respectively, RP_t is the filtered recession probability, I_t^{FOMC} is an indicator variable equal to one on days of scheduled FOMC meetings, DW_{it} are dummy variables for four weekdays, and PRE_t and $POST_t$ are dummy variables equal to one on trading days that immediately precede (PRE_t) and follow ($POST_t$) a holiday. I_t^- is an indicator variable equal to one for negative return shocks. The corresponding term in the conditional variance Eq. (6) accounts for the well-documented asymmetry in the impact of good and bad news on volatility. The weekday dummies are included to capture day-of-the-week effects for return volatility (e.g., Flannery & Protopapadakis, 2002; Jones et al., 1998). The pre- and post-holiday dummies are added to account for volatility changes around holidays (Flannery & Protopapadakis, 2002; Karolyi, 1995).

The expected return Eq. (5) allows testing for state dependence in the expected returns on days of scheduled FOMC meetings. Investors know that on days of scheduled macroeconomic announcements they will have to bear higher risk, and they demand higher expected returns on those days. Savor and Wilson (in press) argue that macroeconomic announcement risk is especially high in times of higher economic uncertainty, and investors demand higher compensation for bearing such risk. Economic uncertainty increases in recessions. Therefore, we expect higher average stock returns on scheduled FOMC meeting days in recessionary periods.

The model estimation results are shown in Table 5. Consistent with the average returns shown in Panel B of Table 1, the β_1 coefficient is negative for stocks and positive for Treasury bonds. Boyd et al. (2005) show a very similar finding: that bond returns tend to be higher in recessions than in expansions, and stock returns are on average higher in expansions than in recessions. At first glance, this finding seems to contradict Fama and French (1989), who show that expected returns decline when economic conditions are strong and increase when economic conditions are weak. However, it is important to distinguish between expected and realized returns. When realized returns are negative (stock prices fall) longer-term expected returns often increase. DeStefano (2004) shows that realized stock returns are especially poor indicators of expected returns prior to business cycle turning points. He documents large negative stock returns in the early stage of recession. As shown in Fig. 1, a large part of our recession sample is represented by the early stage of the recent recession.

Average stock returns on days of scheduled FOMC meetings, captured by β_2 and β_3, are higher than on non-announcement days. However, this announcement day effect on expected returns is statistically significant only in recessions. Controlling for the impact of policy factors, the average returns increase by about 1.14% on FOMC announcement days in recessions. The corresponding estimate for economic expansions is statistically insignificant. This result is consistent with our expectation that higher risk on FOMC announcement days in recessions translates into higher expected returns. This finding also provides evidence that the announcement effect on the equity risk premium documented by Savor and Wilson (in press) is state-dependent. Average Treasury bond returns are higher on days of scheduled FOMC meetings in expansion. This evidence of a risk premium is consistent with Jones et al. (1998). In recession, however, announcement day returns tend to be lower, possibly due to money flows from bonds back to stocks once the uncertainty declines after the announcement.

Consistent with Basistha and Kurov (2008), the stock market tends to respond stronger to the target factor in recessions, as shown by the statistically significant difference between γ_1 and γ_2 coefficient estimates.[17] Supporting the results in Table 4, there is also a strong asymmetry in the effect of the path factor on stock returns.

Estimates of δ_3 reported in Panel B of Table 5 show that the path factor surprises positively affect volatility of stock and Treasury bond returns during recessionary periods. This finding appears to reject Hypothesis 2. In contrast, path factor shocks in periods of economic expansion tend to reduce volatility. These results suggest that the information content of monetary policy statements released in recessions may be qualitatively different, and more difficult for the market to process, compared to the information content of such statements made in good economic times.

Monetary policy statements may contain three types of information relevant for stock values: news about the future risk-free interest rate, equity premium or corporate cash flows. We begin examining possible causes of state dependence in the stock market response to FOMC statements by analyzing the response of Treasury bonds returns to the target and path factors in different states of the economy. Estimates of the gamma coefficients for Treasury bond returns

[16] Treasury yields are commonly used as proxies for the risk-free rate (e.g., Boyd et al., 2005). Following Boyd et al. (2005), we use Treasury constant maturity yields to estimate daily returns on one-year and ten-year Treasury bonds.

[17] Basistha and Kurov (2008) examine the reaction of stock returns to the target rate surprises shown in Eq. (1), rather than to the target and path factor. As Gürkaynak et al. (2005) note, target rate surprises are more affected by changes in timing of expected policy actions than is the target factor.

Table 5
The impact of target and path factors on stock and bond prices and volatility.
The reported coefficients are for the following model:

$$R_t = E_{t-1}(R_t) + \gamma_1 Z_{1t} RP_t + \gamma_2 Z_{1t}(1-RP)_t + \gamma_3 Z_{2t} RP_t + \gamma_4 Z_{2t}(1-RP_t) + u_t,$$

$$E_{t-1}(R_t) = \beta_0 + \beta_1 RP_t + \beta_2 I_t^{FOMC} RP_t + \beta_3 I_t^{FOMC}(1-RP_t),$$

$u_t = h_t \varepsilon_t$, where $\varepsilon_t \sim i.i.d.N(0, 1)$,

$$h_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 u_{t-1}^2 I_{t-1}^- + \alpha_3 h_{t-1}^2 + \delta_1 |Z_{1t}| RP_t + \delta_2 |Z_{1t}|(1-RP_t) + \delta_3 |Z_{2t}| RP_t + \delta_4 |Z_{2t}|(1-RP_t) + \sum_{i=1}^{4} \phi_i DW_{it} + \phi_{h1} PRE_t + \phi_{h2} POST_t,$$

where R_t is the daily return on the S&P 500 index or daily return on one- or ten-year Treasury bonds, Z_1 and Z_2 are target and path factors, respectively, RP_t is the filtered recession probability, I_t^{FOMC} is an indicator variable equal to one on days of scheduled FOMC meetings, I_t^- is an indicator variable equal to one for negative return shocks, DW_{it} are dummy variables for four weekdays, and PRE_t and $POST_t$ are dummy variables for trading days that immediately precede and follow a holiday, respectively.

	S&P 500 Index	One-year treasury	Ten-year treasury
Panel A. First moment parameters			
Intercept (β_0)	0.04 (0.01)***	−0.002 (0.001)**	0.003 (0.008)
Recession (β_1)	−0.24 (0.07)***	0.015 (0.005)***	0.053 (0.045)
FOMC meeting × Recession (β_2)	**1.14 (0.58)****	**−0.017 (0.013)**	**−0.25 (0.13)****
FOMC meeting × Expansion (β_3)	**0.13 (0.09)**	**0.018 (0.003)*****	**0.04 (0.02)***
Target factor ×			
Recession (γ_1)	−12.42 (2.90)***	−0.37 (0.10)***	−1.22 (0.56)**
Expansion (γ_2)	−3.02 (1.99)	−0.58 (0.13)***	−0.08 (0.69)
γ_1–γ_2	−9.40***	0.21	−1.14
Path factor ×			
Recession (γ_3)	**13.78 (4.48)*****	**−0.38 (0.15)*****	**−1.40 (1.07)**
Expansion (γ_4)	**−4.16 (0.72)*****	**−0.33 (0.03)*****	**−3.04 (0.23)*****
γ_3–γ_4	**17.94*****	**−0.05**	**1.64**
Panel B. Second moment parameters			
α_0	0.03 (0.04)	−0.000 (0.000)***	−0.05 (0.01)***
α_1	−0.01 (0.01)	0.084 (0.017)***	0.03 (0.01)***
α_2	0.14 (0.02)***	−0.014 (0.022)	0.02 (0.02)
α_3	0.92 (0.01)***	0.897 (0.016)***	0.91 (0.01)***
δ_1	−1.96 (2.68)	−0.006 (0.006)	−0.15 (0.50)
δ_2	1.32 (1.08)	0.005 (0.005)	0.55 (0.34)
δ_3	**9.10 (2.64)*****	**0.028 (0.012)****	**1.85 (0.65)*****
δ_4	**−1.19 (0.35)*****	**−0.005 (0.001)*****	**−0.18 (0.15)**
R^2	0.017	0.050	0.024

The sample period is from January 1994 through September 2008. The sample contains 3714 daily observations and 126 FOMC meetings. The coefficients of primary interest are shown in bold. Robust standard errors are shown in parentheses (Bollerslev & Wooldridge, 1992). *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively. The coefficient estimates of the weekday and pre-and post-holiday dummies are not reported for brevity.

reported in Table 5 show no evidence of significant asymmetry in the response of bond returns to the policy factors. Treasury prices fall (and yields increase) when the Fed signals tighter policy in the future in both expansions and recessions. If the stock market's response to FOMC statements were driven primarily by changes in the future risk-free rates, stocks would not react positively to the path factor surprises regardless of the state of the economy. Since we find a positive reaction of stocks to the path factor in recessions, information about the risk-free interest rate contained in FOMC statements is unlikely to explain the state dependence in the stock market's response to the path factor.

4.2. Cross-sectional results

We proceed by looking at whether information about cash flow expectations and the equity risk premium contained in monetary policy statements depends on the state of the economy. Most empirical proxies for expected risk premium and cash flow growth rates are available only at relatively low frequencies, such as monthly. Given our relatively short sample period, direct tests of the impact of monetary policy statements on the expected risk premium and future corporate cash flows using such low-frequency proxies are likely to lack power.[18]

We use an indirect approach by looking at a cross-section of stocks on FOMC announcement days and conditioning the response of stock returns to monetary shocks on a given stock's sensitivity to discount rate and cash flow news. For example, if the positive response of stocks to monetary statements in recessions is driven by news about the equity risk premium and expected cash flows, stocks that are more sensitive to such news will respond more strongly to the path factor surprises. To test this hypothesis, we use the return decomposition approach proposed by Campbell and Shiller (1988) to estimate discount rate and cash flow betas of a cross-section of stocks.

Campbell and Shiller (1988) show that unexpected stock returns can be decomposed into news about future dividends and news about future discount rates:

$$r_{t+1} - E_t r_{t+1} = (E_{t+1} - E_t)\sum_{j=0}^{\infty} \rho^i \Delta d_{t+1+j} - (E_{t+1} - E_t)\sum_{j=0}^{\infty} \rho^i r_{t+1+j} = N_{CF,t+1} - N_{DR,t+1}, \quad (7)$$

where r_{t+1} is a log stock return, Δd_{t+1} is a one-period change in the log dividends, ρ is a constant discount factor, $N_{CF,t+1}$ represents news about future cash flows, and $N_{DR,t+1}$ is news about future expected returns. Eq. (7) is a dynamic accounting identity relating unexpected

[18] Boyd et al. (2005) use this approach in their study of unemployment news, but they have a longer sample period.

[19] Bernanke and Kuttner (2005) use a similar VAR-based approach to model the dynamics of expected returns, treating dividends as a residual.

returns to revisions in expectations of future cash flows and discount rates.

To implement this decomposition, Campbell and Vuolteenaho (2004) assume that a vector of state variables $\mathbf{z_{t+1}}$ is generated by a first-order VAR model:

$$\mathbf{z_{t+1}} = \mathbf{a} + \mathbf{\Gamma z_t} + \mathbf{u_{t+1}}, \tag{8}$$

where $\mathbf{a}$ and $\mathbf{\Gamma}$ are coefficient matrices and $\mathbf{u_{t+1}}$ is a vector of shocks. The excess return is the first state variable in the VAR. Then the discount rate news is given by

$$N_{DR,t+1} = \mathbf{e1}'\boldsymbol{\lambda}\mathbf{u_{t+1}}, \tag{9}$$

where $\mathbf{e1}$ is a vector with first element equal to one and the remaining elements equal to zero and $\boldsymbol{\lambda} \equiv \rho\mathbf{\Gamma}(I-\rho\mathbf{\Gamma})^{-1}$ is a matrix that captures the long-run effects of VAR innovations. The discount factor ρ is set to 0.9957 (0.95 annualized). The cash flow news can then be calculated using the unexpected return and the discount rate news as follows:

$$N_{CF,t+1} = \left(\mathbf{e1}' + \mathbf{e1}'\boldsymbol{\lambda}\right)\mathbf{u_{t+1}}. \tag{10}$$

The cash flow news is treated as a residual, with the state variables selected to model the dynamics of expected returns.[19] An alternative approach is to model cash flow news directly, perhaps by using a different VAR model. Studies taking this approach (e.g., Chen & Zhao, 2009) use annual financial statements data. Our relatively short sample period makes direct modeling of cash flow news difficult.

The cash flow and discount rate betas are defined as follows:

$$\beta_{i,CF} \equiv \frac{\mathrm{Cov}\left(r_{i,t}, N_{CF,t}\right)}{\mathrm{Var}\left(r^e_{m,t} - E_{t-1}r^e_{m,t}\right)}, \tag{11}$$

$$\beta_{i,DR} \equiv \frac{\mathrm{Cov}\left(r_{i,t}, -N_{DR,t}\right)}{\mathrm{Var}\left(r^e_{m,t} - E_{t-1}r^e_{m,t}\right)}, \tag{12}$$

where $r_{i,t}$ is the log excess return on stock i in month t and $r^e_{m,t}$ is the log excess market return. Since the unexpected market return is decomposed into cash flow and discount rate news, this definition of the cash flow and discount rate betas implies that the two betas sum up to the total market beta:

$$\beta_{i,m} = \beta_{i,CF} + \beta_{i,DR}. \tag{13}$$

The VAR includes five variables measured at monthly intervals: the log excess return of the CRSP value-weighted index, the log P/E ratio of the S&P 500 price index based on a ten-year moving average of S&P 500 earnings, the relative T-bill rate (the difference between the three-month T-bill rate and its one-year backward moving average), the change in the three-month T-bill rate, and the variance premium constructed as in Bollerslev, Tauchen, and Zhou (2009). The P/E ratio, the relative T-bill rate and the change in the three-month T-bill rate are commonly used for forecasting equity returns. Bollerslev et al. (2009) show that the difference between "model-free" implied and realized return variance has a strong predictive power for the aggregate equity returns, dominating popular predictor variables. Bollerslev et al. (2009) argue that this "variance premium" may be viewed as a proxy for the aggregate degree of risk aversion in the stock market. Consistent with this argument, Rosenberg and Engle (2002) find that investor risk aversion is positively correlated with the difference between implied and realized volatility. Bakshi and Madan (2006) show theoretically that the variance premium is related to risk aversion. Therefore, we include the variance premium in the VAR to model the dynamics of expected returns.

Following Bollerslev et al. (2009), we use the CBOE's VIX index as the measure of implied volatility. Monthly realized variance is estimated by summing up the squared five-minute returns on the S&P 500 index during the regular trading hours, as well as the squared close-to-open overnight returns, within a given month. The variance premium is calculated as the difference between the implied and annualized realized variance, where the implied variance is obtained by squaring the VIX.

The VAR estimation results for the period from January 1991 to September 2008 are shown in Table 6.[20] All four predictor variables are significant in the market excess return equation. Consistent with Campbell and Vuolteenaho (2004) and others, the P/E ratio negatively predicts stock returns.[21] Consistent with Bollerslev et al. (2009), the variance premium positively predicts returns. The coefficient of this variable is significant at the 1% level. The R^2 of the return equation is about 8.2%, compared to the R^2 of about 2.6% reported by Campbell and Vuolteenaho (2004) for a longer sample period. Much of the improved explanatory power comes from the variance premium.

Table 7 shows correlations of innovations in the state variables, as well as their correlations with estimated cash flow news and discount rate news. As expected, the variance premium shocks are negatively correlated with return innovations, i.e., an increase in the variance premium is accompanied by low contemporaneous returns and higher expected future returns. The correlations of return shocks with cash flow news and discount rate news are 0.55 and −0.94, respectively, showing that higher current stock returns are related to higher expected cash flows and lower expected returns. Cash flow news is negatively correlated with discount rate news. For example, bad economic times bring both negative cash flow news and higher risk premiums (e.g., Campbell & Cochrane, 1999).

After estimating the aggregate cash flow and discount rate news, we use Eqs. (11) and (12) to compute cash flow and discount rate betas for 381 S&P 500 stocks that have monthly returns in the CRSP database for the entire sample period. The covariance of individual

Table 6
VAR parameter estimates.

	Constant	$r^e_{m,t}$	PE_t	RTB_t	ΔTB_t	VP_t	R^2
$r^e_{m,t+1}$	0.12**	0.076	−0.037**	0.011***	−0.033**	0.521***	0.082
	(0.049)	(0.074)	(0.015)	(0.004)	(0.015)	(0.151)	
PE_{t+1}	0.116**	0.036	0.963***	0.010***	−0.028*	0.529***	0.970
	(0.046)	(0.071)	(0.014)	(0.003)	(0.014)	(0.144)	
RTB_{t+1}	−0.023	0.890**	0.012	0.946***	0.065	−1.574**	0.931
	(0.23)	(0.380)	(0.069)	(0.033)	(0.105)	(0.753)	
ΔTB_{t+1}	−0.092	0.974***	0.032	0.098***	−0.015	−1.625**	0.179
	(0.228)	(0.357)	(0.068)	(0.032)	(0.102)	(0.718)	
VP_{t+1}	−0.057***	0.033	0.020***	−0.002	−0.006	0.338***	0.243
	(0.019)	(0.036)	(0.006)	(0.001)	(0.006)	(0.110)	

The table shows OLS parameter estimates for first-order VAR including a constant, the excess market return ($r^e_{m,t}$), price-earnings ratio (PE_t), the relative T-bill rate (RTB_t), the change in the three-month T-bill rate (ΔTB_t), and the variance premium (VP_t). The sample period for the dependent variables is from January 1991 through September 2008. Heteroskedasticity consistent standard errors are in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

[19] Bernanke and Kuttner (2005) use a similar VAR-based approach to model the dynamics of expected returns, treating dividends as a residual.

[20] The data for 1991–1993 are included in VAR estimation so that the point-in-time discount rate and cash flow betas can be estimated at the beginning of our sample period (January 1994).

[21] Replacing the relative T-bill rate and the change in the T-bill rate with the term spread or default spread, replacing the P/E ratio with the dividend yield, or adding proxies for investor sentiment in the VAR has no qualitative effect on the results involving cash flow and discount rate betas.

Table 7
Correlations of cash flow news, discount rate news and var innovations.

	r_m^e shock	*PE* shock	*RTB* shock	*ΔTB* shock	*VP* shock	N_{CF}
PE shock	0.963***					
RTB shock	0.093	0.047				
ΔTB shock	0.109	0.060	0.990***			
VP shock	−0.241***	−0.227***	0.176**	0.163**		
N_{CF}	0.550***	0.321***	0.499***	0.506***	−0.029	
N_{DR}	−0.941***	−0.990***	0.094	0.079	0.269***	−0.235***

The table shows Pearson correlations of innovations from the VAR with the estimated cash flow news and discount rate news. The sample period for the dependent variables is from January 1991 through September 2008. *, **, and *** indicate that the correlation is statistically significant at 10%, 5%, and 1% levels, respectively.

stock returns with discount rate and cash flow news may vary over the business cycle. Therefore, we estimate point-in-time betas for each firm in the sample by computing the variance and covariances in Eqs. (11) and (12) using a 36-month rolling window. The mean cash flow beta in our sample is 0.14 with a standard deviation of 0.25. The average discount rate beta is 0.79 with a standard deviation of 0.52.

We estimate the following regression for disaggregated S&P 500 stock returns on FOMC announcement days:

$$\begin{aligned}R_{it} &= \alpha_0 + \alpha_1 RP_t + \alpha_2\beta_{it,CF} + \alpha_3\beta_{it,DR}\\ &+\left(\gamma_1+\gamma_2\beta_{it,CF}+\gamma_3\beta_{it,DR}\right)Z_{1t}RP_t + \left(\gamma_4+\gamma_5\beta_{it,CF}+\gamma_6\beta_{it,DR}\right)Z_{1t}(1-RP_t)\\ &+\left(\gamma_7+\gamma_8\beta_{it,CF}+\gamma_9\beta_{it,DR}\right)Z_{2t}RP_t + \left(\gamma_{10}+\gamma_{11}\beta_{it,CF}+\gamma_{12}\beta_{it,DR}\right)Z_{2t}(1-RP_t) + \varepsilon_{it},\end{aligned} \tag{14}$$

where $\beta_{it,CF}$ and $\beta_{it,DR}$ are the point-in-time cash flow and discount rate betas, respectively. The betas for month t are estimated using information available at the end of month $t-1$. The structure of this model is similar to that of the basic regression in Eq. (3), but this model allows the response of stock returns to the target and path factors to depend on the cash flow and discount rate betas.

The pooled OLS estimation results are reported in Table 8. The coefficient of the recession proxy is significantly positive, supporting the finding of higher announcement risk premium in bad economic times. Cash flow betas have no statistically significant effect on the impact of target rate changes on stock returns. This finding is consistent with target factor shocks having little effect on cash flow expectations. Stocks with higher discount rate betas, however, are more affected by Fed target rate decisions in both states of the economy. This result is consistent with the finding of Bernanke and Kuttner (2005) that the effect of the target rate surprises on the equity premium determines the stock market response to policy actions.

The lower half of Table 8 shows coefficient estimates pertaining to the response of stock returns to the path factor. In recession, cash flow betas have a large and positive effect on the response of stocks to path factor shocks. In expansion, this effect is smaller and statistically insignificant. This result shows that information about expected cash flows is likely to contribute to the strong positive relation between path factor shocks and stock returns in periods of weak economy reported in Tables 4 and 5. The coefficient of the interactive term between the path factor shocks and discount rate betas is positive in recessions and negative in good economic times. Since the discount rate beta is determined by the covariance of stock returns with good news about the stock values represented by unexpected declines in the discount rates, the positive coefficient of the discount rate beta in recession implies a negative effect of path factor surprises on expected returns. For example, the expected stock returns increase

Table 8
Effect of cash flow and discount rate risk on the response of daily disaggregated stock returns to target and path factors.

The reported coefficients are for the following regression:

$$\begin{aligned}R_{it} &= \alpha_0 + \alpha_1 RP_t + \alpha_2\beta_{it,CF} + \alpha_3\beta_{it,DR}\\ &+(\gamma_1+\gamma_2\beta_{it,CF}+\gamma_3\beta_{it,DR})Z_{1t}RP_t + (\gamma_4+\gamma_5\beta_{it,CF}+\gamma_6\beta_{it,DR})Z_{1t}(1-RP_t)\\ &+(\gamma_7+\gamma_8\beta_{it,CF}+\gamma_9\beta_{it,DR})Z_{2t}RP_t + (\gamma_{10}+\gamma_{11}\beta_{it,CF}+\gamma_{12}\beta_{it,DR})Z_{2t}(1-RP_t) + \varepsilon_{it},\end{aligned}$$

where R_{it} is the announcement day stock return for firm *i*, RP_t is the filtered recession probability, Z_1 and Z_2 are target and path factors, respectively, and $\beta_{it,CF}$ and $\beta_{it,DR}$ are the point-in-time cash flow and discount rate betas, respectively.

Intercept (α_0)	0.03 (0.11)
Recession (α_1)	0.83 (0.44)*
Cash flow beta (α_2)	0.53 (0.17)***
Discount rate beta (α_3)	0.26 (0.07)***
Target factor ×	
Recession (γ_1)	0.96 (2.83)
Recession × Cash flow beta (γ_2)	**−1.61 (5.28)**
Recession × Discount rate beta (γ_3)	**−9.37 (2.70)*** **
Expansion (γ_4)	1.90 (1.67)
Expansion × Cash flow beta (γ_5)	**−1.02 (3.02)**
Expansion × Discount rate beta (γ_6)	**−6.63 (1.27)*** **
Path factor ×	
Recession (γ_7)	5.35 (2.88)*
Recession × Cash flow beta (γ_8)	**9.30 (4.29)** **
Recession × Discount rate beta (γ_9)	**6.23 (2.66)** **
Expansion (γ_{10})	−1.57 (0.86)*
Expansion × Cash flow beta (γ_{11})	**2.57 (1.76)**
Expansion × Discount rate beta (γ_{12})	**−1.81 (0.64)*** **
R^2	0.066
N	47,551

The sample period is from January 1994 through September 2008. 381 S&P 500 firms are included in the sample. The regression is estimated using pooled OLS. The coefficients of primary interest are shown in bold. Panel-corrected standard errors are shown in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

when the FOMC issues a statement noting significant risk of continued economic weakness and stating the FOMC's intention to keep the funds target rate low in the months ahead.

Expected stock returns are determined by expected risk-free interest rates and excess returns. Our results reported in Table 5 imply a positive relation between the risk-free rates and path factor shocks in recession. Therefore, the positive relation between the discount rate betas and the reaction of stocks to path factor surprises in recession must be driven by the negative impact of path factor surprises on the risk premium. Overall, the regression results in Table 8 show evidence of state-dependent response of the risk premium and expected corporate cash flows to the path factor.

4.3. Robustness checks

Our sample period includes only two recessions. This limitation is common for comparable event studies (e.g., Andersen et al., 2007; Basistha & Kurov, 2008). Our results are similar with two alternative recession proxies. One of the recession proxies, the recession probability, is a continuous variable that remained elevated long after the 2001 recession ended. In an additional robustness check, we re-estimate the regression in Eq. (3) using the GDP-based recession probability index estimated with the Markov-switching model of Chauvet and Hamilton (2006). The results are very similar to those reported in Table 4.

It is possible that other economic news or Fed communications released on FOMC meeting days may affect the results of event study regressions. Gürkaynak et al. (2005) show that using monetary policy factors and stock returns measured in a narrow intraday window around the release of the FOMC statements effectively controls for such news events and mitigates possible endogeneity issues in daily data. By focusing on the narrow time window around the news release, one can be reasonably sure that the regression results reflect the stock market's response to monetary policy shocks. We perform a robustness check of the results in Table 4 using monetary policy factors and S&P 500 index futures returns computed in a narrow intraday window around the release of the FOMC statements, as in Gürkaynak et al. (2005). The results are similar to those based on daily data shown in Table 4.

In addition to FOMC statements, Federal Reserve officials communicate to the world through speeches, blogs, publication of FOMC minutes, etc. For example, Ehrmann and Fratzscher (2007) show that U.S. financial markets react to statements of the Fed Chairman. We examine the directional effect of such communications on stocks in expansion and recession by looking at days of the Fed Chairman's semiannual testimony to Congress and days of release of FOMC meeting minutes.[22] The sample for this robustness check contains 60 observations, including 30 days of the Fed Chairman's semiannual testimony and 30 days of release of FOMC minutes.[23] The path surprises used in this test are computed as the change in the one-year-ahead Eurodollar futures rate on the event day.[24] Consistent with the results shown in Table 4, the effect of the path surprises on daily stock returns is negative in expansion and positive in recession.

A potential concern about results involving cash flow and discount rate betas is that the VAR-based return decompositions used to estimate cash flow and discount rate news are imprecise (Chen & Zhao, 2009). To provide a robustness check of these results, we construct direct proxies for changes in the risk premium and expected corporate cash flows. As discussed above, the variance premium, i.e., the difference between implied and realized variance, may be viewed as a proxy for investor risk aversion. Therefore, we use unexpected daily changes in the variance premium as a proxy for changes in the expected equity risk premium.[25] The regression results show strong evidence of asymmetric response of the risk premium to the path factor. The response of the risk premium to the path factor is negative and strongly significant in recessions and positive in good economic times. The negative coefficient of the path factor in recession means, for example, that the risk premium increases when the FOMC issues a statement noting significant risk of continued economic weakness and stating the FOMC's intention to keep the target rate low in the months ahead. This result is consistent with the corresponding finding reported in Table 8.

To perform an alternative test of whether information about expected growth rates of corporate cash flows contributes to the state dependence in the stock market's response to monetary statements, we construct a proxy for expected corporate cash flows based on median analyst earnings forecasts for the S&P 500 index. The regression results show that the path factor has a significant positive effect on earnings forecasts in recessions and no significant effect on the expected earnings growth in expansions. These robustness checks support the conclusion that information about the equity risk premium and expected corporate cash flows is likely to be behind the asymmetric response of the stock market to monetary policy statements in different economic states. The results of the robustness checks are not tabulated to save space but are available upon request.

[22] Rigobon and Sack (2004) show that the implicit assumption of the event study approach is that policy shocks dominate all other shocks on event days. This assumption is plausible only for especially important events. For this reason, we limited the sample of this robustness check to days of the Fed Chairman's semiannual testimony to Congress and days of release of FOMC minutes. Both of these events are considered to be very important by market participants.

[23] The sample of days of release of FOMC minutes begins with the minutes of the December 14, 2004 meeting.

[24] The economic interpretation of the target factor has to do with unexpected decisions regarding the fed funds target rate. Since such decisions are made only on the FOMC meeting days, this robustness check is performed only for path factor surprises.

[25] The unexpected change in the variance premium is estimated as the residual from an AR(8) model fitted to the daily changes in the variance premium.

5. Summary and conclusion

This study examines whether the effect of monetary policy statements on the stock market depends on the state of the economy. Such statements contain information about the future path of monetary policy. This information can be captured by the path factor proposed by Gürkaynak et al. (2005), who show that the path factor is an important determinant of long-term Treasury yields but has no significant effect on stocks. Our results show that the path factor surprises have significant state-dependent effects on stock returns. Specifically, the response of stocks to the path factor tends to be positive in recessions and negative in good economic times.

We show that information about the expected equity premium and future corporate cash flows contained in monetary policy statements is a likely driving force behind the state dependence in the stock market's reaction. Since expected returns and corporate cash flows vary over the business cycle, our findings suggest that the Federal Reserve has important information about the economy that is unknown to investors. Some of the Fed's economic forecasts are conveyed through monetary policy statements, along with information about future monetary policy. We also provide new evidence of state dependence in the expected stock returns on days of scheduled FOMC meetings and in the effect of policy statements on stock and bond return volatility.

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