A Unified Measure of Fed Monetary Policy Shocks

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Fed Policy Regimes: Effective Federal Funds Rate
Federal Reserve Balance Sheet

Alternative Measures of Monetary Policy Shocks

- 1990s VAR shock
  - Residual from monthly VAR
- Romer and Romer (monthly)
  - Use Greenbook data
- Kuttner (daily)
  - Unexpected changes in Federal funds futures rate
- Nakumura and Steinsson (intradaily)
  - Policy factor shock, PC from futures data up to 2 years
- Swanson and Rogers-Scotti-Wright (intradaily)
  - Short window around FOMC announcements
- How to unify measurement across regimes without Fed information effects?
This Paper (1) Unified Measure across Regimes

- Technique: Fama-Macbeth meets Rigobon-Sack

- Our new measure
  - Moderately highly correlated with NS shock and Swanson FG shock
  - but has crucially important differences

- Advantages of our method
  - Simplicity: estimation is straightforward, data requirements minimal
  - Broad applicability: use for countries with limited futures market data
  - Bridges periods of conventional and unconventional policy regime
Direct and indirect tests (NS, JK)
- Confirm presence of information effect in existing measures
- Find essentially no evidence of it in our measure

Why this difference?
- estimation technique: ours better filters out noise
- use of long term interest rates: Fed info effect dissipates at long end
This Paper (3) Transmission of Shocks to our Measure

- SVAR and Local Projections on full sample and post-ZLB, on JK info and non-info days

- IRFs significant and with conventional signs

- Different results with alternative shocks. Perversely signed IRFs from shocks to NS or Swanson measures during ZLB. And Perversely signed IRFs for FF3 (used by JK) on information days.
Identification: Fama-Macbeth meets Rigobon-Sack

- Two-step procedure to identify unobserved monetary policy shock.
  
  \[ \Delta R_{5,t} = \alpha_0 + e_t + \eta_t \text{ (normalization)} \]
  
  - \( e_t \) is the true monetary policy shock (unobserved)
  
  - \( \Delta R_{5,t} \) is the change in 5 yr interest rate around FOMC announcement dates
  
  \[ \Delta R_{i,t} = \alpha_i + \beta_i e_t + \epsilon_{i,t}, \text{ for } i = 1, 2, \ldots 30 \text{ (Step 1)} \]
  
  - \( \Delta R_{i,t} \) is the change in i-th year interest rate around FOMC announcement dates
  
  - \( \beta_i \) cannot be directly estimated using OLS because \( e_t \) is unobserved
  
  - Background noise \( \epsilon_{i,t} \) is greater for larger \( i \) (Nakamura and Steinsson)
Rewrite Step 1 equation as,

$$\Delta R_{i,t} = \theta_i + \beta_i \Delta R_{5,t} + \xi_{i,t} \quad \text{for } i = 1, 2 \ldots 30$$

where $\xi_{i,t} = -\beta_i \eta_t + \epsilon_{i,t}$

- Could use OLS but regressor correlated with error term due to $-\beta_i \eta_t$
- Use IDH to identify $\beta_i$ (Rigobon 2003)
- Assumption: on FOMC announcement days, volatility of $e_t$ higher, while volatility of background noise unchanged
- Fama-Macbeth uses OLS; IDH better minimizes background noise

$$\Delta R_{i,t} = \alpha_i + e_t^{aligned} \hat{\beta}_i + \nu_{i,t} \quad \text{(Step 2)}$$
- cross-section regression for each $t = 1 \ldots T$ to get the estimated shock series $e_t$, of length $T$
First Step: Time Series Regression

\[ \Delta R_{i,t} = \alpha_i + \beta_i e_t + \xi_{i,t} \]
Second Step: Cross Section Regression

- $\Delta R_{i,t} = \alpha_i + e_t^{aligned} \hat{\beta}_i + \nu_{i,t}$
- Delivers the (unobserved) monetary policy shock $e_t$. 
Data

- 2-, 5-, and 10-year Treasury rates from FRB
- 1- to 30-year zero-coupon yield estimated by Gurkaynak, Sack, and Swanson (2005)
- Macroeconomic variables from St. Louis FED: Industrial production, CPI
- Commodity price index from Thompson Reuters
- Excess bond premium (EBP) from Gilchrist and Zakrajek (2012)
- Estimated term premia from Adrian, Crump, and Moench (2013)
Note: navy vertical line denotes LSAP; blue vertical line denotes Forward Guidance; orange vertical line denotes Operation Twist.
## Correlations with Shocks in the Literature

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th>Pre-ZLB</th>
<th>ZLB</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS Shock</td>
<td>0.512</td>
<td>0.653</td>
<td>0.494</td>
</tr>
<tr>
<td>SS shock</td>
<td>0.625</td>
<td>0.684</td>
<td>0.532</td>
</tr>
<tr>
<td>R&amp;R Shock</td>
<td></td>
<td>0.131</td>
<td></td>
</tr>
<tr>
<td>Kuttner Shock</td>
<td></td>
<td>0.308</td>
<td></td>
</tr>
<tr>
<td>SS_FFR</td>
<td></td>
<td>0.373</td>
<td></td>
</tr>
<tr>
<td>SS_FG</td>
<td>0.492</td>
<td>0.605</td>
<td>0.575</td>
</tr>
<tr>
<td>SS_LSAP</td>
<td></td>
<td></td>
<td>0.365</td>
</tr>
<tr>
<td>FF3</td>
<td>0.395</td>
<td>0.593</td>
<td>0.336</td>
</tr>
</tbody>
</table>
Robustness: Alternative BRW Construction Exercises

- Normalization: 2yr, 10yr Treasury Rate
- Extend back to 1969
- Outcome variables: only 1, 2, 5, 10, 30-year zero coupon yields
- Omit QE1
- Include unscheduled FOMC meetings
- 1 day window to 2 day window
- Alternative IV (*one-day* before FOMC meeting)
Fed Information Effect

- **Direct test: NS expectations-based test**
  - regress next quarter private sector output forecast change on FOMC announcement day surprises
  - regress current month FOMC announcement day surprises on the Fed private information (the gap between the Greenbook output forecast and the blue chip output forecast)

- **Indirect test: Jarocinski and Karadi (2018)**
  - classify FOMC announcement days in which stock market goes in same direction as interest rate surprise as information effect days
  - estimated IRFs different on info and non-info days
### NS Fed Information Effect Regression

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>BRW Shock</td>
<td>0.09 (0.20)</td>
<td>0.10 (0.20)</td>
<td>0.33 (0.31)</td>
<td>0.08 (0.49)</td>
</tr>
<tr>
<td>SS Shock</td>
<td>1.94** (0.79)</td>
<td>1.81* (0.99)</td>
<td>2.38*** (0.84)</td>
<td>2.63*** (0.81)</td>
</tr>
<tr>
<td>N&amp;S Shock</td>
<td>0.81*** (0.24)</td>
<td>0.82*** (0.29)</td>
<td>0.81*** (0.27)</td>
<td>0.83** (0.33)</td>
</tr>
<tr>
<td>Observations</td>
<td>121</td>
<td>89</td>
<td>52</td>
<td>32</td>
</tr>
</tbody>
</table>
Empirically Account for Fed Private Information

- Create a central bank information proxy

- Purge raw surprises series of this proxy; re-estimate the VARs with purged series
GDP Growth Forecasts, Fed Minus Blue Chip

![Chart showing GDP growth forecasts, Fed Minus Blue Chip. The chart displays a line graph with dates from 1995m1 to 2015m1 on the x-axis and Fed Forecasts Minus Blue Chip Forecasts on the y-axis. The graph shows fluctuations over time.]
## Shock Regressed on GDP Growth Forecast Difference

<table>
<thead>
<tr>
<th></th>
<th>N&amp;S Shock</th>
<th>Updated N&amp;S Shock</th>
<th>BRW Shock</th>
<th>Swanson’s Shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fed - BC</td>
<td>2.00** (0.77)</td>
<td>1.93*** (0.70)</td>
<td>1.95 (1.53)</td>
<td>0.67** (0.31)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.22 (0.34)</td>
<td>0.24 (0.29)</td>
<td>-0.72 (0.65)</td>
<td>0.07 (0.11)</td>
</tr>
<tr>
<td>Observations</td>
<td>130</td>
<td>150</td>
<td>150</td>
<td>149</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.09</td>
<td>0.08</td>
<td>0.02</td>
<td>0.07</td>
</tr>
</tbody>
</table>
## NS Fed Information Effect Regression On JK info days

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BRW(JK Info days)</strong></td>
<td>0.69</td>
<td>0.89</td>
<td>-0.39</td>
</tr>
<tr>
<td></td>
<td>(0.78)</td>
<td>(0.81)</td>
<td>(0.92)</td>
</tr>
<tr>
<td><strong>BRW(JK non-info days)</strong></td>
<td>0.00</td>
<td>-0.02</td>
<td>0.71</td>
</tr>
<tr>
<td></td>
<td>(0.36)</td>
<td>(0.35)</td>
<td>(0.59)</td>
</tr>
<tr>
<td><strong>FF3(JK Info days)</strong></td>
<td>1.028***</td>
<td>0.871***</td>
<td>4.874***</td>
</tr>
<tr>
<td></td>
<td>(0.25)</td>
<td>(0.23)</td>
<td>(0.98)</td>
</tr>
<tr>
<td><strong>FF3(JK non-info days)</strong></td>
<td>0.25</td>
<td>0.217</td>
<td>0.416**</td>
</tr>
<tr>
<td></td>
<td>(0.20)</td>
<td>(0.23)</td>
<td>(0.15)</td>
</tr>
</tbody>
</table>
Replicating JK: SVAR on JK monetary policy and information shocks
SVAR on BRW monetary policy and information shocks

- BRW
- Industrial Production
- CPI
- Excess Bond Premium
- BRW
- IP
- CPI
- EBP
- BRW (Info.)
- Industrial Production
- CPI
- Excess Bond Premium
### Why Less Info Effect in BRW Shock? 1. Data Matters

<table>
<thead>
<tr>
<th></th>
<th>Kuttner</th>
<th>6-month</th>
<th>2-yr.</th>
<th>5-yr.</th>
<th>10-yr.</th>
<th>30-yr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coef.</td>
<td>0.296***</td>
<td>0.389*</td>
<td>0.368**</td>
<td>0.277</td>
<td>0.308</td>
<td>0.214</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td>(0.22)</td>
<td>(0.17)</td>
<td>(0.18)</td>
<td>(0.22)</td>
<td>(0.30)</td>
</tr>
<tr>
<td>Observations</td>
<td>144</td>
<td>144</td>
<td>144</td>
<td>144</td>
<td>144</td>
<td>144</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.04</td>
<td>0.024</td>
<td>0.034</td>
<td>0.017</td>
<td>0.012</td>
<td>0.004</td>
</tr>
</tbody>
</table>
Why Less Info Effect? II. Econometric Procedure

- Use BRW data with NS PCA method, obtain “PCA shock”
  - Corr(PCA, BRW) = 0.25
  - VAR results using this PCA shock: very noisy
  - Role of IDH vs. PLS? PLS more important

- PLS vs. PCA
  - PCA maximizes the ability of factors to explain variation in all variables; likely picks up a lot of noise (Kelly and Pruitt 2013)
  - PLS instead maximizes factors’ ability to capture variation in the policy indicator. Saw that there is less of an info effect in longer rates
Why Less Info Effect? III. Encompassing

- Saw above that BRW data in NS regression does not diminish evidence of information effect
- Use NS data in Fama-Macbeth regression: “tight window” shock
  - Much less evidence of “perverse” IRFs compared to using NS shock
  - Data and the econometric procedure both matter
Transmission effects of monetary policy
Note: 5-variable structural VAR model with monthly data during 1994-2017. Variables ordered as: cumulative monetary policy shock, log industrial production, log CPI, log commodity price index, EBP. Deep and shallow gray shaded areas are 68% and 90% confidence intervals produced by bootstrapping 100 times, respectively.
Note: 5-variable structural VAR model with monthly data during 1994-2017. Variables ordered:

- Cumulative monetary policy shock
- Log industrial production
- Log CPI
- Log commodity price index
- EBP

Deep and shallow gray shaded areas are 68% and 90% confidence intervals produced by bootstrapping 100 times, respectively.

Note: Deep and shallow gray shaded areas are 68% and 90% confidence intervals produced by bootstrapping 100 times, respectively.
Robustness:

- Accounting for term premium
- Use 2-, 10-y Treasury Rates as benchmark
- Use alternative IV
- Include all unscheduled FOMC meetings
- Use only 1, 2, 5, 10, 30-y Treasury Rates
- Use tight window (intraday shocks)
- Extending back to 1969
VAR estimates with alternative monetary policy shocks

- Updated NS shocks
- Swanson shocks, sum (results robust using components)
VARs with alternative monetary policy shocks (1994-2015)

BRW, NS and Swanson Shocks
VARs with alternative monetary policy shocks (2008-15)

BRW, NS and Swanson Shocks
SVARs using Purged Shock Series

SVARs using Purged Shock Series

b. NS Shock: Original (blue) versus Purged (red) Series
SVARs using Purged Shock Series

c. BRW Shock: Original (blue) versus Purged (red) Series
Conclusions

- New measure of US monetary policy shock
  - easy to implement, minimal data requirements
  - bridges periods of conventional and unconventional policymaking
  - similarities with NS and Swanson shocks, but important differences

- Fed information effect essentially non-existent in our series
  - Direct NS test and indirect JK test
  - why no Fed information effect in BRW series?
    - less information effect in long term interest rates
    - estimation technique matters

- Transmission
  - SVAR and Local Projections on full sample and post-ZLB
  - BRW shocks produce IRFs with conventional signs
  - alternative shocks: perversely signed IRFs, especially during ZLB.
IV implementation of IDH

- We prove that \( \beta_i \) can be estimated using an IV approach,

\[
[\Delta R_{i,t}] = \alpha_i + \beta_i[\Delta R_{5,t}] + \mu_{i,t} \quad i = 1, 2, \ldots, 30
\]

\[
[\Delta R_{5,t}] = (\Delta R_{5,t}, \Delta R_{5,t}^*)', \quad \Delta R_{5,t} \text{ is 1-day movement in policy indicator around the FOMC announcement, and } \Delta R_{5,t}^* \text{ is the change one week before.}
\]

- \( \beta_i \) can be estimated using an instrumental variable

\[
\Delta R_{t}^{IV} = (\Delta R_{5,t}, -\Delta R_{5,t}^*)' \text{ for the independent variable.}
\]

- Assumption: on days of FOMC meetings, variance of the true monetary policy shock increases while that of background noise is unchanged.

- Straightforward to prove that the instrument is correlated with the independent variable, but not correlated with the error term.

Note: Deep and shallow gray shaded areas are 68% and 90% confidence intervals produced by bootstrapping 100 times, respectively.
Appendix 1: Rolling Sample

![Graph showing rolling sample analysis with different beta levels]
Appendix 4: Tight Window (NS) 1994-2017

Cumulative Shock

Industrial Production

CPI

Excess Bond Premium

Note: Deep and shallow gray shaded areas are 68% and 90% confidence intervals produced by bootstrapping 100 times, respectively.

Chunya Bu, John Rogers, Wenbin Wu
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Appendix 4: Tight Window (NS) 2008-2017

Note: Deep and shallow gray shaded areas are 68% and 90% confidence intervals produced by bootstrapping 100 times, respectively.
Note: Deep and shallow gray shaded areas are 68% and 90% confidence intervals produced by bootstrapping 100 times.
Appendix 5: Tight Window (Full) 2008-2017

Note: Deep and shallow gray shaded areas are 68% and 90% confidence intervals produced by bootstrapping 100 times, respectively.
BRW, NS, RR, and Kuttner Shocks

- BRW shock, the solid blue line.
- Nakamura and Steinsson (2018) Shock, the black dotted line.
- Kuttner Shock (the 30-minute fed funds rate changes around FOMC announcement), the solid black line.
- Romer and Romer (2004) Shock, the blue dashed line.
BRW and Alternative UMP Shocks (Swanson, 2018)

- Navy bars are BRW.
- Gray bars are: SS_FFR, SS_FG, SS_LSAP, and SS_Sum, shocks to the federal funds rate, forward guidance, large asset purchases, and the sum of the three shocks, all from Swanson (2018).