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***Highlights (for review)**

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-Stock returns respond strongly to monetary policy surprises during the 2000s.
-Stock returns do not respond to monetary policy surprises during the 1990s.
-Bond markets do not demonstrate such time variation.
-Monetary policy's time varying effect is driven by events in the stock market.

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The Time Varying Effect of Monetary Policy on Stock Returns

Dennis W. Jansen[a] Anastasia Zervou[b]

August 18, 2017

Abstract

We find that a surprise increase on the federal funds rate has five times stronger and statistically significant effects on stock returns during 2000-2007, versus statistically insignificant effects during 1989-2000. These differences are not apparent in the bond markets.

JEL classification: E52; E44; G14; C22.
Keywords: Monetary Policy transmission; Stock prices; Time Varying Parameter Model.

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1 Introduction

The monetary transmission mechanism is in the center of discussions for central bankers and academic researchers. Previous research finds that a monetary policy surprise strongly impacts the stock market (Thorbecke, 1997; Bernanke and Kuttner, 2005; Basistha and Kurov, 2008; Jansen and Tsai, 2010; Neely and Fawley, 2014). However, given many structural changes in recent decades, both in the conduct of monetary policy and in the operation of financial markets, this relationship might not have been a stable one.

Using daily information on the federal funds futures market and a long sample period we find that a monetary policy surprise strongly and significantly affects stock prices, similarly to what previous research has established.[1] However, our time varying coefficient estimates reveal that the effect comes from the period after the 2000s; monetary policy surprise has a weak and insignificant effect before that time.

Looking at the bond market we do not find evidence that the effect of monetary policy surprise differs between the 1990s and the 2000s. Thus, the lower effectiveness of monetary policy in the 1990s is an issue specific to the stock market. The rational bubble theory (Gali, 2014) provides one explanation consistent with our findings.

2 Data

We use the daily futures federal funds rate contracts, as described by Kuttner (2001) and Bernanke and Kuttner (2005) from 149 FOMC meetings over the period June 1989-December 2007. This measure assumes that the monetary policy surprise is the adjusted for the relevant days' difference between the spot-month futures rate on the announcment date, minus the previous day's one. If the monetary policy announcement did not surprise the markets, then these two contracts should be the same. We specify meeting dates as Barakchian and Crowe (2013).

[1] The Federal funds futures market opens in 1989, and we use information until the Great Recession.

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3 Econometric Model

We use the time-varying parameters model (Kim and Nelson, 2006) allowing for GARCH(1,1) heteroskedastic errors. We take into account the time-changing variance as stock returns often exhibit this feature; in addition, if we do not, we could be falsely detecting instability in the coefficients. We consider stock returns, R_t, affected by monetary policy surprise, S_t, and an indicator variable, C_t, taking into account economic conditions, i.e., recessions and expansions:

$$\begin{aligned} R_t =& \beta_{0,t} + \beta_{1,t} S_t + \beta_{2,t} C_t + e_t, \\ & e_t \mid I_{t-1} \sim i.i.d.N(0, \sigma^2_{e_t}), \end{aligned} \tag{1}$$

where

$$\sigma^2_{e_t} = a_0 + a_1 e^2_{t-1} + a_2 \sigma^2_{e_{t-1}}, \tag{2}$$

and I_{t-1} summarizes information up to time $t-1$. Also,

$$\begin{aligned} & \beta_{k,t} = \beta_{k,t-1} + \epsilon_{k,t}, \\ & \epsilon_{k,t} \sim i.i.d.N(0, \sigma^2_{\epsilon,k}), \quad k = 0, 1, 2. \end{aligned} \tag{3}$$

We estimate the system of equations (1), (2), (3), in the following state-space form:

$$R_t = \begin{bmatrix} \mathbf{X'_{t|t-1}} & 1 \end{bmatrix} \begin{bmatrix} \boldsymbol{\beta_t} \\ e_t \end{bmatrix}, \tag{4}$$

$$(R_t = \tilde{\boldsymbol{X}}'_{\mathbf{t|t-1}} \tilde{\boldsymbol{\beta}}_{\boldsymbol{t}})$$

and

$$\begin{aligned} \begin{bmatrix} \boldsymbol{\beta_t} \\ e_t \end{bmatrix} &= \begin{bmatrix} \mathbf{I_3} & \mathbf{0_3} \\ \mathbf{0_3}' & 0 \end{bmatrix} \begin{bmatrix} \boldsymbol{\beta_{t-1}} \\ e_{t-1} \end{bmatrix} + \begin{bmatrix} \epsilon_t \\ e_t \end{bmatrix}, \\ \begin{bmatrix} \boldsymbol{\epsilon_t} \\ e_t \end{bmatrix} &\sim i.i.d.N \left(\begin{bmatrix} \mathbf{0_3} \\ 0 \end{bmatrix}, \begin{bmatrix} \boldsymbol{\Sigma_\epsilon} & \mathbf{0_3} \\ \mathbf{0_3}' & \sigma^2_{e_t} \end{bmatrix} \right), \end{aligned} \tag{5}$$

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$$(\tilde{\boldsymbol{\beta}}_{\boldsymbol{t}} = \mathbf{B}\tilde{\boldsymbol{\beta}}_{\boldsymbol{t-1}} + \tilde{\boldsymbol{\epsilon}}_{\boldsymbol{t}}, \;\; \tilde{\boldsymbol{\epsilon}}_{\boldsymbol{t}} \sim i.i.d.N(\mathbf{0_4}, \boldsymbol{\Sigma}_{\tilde{\boldsymbol{\epsilon}}}))$$

where $\boldsymbol{\beta_t} = [\beta_{0,t} \quad \beta_{1,t} \quad \beta_{2,t}]'$ and $\mathbf{X_t} = [1 \;\; S_t \;\; S_t C_t]'$. $\boldsymbol{\Sigma_{\epsilon,i}}$ is a 3x3 diagonal matrix with $\sigma^2_{\epsilon,k}$ as diagonal elements, for $k = 0, 1, 2$.

The first round of Kalman filter iterations estimate the model's hyperparameters ($\boldsymbol{\Sigma}_{\tilde{\boldsymbol{\epsilon}}}$) maximizing the likelihood function. The second round produces an estimate for $\boldsymbol{\beta_t}$.

4 Empirical results

Figure 1 shows the time varying effect of monetary policy surprise on stock returns allowing for GARCH errors.[2] We see that for most of the sample period a monetary policy surprise tightening decreases stock price returns. However, the effect varies widely in strength and significance over time.[3] A monetary policy surprise has a weak and insignificant effect on stock price returns during the 1990s. Yet, there is a substantial change taking place during the 2000s, when the effect becomes stronger and statistically significant.[4]

Fixed coefficient estimation (Table 1) of the whole sample implies, similarly to previous literature, a significant decrease of 3.8% in the one-day stock price return in response to a one-percentage point surprise federal funds rate increase. However, the same surprise decreases the one-day stock price return by 1.33% during $1989-2000$ and by 7.47% during $2001-2007$, i.e., over five times more. In addition, our approach of using low-frequency data to identify monetary policy shocks, allows us to use single-equation estimation and be able to identify changes in significance level. The effect is not statistically significant in the first subsample, but it is during the second subsample. Hence, our results reveal that the strength of the monetary transmission through stock prices varies substantially over time; during the 1990s monetary policy was not able to affect stock prices nearly as much as it was able to do during the 2000s.[5]

[2] We do not find significant variation across recessions and expansions when time variation is taken into account, and thus we present results that do not address this asymmetry.

[3] The estimated time-varying intercept does not exhibit large time variation.

[4] There is also a significant period for a few observations within 1994.

[5] Omitting dates that employment reports released (7/5/91, 7/2/92, 2/4/94), does not change our conclusions.

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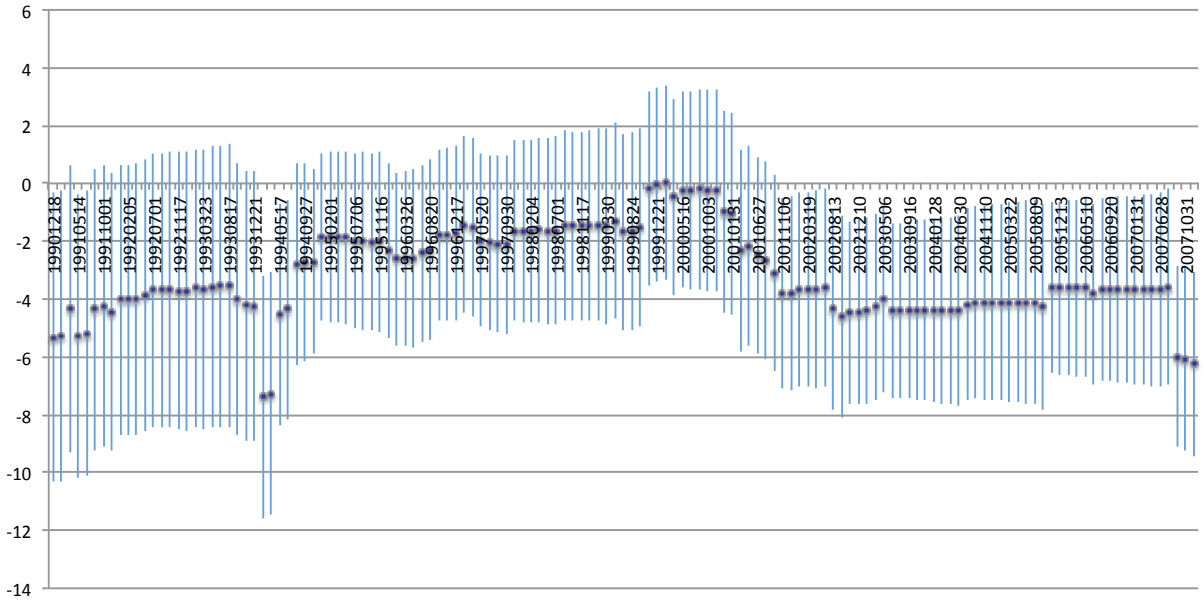

Figure 1: Time varying effects of monetary policy on stock price returns and 90% significance bands.

	All	1989-1993	1989-2000	1994-2000	1994-2007	2001-2007
$\hat{\beta}_1$	-3.869	-4.450	-1.332	-0.343	-3.773	-7.473
$t_{\hat{\beta}_1}$	-2.485	-3.228	-0.736	-0.169	-2.125	-3.109
N	149	37	93	56	112	56

Table 1: Monetary policy effects on stock price returns with Newy-West standard errors.

5 Explanations

We seek explanations for the time varying response of stock price returns to monetary policy surprise. Luca's critique implies that structural changes in monetary policy conduct or/and in the stock market operation would affect our estimation coefficients. We focus on explanations that address the timing of our findings, i.e., we consider events that occurred around the beginning of the 2000s.

Table 2 shows important dates when changes in the Federal Reserve's transparency were implemented. From there we observe a gradual process in improving communication with the public. Introducing monetary policy announcements in $1994-95$ was an important development. Announcing the direction of the Fed's future policy and releasing statements about projections of future economic risks in the early 2000s, is another important devel-

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1992-2000	Policy actions gradual shift to regularly scheduled meeting dates
03/1993	FOMC meetings minutes releases (with 6-8 week lag)
11/1993	FOMC meetings transcripts releases (with 5 year lag)
02/04/1994	Announcements after FOMC meetings about policy action rationale
08/1994	State of economy descriptions and detailed rationale for policy action after decisions
1994-2003	Gradually shifts to longer, more descriptive press releases after decisions
07/1995	Explicit announcements of changes in federal funds rate target
05/1999	Policy tilt announcements indicating most likely future interest rate action
01/2000	Replaces tilt with statement describing balance of risks to economic outlook
10/2001	Chairman Greenspan delivers speech highlighting FOMCs move towards transparency
03/2002	Votes releases of individual Committee members and preferred policy choices of dissenters
08/2003	Releases of explicit signals of future policy
02/2005	Releases of expedited minutes, available before subsequent FOMC meeting
11/2007	Releases of frequent, detailed and longer horizon forecasts

Table 2: Highlighted Changes in FOMC transparency.
Note: Part of the table is taken from Swanson (2006).

opment. The latter is a step towards forward guidance. Central bank's transparency, and especially transparency that refers to its future plans, is an institutional change in policy conduct that may affect the estimates of our model.

With respect to changes in the stock market, the early 2000s is the period when stock prices abruptly collapsed after steeply increasing in the late 1990s. Gali and Gambetti (2015) find a strong bubble component in the stock prices after the 1990s. Gali (2014)'s theory of rational bubbles suggests that contrary to the conventional view, tight monetary policy might act to increase the expected bubble component of asset prices when the bubble component is strong. According to the rational bubble theory, the existence of bubble could affect our results. Monetary policy has insignificant effects on stock returns at the beginning of the 1990s, when the bubble component starts developing. Monetary policy has essentially no effect on stock returns at the end of the 1990s, when the bubble component was strong. Monetary policy becomes more effective and has statistically significant effects on stock prices after the 2000s, when the bubble component shrinks.

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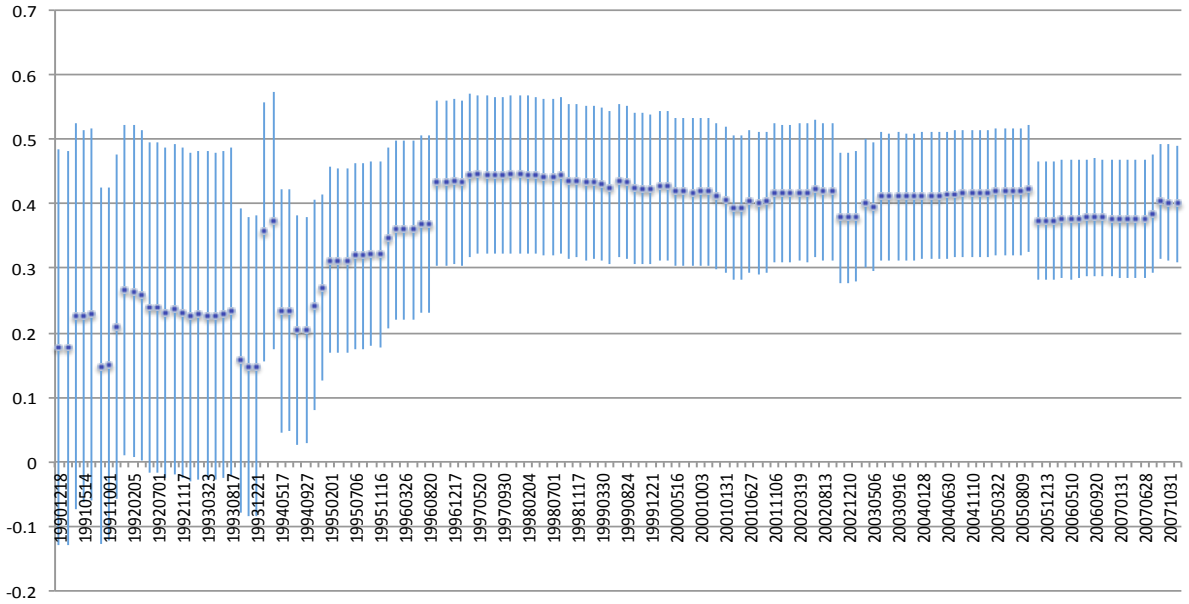

Figure 2: Time varying effects of monetary policy on 1-year bond returns and 80% significance bands.

6 Comparing to Bond Returns

Our finding that monetary policy surprise is more effective after the 2000s compared to the 1990s could be driven by changes in monetary policy conduct (e.g., transparency), or by issues specific to the stock market (e.g., bubbles). We estimate the effects of monetary policy surprise on bond returns in order to detect the source of our results. The time varying effects of monetary policy surprise on the returns of 1 and 10-year constant maturity government bonds are shown in Figures 2 and 3.[6] There we see no apparent change in strength or significance over time. The effect on the shorter maturity bonds is always significant given the 80% bands, but also using 90% bands. The effect on the longer maturity bonds is almost always significant given the 80% bands, but is not when using 90% bands.

Furthermore, residuals analysis shows that the relationship between monetary policy surprise, S_t, and the fitted values of residuals has changed over the sample for the stocks; however, it has not change for the bonds.

Finally we use the estimated series of Campbell et al. (2012) and find that the effect of path shocks on stock returns is initially not statistically significant and becomes significant

[6]We find similar effects for 2, 3, 5 and 7 years bonds.

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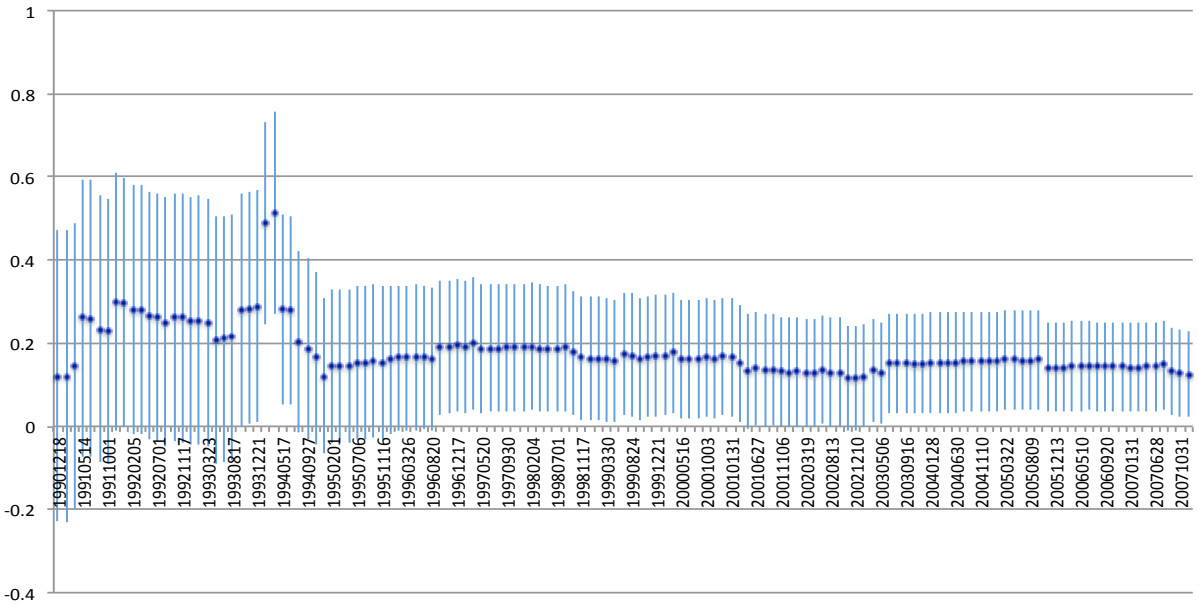

Figure 3: Time varying effects of monetary policy on 10-year bond returns and 80% significance bands.

after around 2005.[7,8] Thus, forward guidance becomes important for the stocks later in the sample. The effect on bonds is almost always significant.

7 Conclusions

We reveal substantial variation over time on the strength of monetary policy transmission through the stock market. Monetary policy surprises have weak effects on stock returns during most of the 1990s but strong and statistically significant effects during the 2000s.

Our results are in line with previous literature (Gali, 2014; Gali and Gambetti, 2015) that supports weak and insignificant contemporaneous effect of monetary policy surprise on stock prices during periods with large bubbles. However, our findings differ from previous empirical literature (Gali and Gambetti, 2015) in that we suggest that the effect of monetary policy shocks is restored after the bubble bursts.

[7] Gürkaynak et al. (2005) who's sample ends in 2004 find that the path factor is not significant for stocks.
[8] We thank Alejandro Justiniano for providing the series.

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