Disentangling the Information and Forward Guidance Effect of Monetary Policy Announcements

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Is forward guidance effective in influencing the economy?

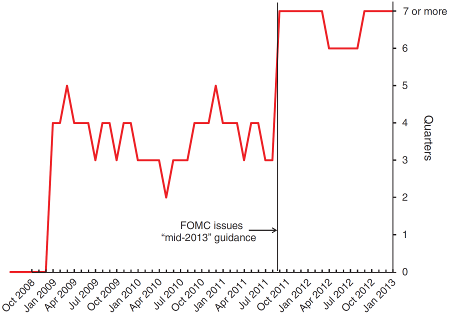
⇒ Identify a clear measure of forward guidance shocks

⇒ **Problem:** Information content of empirical monetary policy shocks (Romer and Romer, 2000, Miranda-Agrippino, 2016, …)

Motivation: FOMC on August 9, 2011

Calender-based forward guidance:

- Since March 2009: Fed funds rate will remain exceptional low for an "*extended period*"
- On August 2011: exceptional low levels will remain "*at least through mid-2013*"



Note: Expected number of quarters until first Fed funds rate hike (Source: Swanson and Williams, 2014)

⇒ Del Negro et al. (2015) and Andrade et al. (2017): expectations about economic prospects **decreased** slightly

Dimensions of monetary policy:

- **Classical monetary policy shock:** central banks set the risk-free nominal short-term interest rate $\Rightarrow$ Christiano et al. (1999)
- **Forward guidance:** central bank provides information about the future path of the short-term rate $\Rightarrow$ Gürkaynak et al. (2005)
- **Information effect:** central bank actions and statements may alter private sector expectations about the economic prospects $\Rightarrow$ Romer and Romer (2000), Nakamura and Steinsson (2018)

$\Rightarrow$ Forward guidance and information effect may have potentially contrary impact on expected economic prospects (Campbell et al., 2012, Andrade and Ferroni, 2016, Jarociński and Karadi, 2018)

How could one disentangle the effects of distinct dimensions of monetary policy?

1. Identification strategy $\Rightarrow$ baseline NKM
2. Construction of instruments for these three structural shocks
   - High-frequency data (daily)
   - Novel approach to decompose yield curve response
3. Proxy SVAR and LP-IV (Mertens and Ravn, 2013, Stock and Watson, 2018) to identify dynamic effects

Preliminary findings:

- Different policy measures have distinct effects on term structure
- Forward guidance is quite effective

Identifying Assumption

Standard New Keynesian Model

- Variations of the yield curve due to central bank announcements
  - **Forward guidance:** communication of intended path of future short rates
  - **Information effect:** private sector updates expectations about economic prospects

$$\underbrace{\Delta_\epsilon(\mathbb{E}_t[i_{t+N} - i_{t+j}])}_{\text{change in the slope of the term structure}} = \overbrace{\Delta_\epsilon((\phi_N - \phi_j)\mathbb{E}_t\hat{\Omega}_t)}^{\text{change in nowcast and projection inferred from it}} + \underbrace{(1+\psi_j)\varepsilon^{mp}_{t+N,t}}_{\text{forward guidance shock}} \quad (1)$$

- However, horizon for forward guidance is limited
  - Monetary policy's leverage over real variables depends on price stickiness

$$\Delta_\epsilon(\mathbb{E}_t[\pi_{t+T} - \pi_{t+N+1}]) = \Delta_\epsilon((\phi_T - \phi_{N+1})\mathbb{E}_t\hat{\Omega}_t) \quad (2)$$

Assumption:

$\Rightarrow$ Variations in 5-Year, 5-Year forward breakeven inflation rates are driven by the information effect but not by forward guidance NKM EH

Instruments for Monetary Policy Dimensions

- **High Frequency Identification** approach to construct instruments for monetary policy shocks (Kuttner, 2001, Gürkaynak et al., 2005)
  - Monetary policy surprises: changes in money market futures rates surrounding FOMC announcement dates
  - Daily data: eight asset price responses along the yield curve between July 1991 and September 2017
- **Factor model:** asset price responses are driven by three factors $\Rightarrow$ Swanson (2017)

$$X = F\Lambda + \xi = FUU'\Lambda + \xi \tag{3}$$

$\Rightarrow$ Orthogonal rotation matrix U $(UU' = I)$ $\Rightarrow$ structural interpretation of factors

PCA

Instruments for Monetary Policy Dimensions

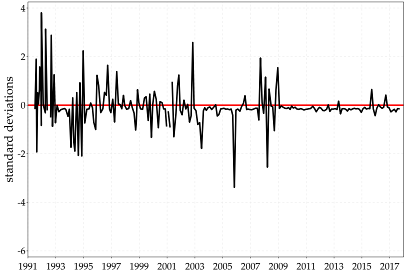
- Three distinct dimensions of monetary policy
  1. **Information effect:** single component of surprise changes that is correlated with simultaneous changes in 5-Year, 5-Year forward breakeven inflation rates (sample period: $01/2001 - 06/2008$ & $06/2009 - 09/2017$)

     $\Rightarrow$ External instrument approach (Mertens and Ravn, 2013)
  2. **Forward guidance:** news not related to a change in the current policy rate
  3. **Target shock:** surprise change in the current policy rate

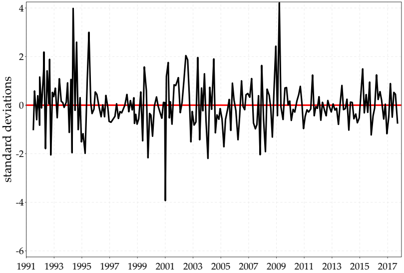
Loadings Identification

Estimated Factors

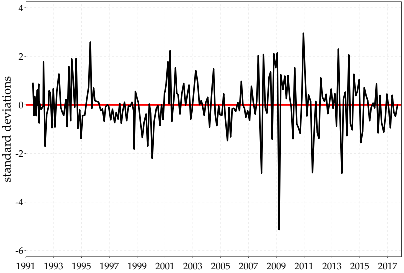
Target shock



Forward guidance shock

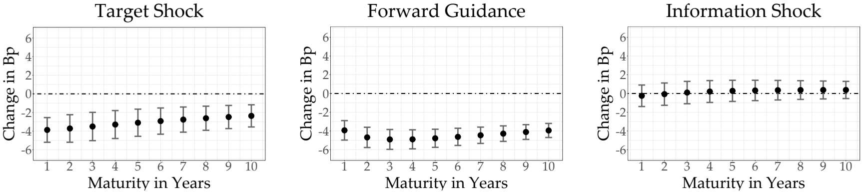


Information effect

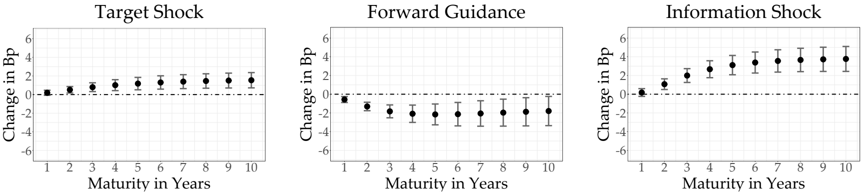


Effects on Nominal Term Structure (Adrian et al., 2013)

Expected average level of short-term interest rates



Term premium



Notes: Figures show estimated coefficients and 95% robust confidence intervals (bars) from regressions of daily changes in the components of nominal yields across different maturities on the identified shocks.

Private Information of the Fed

$$mps_t^i = \alpha + \sum_{h=0}^{3} \beta_h (\hat{X}^{GB}_{t+h|t} - \hat{X}^{SPF}_{t+h|t}) + \epsilon_t$$

$\hat{X}$	Target shock		Forward guidance		Information effect	
Δy_t	**-0.14***	(0.08)	**-0.18***	(0.11)	**0.17***	(0.10)
Δy_{t+1}	−0.05	(0.13)	0.06	(0.20)	**-0.43*****	(0.16)
Δy_{t+2}	−0.16	(0.16)	−0.08	(0.24)	−0.08	(0.15)
Δy_{t+3}	0.15	(0.15)	−0.16	(0.22)	0.31	(0.19)
π_t	−0.06	(0.08)	0.02	(0.15)	−0.08	(0.17)
π_{t+1}	0.21	(0.16)	−0.05	(0.17)	0.07	(0.15)
π_{t+2}	0.01	(0.21)	−0.05	(0.30)	−0.13	(0.32)
π_{t+3}	0.06	(0.17)	−0.10	(0.29)	**-0.63***	(0.38)
u_t	−0.21	(0.35)	0.26	(0.47)	**1.17****	(0.51)
R^2	0.07		0.07		0.18	
F	1.33		1.24		**3.94*****	

Note: Regressions include a constant; sample period: **04/1992 - 12/2012**. Independent variables: Greenbook forecast minus last SPF forecast for respective variable and quarter. Robust standard errors reported in brackets, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

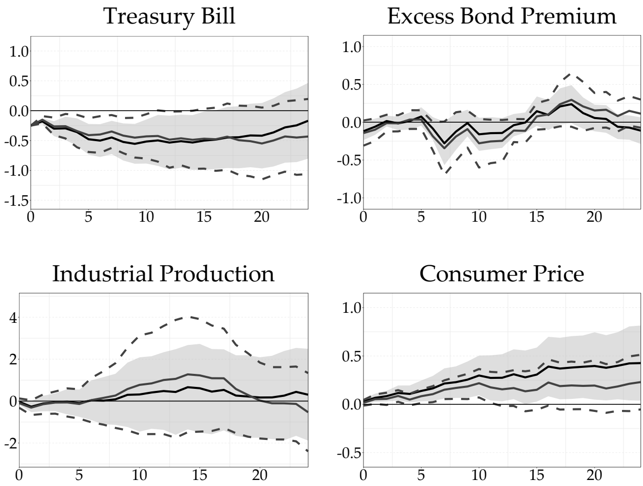
LP-IV

Instrumental variables local projection (Jordá, 2005, Stock and Watson, 2018)

$$Y_{i,t+h} = \alpha_{i,h} + \gamma_{i,h} W_t + \theta_{i,h} Y_{1,t} + \xi_{i,t+h}, \tag{4}$$

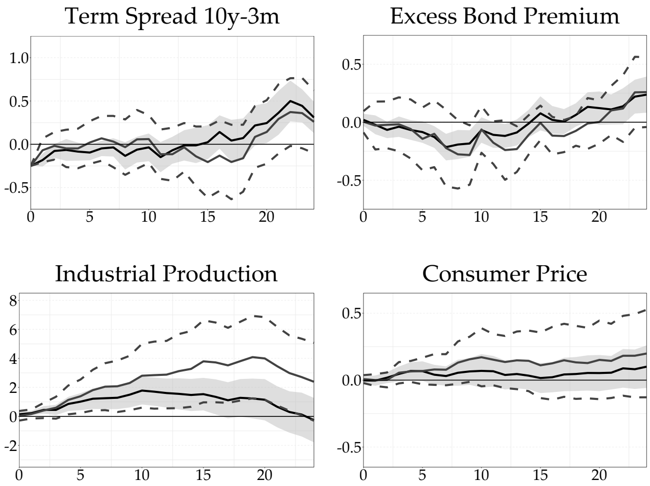
- Variables $Y_{i,t}$: Policy indicator (3-Month TBill or 10-Year-3-Month term spread), IP, CPI, EBP
- Controls W_t: lags of $Y_{i,t}$, 4 PCs the FRED-MD data set, other shock measures
- IV: $m_{j,t}$ as **instrument for policy indicator** $Y_{1,t}$
- Monthly data, July 1991 - August 2016
- Number of lags: max F-statistics (max p=12)

LP-IV: Target shock (F=26.6)



Note: Figures show responses to an expansionary monetary policy shock that increases the TBill rate by 25bp on impact. Specification with highest F value (2 lags): solid black lines are point estimates, gray areas represent 90% confidence intervals; Specification with 4 lags: dark gray lines are point estimates, grey dashed lines are 90% confidence intervals. Sample period: 07/1991 - 08/2016

LP-IV: Forward guidance (F=19.0)



Note: Figures show responses to an expansionary forward guidance shock that lowers the term spread by 25bp on impact. Specification with highest F value (11 lags): solid black lines are point estimates, gray areas represent 90% confidence intervals; Specification with 4 lags: dark gray lines are point estimates, grey dashed lines are 90% confidence intervals. Sample period: 07/1991 - 08/2016

Conclusion

Disentangling the effects of monetary policy announcements $\Rightarrow$ long-term inflation rate forwards

- Target shock and forward guidance measure uncorrelated with Fed's private information
- Distinct effects on term structure
- Reasonable dynamic effects on macro variables

Thank you for your attention.

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Appendix

Assuming that the Expectation hypothesis does not hold true

$$\Delta_\epsilon(\mathbb{E}_t[i_{t+T} - i_{t+N+1}]) = \Delta_\epsilon(\mathbb{E}_t[r_{t+T,T} - r_{t+N+1,N+1}]) + \Delta_\epsilon(\zeta^{tp}_{t,T} - \zeta^{tp}_{t,N+1}) \dots$$
$$+ \Delta_\epsilon(\mathbb{E}_t[\pi_{t+T,T} - \pi_{t+N+1,N+1}]) + \Delta_\epsilon(\zeta^{irp}_{t,T} - \zeta^{irp}_{t,N+1})$$

Change in breakeven inflation forward rates (TIPS):

$$\Delta_\epsilon(\mathbb{E}_t[\pi_{t+T} - \pi_{t+N+1}]) + \Delta_\epsilon(\zeta^{irp}_{t,T} - \zeta^{irp}_{t,N+1})$$

Additional assumption: effect of monetary policy on real risk premia $\Rightarrow$ parallel shift for longer maturities

$$\Delta_\epsilon(\mathbb{E}_t[\pi_{t+T} - \pi_{t+N+1}]) + \Delta_\epsilon(\zeta^{irp}_{t,T} - \zeta^{irp}_{t,N+1}) = \Delta_\epsilon((\phi_T - \phi_{N+1})\mathbb{E}_t[\hat{\Omega}_t])$$

back

Monetary policy in the NKM

Standard NKM with optimal monetary policy

- $r_t = i_t - \mathbb{E}_t \pi_{t+1} = r_t^n + \varepsilon_{t,t-j}^{mp}$
- $\varepsilon_{t,t-j}^{mp}$: forward guidance shock
- Expansionary shock in N: $\varepsilon_{t+N,t}^{mp} < 0 \Rightarrow E_t r_{t+N} < E_t r_{t+N}^n$
- $\mathbb{E}_t r_{t+j}^n$ is projection of current state of fundamentals, Ω_t
- Term structure of interest rates:

$$\mathbb{E}_t[i_{t+N} - i_{t+j}] = (\phi_N - \phi_j)\Omega_t + (1 + \psi_j)\varepsilon_{t+N,t}^{mp}$$

- Change due to monetary policy announcement of $\varepsilon_{t+N,t}^{mp}$:

$$\underbrace{\Delta_\epsilon(\mathbb{E}_t i_{t+N} - \mathbb{E}_t i_{t+j})}_{\text{observed change in slope of the term structure}} = \overbrace{\Delta_\epsilon(\phi_N - \phi_j)\mathbb{E}_t \hat{\Omega}_t}^{\text{change in nowcast and projection inferred from it}} + (1 + \psi_j)\varepsilon_{t+N,t}^{mp}$$

back

Assuming that:

1. $\Delta_\epsilon(\mathbb{E}_t i_{t+N} - \mathbb{E}_t i_{t+j})$ is only driven by monetary policy announcement
2. Forward guidance, $\varepsilon^{mp}_{t+N,t}$, only credible on a limited horizon $\Rightarrow N \overset{!}{<} T$

Changes exclusively driven by an **information effect**:

$$\Delta_\epsilon(\mathbb{E}_t i_{t+T} - \mathbb{E}_t i_{t+N+1}) = \Delta_\epsilon(\phi_T - \phi_{N+1})\mathbb{E}_t \hat{\Omega}_t$$

Using the Fisher equation:

$$\underbrace{\Delta_\epsilon(\mathbb{E}_t[r_{t+T} - r_{t+N+1}])}_{\text{implausible high degree of nominal rigidities}} + \overbrace{\Delta_\epsilon(\mathbb{E}_t[\pi_{t+T} - \pi_{t+N+1}])}^{\text{observable: 5-Year, 5-Year forward breakeven inflation rates}} = \Delta_\epsilon(\phi_T - \phi_{N+1})\mathbb{E}_t \hat{\Omega}_t$$

back to (*):

$$\Delta_\epsilon(\mathbb{E}_t i_{t+N} - \mathbb{E}_t i_{t+j}) = \underbrace{\Delta_\epsilon(\phi_N - \phi_j)\mathbb{E}_t \hat{\Omega}_t}_{\Delta_\epsilon(\phi_T - \phi_{N+1})\mathbb{E}_t \hat{\Omega}_t \text{ used as proxy}} + (1 + \psi_j)\varepsilon^{mp}_{t+N,t}$$

back

Principal component analysis

- Reduction in dimensionality of a dataset
- PCA performed on scheduled FOMC meeting days data only

$$z = A'X^*$$

- X^*: Input data (standardized)
- A: Orthogonal matrix; columns consisting of the eigenvectors of the correlation matrix
- z: Vector of PCs (decreasing variance, uncorrelated)

- Using the first three PC's (z_1, z_2, and z_3; explained variation 94%) as latent factors Λ in a factor model

$$X = F_{1-3}\Lambda + \xi$$

back

Identification of the instruments I

Data:

- $T = 222$ scheduled FOMC meetings in sample period July 1991 - September 2017
- $n = 8$ asset price responses on announcement days:
  - current-month and three-month-ahead Federal funds futures
  - two-, three-, and four-quarter-ahead Eurodollar futures
  - two-, five-, and ten-year Treasury yields

Factor model:

$$\underbrace{X}_{(T\times n)} = \underbrace{F}_{(T\times 3)} \underbrace{\Lambda}_{(3\times n)} +\xi$$

- latent factors F estimated as the first three principal components $\Rightarrow$ explain 94% of variance of X

Information effect factor
Partitioning of U

$$\underset{(3\times 1)}{f_t} = \underset{(3\times 3)}{U}\underset{(3\times 1)}{\tilde{f}_t}$$

$$f_t = U_{12}\begin{bmatrix}\tilde{f}_{1,t}\\ \tilde{f}_{2,t}\end{bmatrix} + U_3\tilde{f}^*_{3,t}$$

External instrument variable m_t: responses of 5-Year, 5-Year forward breakeven inflation rate at announcement days

$$\mathbb{E}\left(m_t\begin{bmatrix}\tilde{f}_{1,t}\\ \tilde{f}_{2,t}\end{bmatrix}'\right) = 0$$

$$\mathbb{E}(m_t\tilde{f}^*_{3,t}) = \phi$$

$$\begin{aligned}\mathbb{E}(m_t f_t) &= \mathbb{E}\left(m_t(U_{12}\begin{bmatrix}\tilde{f}_{1,t}\\ \tilde{f}_{2,t}\end{bmatrix} + U_3\tilde{f}^*_{3,t})'\right)\\ &= U_{12}\mathbb{E}\left(m_t\begin{bmatrix}\tilde{f}_{1,t}\\ \tilde{f}_{2,t}\end{bmatrix}'\right) + U_3\mathbb{E}(m_t\tilde{f}^*_{3,t})\\ &= U_3\phi\end{aligned}$$

Identification of the instruments III

Forward guidance factor

- Should not load into the current-month Federal funds futures rate
- Should be orthogonal to the information effect factor

$$\begin{bmatrix} \Lambda_1' \\ U_3' \end{bmatrix} U_2 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Target factor

- Should be orthogonal to the other two factors

$$\begin{bmatrix} U_2' \\ U_3' \end{bmatrix} U_1 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Rotation matrix U

- All column vectors rescaled to have a unit length (preserves unit variance normalization of F)
- U uniquely solved up to a sign convention

back

Estimated factors

Table: Estimated Factor Loadings (Sample Period: 1991-2017)

	Target Factor	Forward Guidance Factor	Information Effect Factor
FF1	−1.00	0.00	0.00
FF2	−0.61	−0.57	−0.39
EDF2	−0.64	−0.72	−0.15
EDF3	−0.53	−0.80	−0.12
EDF4	−0.44	−0.87	−0.04
2y-TR	−0.46	−0.83	0.09
5y-TR	−0.29	−0.86	0.39
10y-TR	−0.16	−0.81	0.52

Note: FF1 and FF2 denote the current-month and three-month-ahead Federal funds futures contracts, EDF2 to EDF4 denote the two-, three-, and four-quarter-ahead Eurodollar futures contracts, and the two-, five-, and ten-year Treasury yields are denoted as 2y-TR to 10y-TR.

back

Proxy SVAR approach

Reduced-form VAR:

$$A(L)Y_t = u_t$$

- $Y_t = [TBill_t \quad TP_t^{10y3m} \quad EBP_t \quad \ln IP_t \quad \ln CPI_t]'$; Lags = 12
- Sample period: $06/1990 - 08/2016$

Structural shocks:

$$u_t = B\varepsilon_t$$

Partial identification

⇒ Partitioning $B = [B^x, B^{mp}]$ and $\varepsilon_t = [\varepsilon_t^{x'} \, \varepsilon_t^{mp'}]'$

Identification conditions:

$$E(m_t \varepsilon_t^{mp\prime}) = \Phi \qquad \text{(relevance)}$$
$$E(m_t \varepsilon_t^{x\prime}) = 0 \qquad \text{(exogeneity)}$$

⇒ where m_t is the vector of proxy variables

Proxy SVAR approach

Closed-form solution by Mertens and Ravn (2013) provides estimate of

$$S_1 S_1' = (I - B^{1,x} B^{2,x^{-1}} B^{2,mp} B^{1,mp^{-1}}) \ldots \\ \times B^{1,mp} B^{1,mp'} (I - B^{1,x} B^{2,x^{-1}} B^{2,mp} B^{1,mp^{-1}})'$$

Remaining identification problem:

$$\begin{pmatrix} u_t^{\text{tb3m}} \\ u_t^{\text{term}} \end{pmatrix} = \eta u_t^x + S_1 \begin{pmatrix} \varepsilon_t^{\text{target}} \\ \varepsilon_t^{\text{fwg}} \end{pmatrix}$$

Proxy SVAR approach

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$$S_1 S_1' = (I - B^{1,x} B^{2,x^{-1}} B^{2,mp} B^{1,mp^{-1}}) \dots$$
$$\times B^{1,mp} B^{1,mp'} (I - B^{1,x} B^{2,x^{-1}} B^{2,mp} B^{1,mp^{-1}})'$$

Remaining identification problem:

$$\begin{pmatrix} u_t^{\text{tb3m}} \\ u_t^{\text{term}} \end{pmatrix} = \eta u_t^x + \begin{bmatrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{\text{target}} \\ \varepsilon_t^{\text{fwg}} \end{pmatrix}$$

Proxy SVAR approach

Closed-form solution by Mertens and Ravn (2013) provides estimate of

$$S_1 S_1' = (I - B^{1,x} B^{2,x^{-1}} B^{2,mp} B^{1,mp^{-1}}) \dots \\ \times B^{1,mp} B^{1,mp'} (I - B^{1,x} B^{2,x^{-1}} B^{2,mp} B^{1,mp^{-1}})'$$

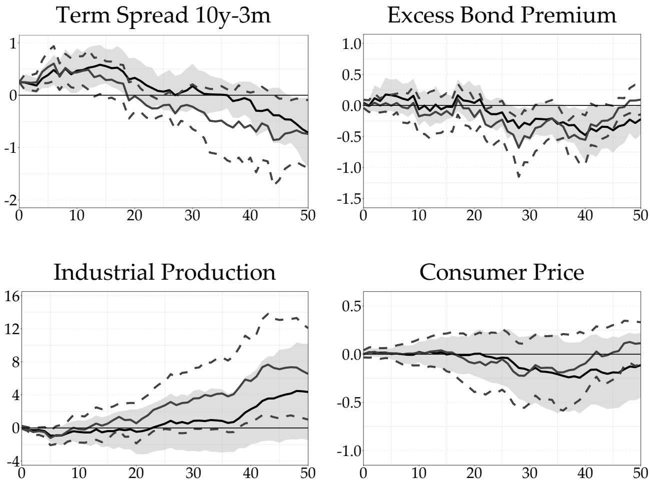
Remaining identification problem:

$$\begin{pmatrix} u_t^{\text{ff}} \\ u_t^{\text{term}} \\ u_t^{\text{ebp}} \end{pmatrix} = \eta u_t^x + \begin{bmatrix} s_{11} & 0 \\ s_{21} & s_{22} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{\text{target}} \\ \varepsilon_t^{\text{fwg}} \end{pmatrix}$$

Restrictions:

- Forward guidance does not affect policy rate on impact

LP-IV: Information effect



Notes: Figures show responses to an information effect that increases the term spread by 25bp on impact. Specification with 1 lag (highest F value): solid black lines are point estimates, gray areas represent 90% confidence intervals; Specification with 8 lags: dark gray lines are point estimates, grey dashed lines are 90% confidence intervals. Sample period: 07/1991 - 08/2016

back

SVAR Evidence: Monetary Policy

Proxy SVAR approach (Mertens and Ravn, 2013, Gertler and Karadi, 2015)

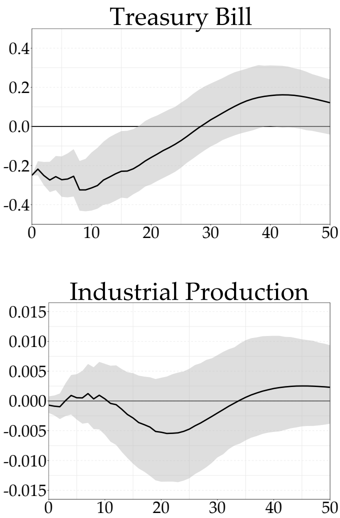
- **Monthly small scale VAR model** (12 lags): IP, CPI, EBP, 3-Month TBill, 10-Year-3-Month term spread
- Sample period: **June 1990 - August 2016**
- Proxy variables: two instruments for two shocks

$$\begin{pmatrix} u_t^{\text{tb3m}} \\ u_t^{\text{term}} \end{pmatrix} = \eta u_t^x + \begin{bmatrix} s_{11} & 0 \\ s_{21} & s_{22} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{\text{target}} \\ \varepsilon_t^{\text{fwg}} \end{pmatrix}$$

Restrictions:

- **Forward guidance** does not affect policy rate on impact

IRFs: Target shock (F=14.9)



Note: Solid lines are point estimates, blue dashed lines represent 90 percent confidence intervals (Recursive design wild bootstrap, 1000 iterations).

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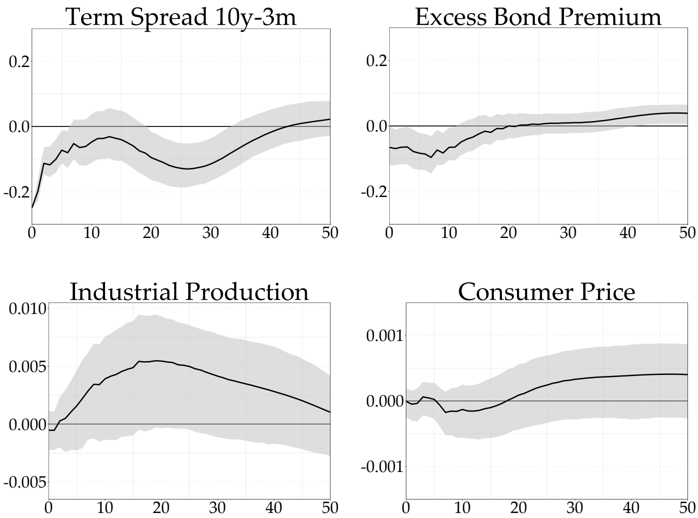
IRFs: Forward guidance (F=10.5)



Note: Solid lines are point estimates, blue dashed lines represent 90 percent confidence intervals (Recursive design wild bootstrap, 1000 iterations).

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