Central Bank Information Shocks

Marek Jarociński and Peter Karadi

October 2017

The views expressed here are solely those of the authors and do not necessarily reflect the views of the ECB
Background

- We study empirically the impact of central bank policy announcements on the economy.

- Key data: movements of financial markets within 30 minutes of a policy announcement (surprises)
  - surprises as proxies for *monetary policy shocks*, track their effect on the economy, see e.g. Kuttner (2001), Gürkaynak, Sack and Swanson (2005), Gertler and Karadi (2015)
  - We will improve the proxy by separating it from a contemporaneous shock that biases its estimated impact.
Example of a policy announcement: January 22, 2008, 2pm

Press Release

For immediate release

The Federal Open Market Committee has decided to lower its target for the federal funds rate 75 basis points to 3-1/2 percent.

The Committee took this action in view of a weakening of the economic outlook and increasing downside risks to growth. ...

surprise: change in financial asset prices between 1:50pm and 2:20pm
Economics 101: stock prices increase after a surprise cut of the fed funds rate

- After news about interest rates, stock prices should always move in the *opposite* direction to the interest rate
  
  - *lower* fed funds rate:

    → cheaper credit, demand stimulus → higher future dividends

    → lower discount rate

    ⇒ present discounted value of dividends rises = stock price *rises*
An intriguing fact that motivates this paper: stock prices often do not increase after a surprise interest rate cuts (or vice-versa)

Histogram of the surprises

![Histogram of Interest Rate and Stock Prices](image.png)
How to account for the stock price surprises that go in the wrong direction?

- Two possibilities:
  1. Stock prices are noisy
  2. Another shock (another piece of news) arrives often during the same half-hour window
What we do in this paper

- We partition monetary policy surprises into two components
  - monetary policy shock: temporary deviation from interest rate rule
  - central bank information shock: CB private info on the economy
- We measure the effect of each component on the economy
- We use a Structural VAR with a mix of high-frequency identification and sign restrictions. We study the United States and the euro area.
- Interpret the results through the lens of a macroeconomic model.
New findings

- Monetary policy surprises $\neq$ monetary policy shocks
  - They are a mix of monetary policy shocks and central bank information shocks

- These two shocks have very different effects on the macroeconomy

- Pure monetary policy shocks cause a more vigorous price decline than in the literature, price puzzles don’t appear

- Central bank information shocks look like demand shocks
Plan of this presentation

- Data
- VAR, identification
- Results: IRFs
- A structural DSGE interpretation
Data: surprises

Updated Gürkaynak, Sack and Swanson (2005) dataset

- 241 announcements of the Federal Open Market Committee (FOMC) from 1990 to 2016, each with the exact date/time $t$

- High-frequency data on fed funds futures (1, 3, 6 months), benchmark Treasury bond yields (2, 5, 10 years), log of the S&P500 stock market index (also NASDAQ and Wilshire 5000), dollar/euro exchange rate

- We compute surprises: change of the price of instrument $X$ between $t - 10\text{min}$ and $t + 20\text{min}$

- We aggregate these surprises at the monthly frequency - $m_t$
Data - low frequency

Monthly data on $y_t$:

- government bond yields
- stock market index S&P500
- real GDP and GDP deflator (interpolated using Kalman filter, Stock and Watson 2010) or industrial production, consumer prices
- Excess bond premium (Gilchrist and Zakrajsek, 2012 - fin.conditions)
- VIX (uncertainty); GDP and CPI expectations by professional forecasters; dividends on S&P500
VAR with surprises

$m_t$ - surprises (monthly), $y_t$ - macroeconomic variables (monthly)

Specification A, unrestricted:

$$\begin{pmatrix} m_t \\ y_t \end{pmatrix} = \sum_{p=1}^{P} \begin{pmatrix} B^p_{MM} & B^p_{MY} \\ B^p_{YM} & B^p_{YY} \end{pmatrix} \begin{pmatrix} m_{t-p} \\ y_{t-p} \end{pmatrix} + \begin{pmatrix} c_m \\ c_y \end{pmatrix} + \begin{pmatrix} u^m_t \\ u^y_t \end{pmatrix}. $$

Specification B, $m_t$ are i.i.d.:

$$\begin{pmatrix} m_t \\ y_t \end{pmatrix} = \sum_{p=1}^{P} \begin{pmatrix} 0 & 0 \\ B^p_{YM} & B^p_{YY} \end{pmatrix} \begin{pmatrix} m_{t-p} \\ y_{t-p} \end{pmatrix} + \begin{pmatrix} 0 \\ c_y \end{pmatrix} + \begin{pmatrix} u^m_t \\ u^y_t \end{pmatrix}. $$

One can test A vs B using the Bayes Factor of Jarocinski and Mackowiak (2017 REStat).
Bayesian estimation

- Minnesota prior on the nonzero coefficients $B_{YM}, B_{YY}$ and $\Sigma$ 
  
  \[ \equiv \text{var} \begin{pmatrix} u_{ym} \\ u_{yt} \end{pmatrix} \]

  - Independent, Normal on $Bs$, Inverted Wishart on $\Sigma$
  - Standard hyperparameter values (Sims and Zha, 1998)

- Gibbs sampler

- We also draw the missing observations on $m_t$
Identification: combine two elements

- High-frequency: only monetary policy and central bank information shocks affect $m_t$

- Sign restrictions: disentangle monetary policy and central bank information shocks based on the comovement of the interest rates and stock prices
Identification: sign restrictions

We distinguish the two shocks based on the response of the stock market to the CB communication in the half-hour window.

- Contractionary monetary policy shock: (interest rates increase)
  - Downturn $\rightarrow$ lower dividends; higher interest rate $\rightarrow$ lower present value of dividends $\Rightarrow$ stock prices drop

- Positive CB information shock: (interest rates increase)
  - Reveals a boom: higher dividends. Monetary policy tightens to partially contain it: somewhat higher discount rate $\Rightarrow$ stock prices increase
### Identification

<table>
<thead>
<tr>
<th>variable</th>
<th>Monetary Policy</th>
<th>shock Central Bank Information</th>
<th>all other</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m$ (high frequency)</td>
<td>interest rate</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>stock index</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>$y$ (low frequency)</td>
<td>...</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

For comparison: Choleski*

<table>
<thead>
<tr>
<th>variable ↓ shock →</th>
<th>mon.pol.</th>
<th>all other</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m$ interest rate</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>$y$ ...</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>
Impulse responses

Monetary Policy

surprise in 3m FF futures

CB information

surprise in S&P500

1y govt. bond yield (%)

S&P500 (100 x log)

real GDP (100 x log)

GDP deflator (100 x log)

EBP (%)
Impulse responses

- Monetary Policy surprise in 3m FF futures
- CB information
- Monetary Policy surprise in S&P500
- CB information
- 1y govt. bond yield (%)
- S&P500 (100 x log)
- Real GDP (100 x log)
- GDP deflator (100 x log)
- EBP (%)

Time (months): 0 20 40
Values: -0.05 0 0.05

- S&P500
- Real GDP
- GDP deflator
- EBP (%)

Values: -0.5 0 0.5 1
Adding other high frequency variables: breakeven rates and corporate spreads

- 2-year inflation breakeven rates: in line with interpretation

- Daily corporate spreads: as EBP
Adding other low frequency variables: expectations and dividends

- expectations of output and prices comove: looks like demand shocks

- dividends consistent with stock prices (no surprise)
Comparing with the simple proxy variable identification of monetary policy shocks

Simple proxy variable identification:

<table>
<thead>
<tr>
<th>variable ↓ shock → mon.pol.</th>
<th>all other</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m$</td>
<td>interest rate</td>
</tr>
<tr>
<td>$y$</td>
<td>...</td>
</tr>
</tbody>
</table>
Comparison with proxy variable identification
A structural interpretation

• Consistent with a canonical DSGE model with financial frictions (Gertler-Karadi, 2011, 2013)

• For real effects of monetary policy shocks
  – Nominal frictions less important
  – Financial frictions more important

in the baseline vs. the naive identification.

• Central bank information shock is akin to a (financial) demand shock
Some related literature

- Information channel/shock of monetary policy: Nakamura and Steiss-on (2016) (see also Donghai Zhang) → Estimated theoretical model – no independent communication policy, no VAR evidence


- CB information shocks: Campbell et.al. (2016) - Surprises explained by Fed private info; Hansen and McMahon (2016) - Measure of CB information shock from statements → we use the markets.
Conclusions

• We partition monetary policy surprises into two components
  – monetary policy shock
  – central bank information shock

• We measure the effect of each component on the economy
  – Their effects are very different
  – Lessons: Prices are more flexible than in the literature; Central bank information shocks look like (financial) demand shocks
A structural interpretation

• Off-the-shelf macroeconomic model (Gertler-Karadi, 2011) with
  – Nominal rigidities
  – Financial frictions
  – CB ‘communication policy’

• Implications our results for
  – Relevance of nominal rigidities vs. financial frictions
  – Nature of the central bank information shock
Model

- Workhorse New Keynesian model
  - Representative households with habit formation
  - Intermediate good producers with ‘working capital’ constraint
  - Capital producing firms with investment adjustment costs
  - Retailers with monopolistic competition and staggered price setting

- Balance sheet constrained financial intermediaries

- Central bank
Nominal rigidities

- Nominal Rigidities
  - Monopolistic competition
  - Staggered price setting la Calvo (1983)
  - Partial backward indexation

- New Keynesian Phillips curve

\[ \pi_t - \gamma P \pi_{t-1} = \beta (E_t \{ \pi_{t+1} \} - \gamma P \pi_t) + \frac{(1 - \gamma)(1 - \beta \gamma)}{\gamma} x_t \]

\( \pi_t \) is inflation, \( x_t \) output gap, \( \gamma \), \( \gamma_P \) and \( \beta \) are structural parameters
Financial frictions

- Firms borrow \((S_t)\) to finance capital \((K_t + 1)\)

\[ Q_t S_t = Q_t K_{t+1} \]

where \(Q_t\) is the value of capital

- Households lend \((S_{ht})\) subject to portfolio adjustment costs \((\kappa, \text{as in GK, 2013})\)

\[ S_{ht} = \bar{S}_h + \frac{1}{\kappa} E_t \Lambda_{t,t+1} (R_{kt+1} - R_{t+1}) \]

where \(\Lambda_{t,t+1}\) is the stochastic discount factor, \(R_{kt+1}\) is (gross) capital return, \(R_{t+1}\) is (gross) risk-free return, \(E_t \Lambda_{t,t+1} (R_{kt+1} - R_{t+1})\) is discounted excess premium
Financial frictions, cont.

- Financial intermediaries face agency friction (can abscond with $\theta$ fraction of the assets)

- Depositors set endogenous leverage ($\phi_t$) constraint to avoid this

$$Q_t(S_t - S_{ht}) = \phi_t N_t$$

(1)

where $N_t$ is bank net worth

- Financial intermediaries build net worth from retained earnings and exogenous capital injections

$$N_t = \sigma [(R_{kt} - R_t)\phi_{t-1} + R_t] N_{t-1} + \omega$$

(2)

where $\sigma$ and $\omega$ are parameters
Central bank

- Sets interest rates following a Taylor rule without smoothing

- Communication policy
  * CB has information advantage about shocks
  * It announces them together with interest rate changes
  * The announcement is credible

- Model solved by perturbation around a non-stochastic steady state
Calibration

- Three key parameters
  - Financial friction: HH portfolio adjustment cost $\kappa > 0$. As $\kappa \to 0$, no financial friction.
  - Nominal rigidity: price stickiness parameters: $\gamma \in [0, 1]$ a Calvo parameter and $\gamma_P \in [0, 1]$ the inflation indexation parameter
  - Calibrated to match the impulse responses to a monetary policy shock

- Other parameters as in GK, 2011 and GK, 2013.
Naive identification: disregarding information shocks

High price stickiness: $\gamma = 0.9$, $\gamma P = 0.80$, low financial frictions: $\kappa = 0.001$. (Shock parameters: $\sigma_i = 14\,bps$, $\rho_i = 0.67$)
Baseline identification: monetary policy shock

Reasonable price stickiness: $\gamma = 0.72$, $\gamma_P = 0$, sizable financial frictions: $\kappa = 0.13$. (Shock parameters: $\sigma_i = 14bps$, $\rho_i = 0.55$)
Baseline identification: risk shock

Contemporaneous shock to ‘capital quality’ ($\sigma_\xi = 4bps$, $\rho_\xi = 0.88$); i.e. ‘risk shock’
Results

• Result #1: Baseline identification suggests
  
  – Nominal frictions less important
  
  – Financial frictions more important

  to explain the real effects of monetary policy shocks

• Results #2: Central bank information shock is akin to a risk shock
### Variance decomposition

<table>
<thead>
<tr>
<th>variable</th>
<th>Monetary Policy</th>
<th>C.B. Information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 year</td>
<td>2 years</td>
</tr>
<tr>
<td>$m$ 3-month fed funds future</td>
<td>0.65</td>
<td>0.35</td>
</tr>
<tr>
<td>S&amp;P500</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>$y$ 1-year govt. bond yield</td>
<td>0.10</td>
<td>0.09</td>
</tr>
<tr>
<td>S&amp;P500</td>
<td>0.09</td>
<td>0.08</td>
</tr>
<tr>
<td>Real GDP</td>
<td>0.04</td>
<td>0.05</td>
</tr>
<tr>
<td>GDP deflator</td>
<td>0.06</td>
<td>0.08</td>
</tr>
<tr>
<td>Excess Bond Premium</td>
<td>0.06</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Note: Posterior means. For the i.i.d. variables in $m$ the forecast variance does not depend on the horizon, so for these variables we only report a single number.
Adding other high-frequency surprises: contemporaneous responses to shocks

<table>
<thead>
<tr>
<th>surprise in:</th>
<th>Monetary Policy</th>
<th>CB information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50pct</td>
<td>(5pct, 95pct)</td>
</tr>
<tr>
<td>SP500</td>
<td>-0.42(*)</td>
<td>(-0.516, -0.227)</td>
</tr>
<tr>
<td>WILSHIRE</td>
<td>-0.44*</td>
<td>(-0.536, -0.265)</td>
</tr>
<tr>
<td>Current month fed funds future</td>
<td>0.06*</td>
<td>(0.032, 0.073)</td>
</tr>
<tr>
<td>3-month fed funds future</td>
<td>0.05(*)</td>
<td>(0.028, 0.065)</td>
</tr>
<tr>
<td>2-year bond yield</td>
<td>0.04*</td>
<td>(0.026, 0.046)</td>
</tr>
<tr>
<td>5-year bond yield</td>
<td>0.03*</td>
<td>(0.020, 0.033)</td>
</tr>
<tr>
<td>10-year bond yield</td>
<td>0.02*</td>
<td>(0.010, 0.021)</td>
</tr>
<tr>
<td>USD per EURO</td>
<td>-0.26*</td>
<td>(-0.329, -0.179)</td>
</tr>
<tr>
<td>USD per YEN</td>
<td>-0.15*</td>
<td>(-0.205, -0.101)</td>
</tr>
</tbody>
</table>

Note: * highlights the cases where 95 or more percent of the posterior density is on the same side of zero. For the 3-month fed funds future the S&P500 this happens by construction (because of the sign restrictions), so we put the asterisk in brackets, (*).
Adding other low frequency variables: uncertainty indicators

- CB information: good news about the economy associated with lower uncertainty