Evidence for Monetary Non-Neutrality

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- Much controversy in academia
  (Often quite heated and antagonistic)
- Scientific question!!
  - Conclusive empirical evidence should be able to settle this issue
    (for those willing to base opinion on evidence as opposed to ideology)

Why Don't We Already Know?

Given central importance, how can we not already know?

Why Don't We Already Know?

Given central importance, how can we not already know?

- Changes in monetary policy occur for a reason!!
- Purpose of central banks to conduct systematic policy that reacts to developments in economy
- Fed employs hundreds of PhD economists to pore over data
- Leaves little room for exogenous variation in policy needed to identify effects of policy

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- Consider simple OLS regression:

$$\Delta y_t = \alpha + \beta \Delta i_t + \epsilon_t$$

- This regression will not identify effects of policy
- Financial crisis – event that induced Fed to act – is a confounding factor (in error term and correlated with Δi_t)

What Is the Best Evidence We Have?

When we ask prominent macroeconomists, most common answers are:[1]

- Friedman and Schwartz 63
- Volcker disinflation
- Mussa 86

Any mention of VARs and evident from other modern econometric methods is conspicuous by its absence

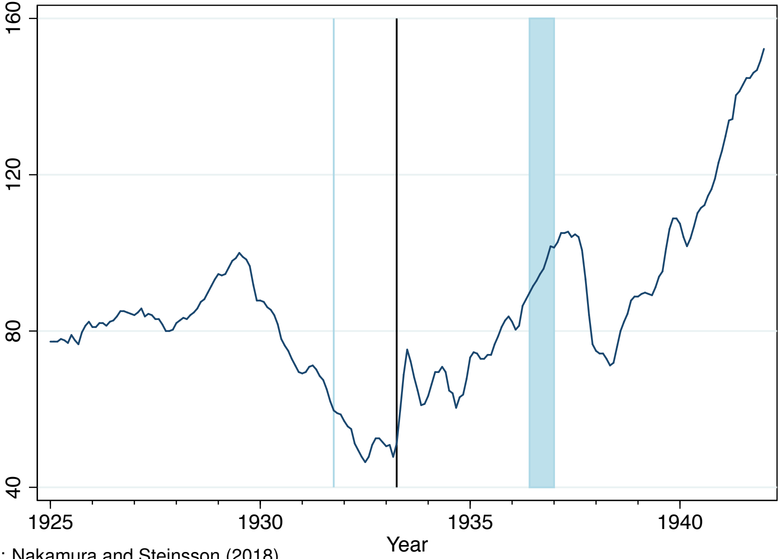
[1] Of course, a significant fraction say something along the lines of “I know it in my bones that monetary policy has no effect on output.”

Types of Evidence

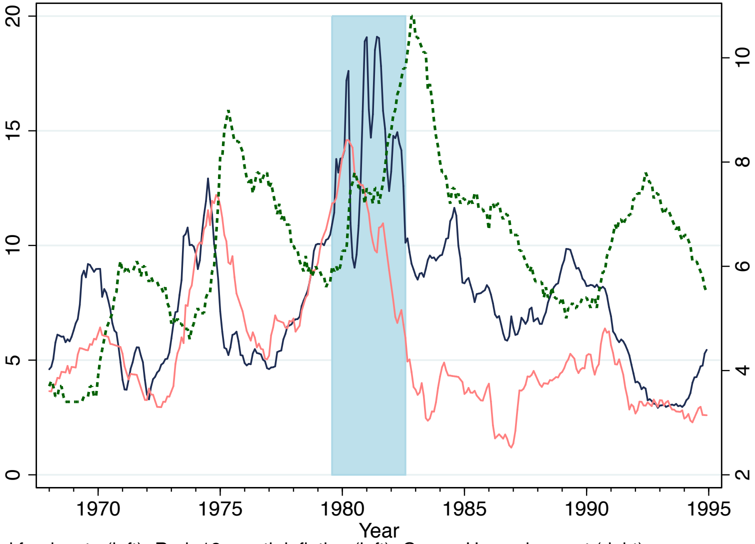
- Evidence from Large Shocks
- Discontinuity-Based Evidence / High-Frequency Evidence
- Evidence from the Narrative Record
- Controlling for Confounding Factors
  - Structural Vector Autoregressions
  - Romer and Romer (2004)

Evidence from Large Shocks

Industrial Production in U.S. Great Depression



Source: Nakamura and Steinsson (2018)



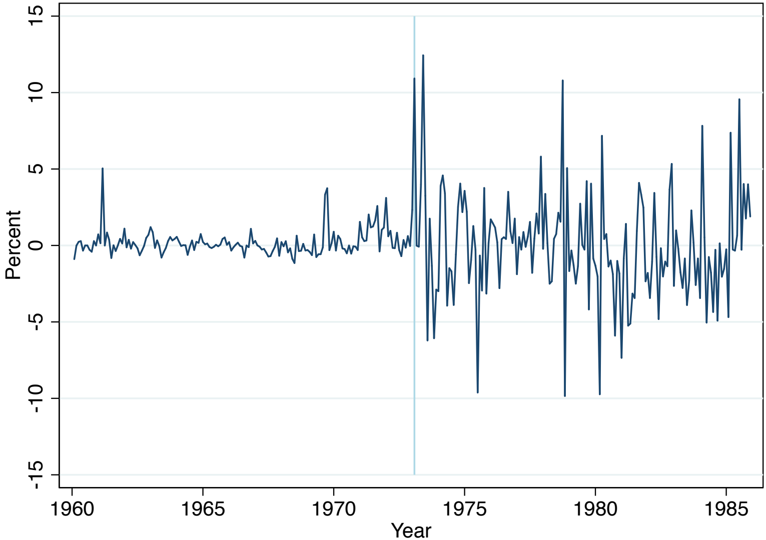
Blue: Fed funds rate (left). Red: 12-month inflation (left). Green: Unemployment (right).

Discontinuity-Based Evidence

Monetary Policy and Relative Prices

- Strong evidence for effects of monetary policy on relative prices
- Important reason: Can be assessed using discontinuity-based identification

Mussa 86 – Breakdown of Bretton Woods



Change in U.S. - German real exchange rate. Source: Nakamura and Steinsson (2018)

Monetary Policy and Real Exchange Rate

- Bretton Woods system of fixed exchange rates breaks down in Feb 73
  - This is a pure high-frequency change in monetary policy
- Sharp break in volatility of **real** exchange rate

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  - This is a pure high-frequency change in monetary policy
- Sharp break in volatility of **real** exchange rate
- Identifying assumption:
  - Nothing else changed discontinuously in Feb 73
- Imbalances had been building up gradually
  - More inflationary policy in US than in Germany, Japan, etc.
  - US running substantial current account deficit
  - Intense negotiations for months about future of system
  - Hard to see anything else that discontinuously changes in Feb 73

Monetary Policy and Real Interest Rates

- High-frequency evidence on **real** interest rates:
  - Look at narrow time windows around FOMC announcements
  - Measure real interest rate using yields on TIPS
- Identifying assumption:
  - Little else happens during narrow window (30-minutes)
  - Changes must be due to what Fed did and announced
- Nominal and real rates respond roughly one-for-one several years into term structure (see, e.g., Hansen-Stein 15, Nakamura-Steinsson 18)
- We will return to this on Thursday

Evidence on Relative Prices

Advantages:

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Disadvantages:

- No direct link to output
- Effects depend on how we interpret price changes (information, risk premia)
- Effect on output depends on various other parameters in the “real” model (e.g., IES)

High-frequency Evidence on Output?

- Much weaker!

  (e.g., Cochrane-Piazzesi 02, Angrist et al. 17)

  - Output not observed at high frequency
  - Monetary policy may affect output with "long and variable lags"
  - Too many other shocks occur over several quarters
  - Not enough statistical power to estimate effects on output using this method

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  - Too many other shocks occur over several quarters
  - Not enough statistical power to estimate effects on output using this method
- But, effect on relative prices is – arguably – the key empirical issue
  - Relative prices affect output in all models
  - Monetary and non-monetary models (e.g., NK versus RBC) differ sharply on whether monetary policy can affect relative prices

Evidence from the Narrative Record

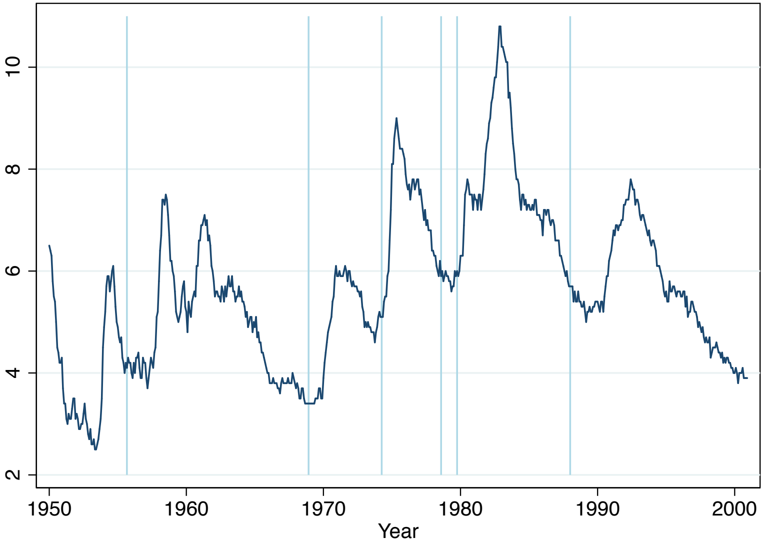
Narrative Evidence – Romer-Romer 89

Romer-Romer 89:

- Fed records can be used to identify natural experiments
- Specifically: “Episodes in which the Federal Reserve attempted to exert a contractionary influence on the economy in order to reduce inflation.”
- Six episodes (Romer-Romer 94 added a seventh)
- After each one, unemployment rises sharply
- Strong evidence for substantial real effects of monetary policy

(Paper also contains an interesting critical assessment of Friedman-Szhwartz 63)

Romer-Romer 89 Dates



Unemployment rate. Vertical lines are Romer-Romer 89 dates. Source: Nakamura and Steinsson (2018)

Romer-Romer 89 – Critiques

- Process for selecting the shock dates is opaque
  - High cost of replication
  - Similar critique applies to many complex econometric methods
- Few data points
  - May happen to be correlated with other shocks
  - Hoover-Perez 94 point out high correlation with oil shocks
- Shocks predictable suggesting endogeneity
  - Difficult to establish convincingly due to overfitting concerns
  - Cumulative number of predictability regressions run hard to know

Table A.1: Romer-Romer Dates and Oil-Shock Dates

Romer and Romer Dates	Oil Shock Dates
October 1947	December 1947
	June 1953
September 1955	June 1956
	February 1957
December 1968	March 1969
	December 1970
April 1974	January 1974
August 1978	March 1978
October 1979	September 1979
	February 1981
	January 1987
December 1988	December 1988
	August 1990

Notes: Romer-Romer dates are dates are identified by Romer and Romer (1989) and Romer and Romer (1994). Oil-shock dates up to 1981 are taken from Hoover and Perez (1994), who refine the narrative identification of these shocks by Hamilton (1983). The last three oil shock dates are from Romer and Romer (1994).

Source: Nakamura and Steinsson (2018)

Controlling for Confounding Factors

Detour: Linear RE Models and VARs

Large class of linear rational expectations models can be written as follows: (state space representation)

$$AY_{t+1} = BY_t + C\epsilon_{t+1} + D\eta_{t+1}$$

where

- Y_t is an $n \times 1$ vector
- $E[\epsilon_{t+1}|I_t] = 0$, $E[\eta_{t+1}|I_t] = 0$
- ϵ_{t+1} are exogenous shocks ($m_1 \times 1$ vector)
- η_{t+1} are prediction errors ($m_2 \times 1$ vector)
- Only some elements of Y_{t+1} have initial conditions

Example: New Keynesian Model

$$
\begin{aligned}
\pi_t &= E_t \pi_{t+1} + \kappa (y_t - y_t^n) \\
y_t &= E_t y_{t+1} - \sigma (i_t - E_t \pi_{t+1} - r_t^n) \\
i_t &= \phi_\pi \pi_t + \phi_y y_t + \nu_t
\end{aligned}
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$$

Some manipulation yields:

$$
\begin{aligned}
\pi_{t+1} &= \pi_t - \kappa y_t + \kappa y_t^n + \eta_{\pi,t+1} \\
y_{t+1} + \sigma\pi_{t+1} &= y_t + \sigma i_t - \sigma r_t^n + \eta_{y,t+1} + \sigma\eta_{\pi,t+1} \\
i_{t+1} - \phi_\pi\pi_{t+1} - \phi_y y_{t+1} &= \nu_{t+1}
\end{aligned}
$$

where $\eta_{\pi,t+1} = \pi_{t+1} - E_t\pi_{t+1}$ and $\eta_{y,t+1} = y_{t+1} - E_t y_{t+1}$

Example: New Keynesian Model

$$
\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ \sigma & 1 & 0 & 0 & 0 & 0 \\ -\phi_\pi & -\phi_y & 1 & 0 & 0 & -1 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}
\begin{bmatrix} \pi_{t+1} \\ y_{t+1} \\ i_{t+1} \\ y^n_{t+1} \\ r^n_{t+1} \\ \nu_{t+1} \end{bmatrix}
=
\begin{bmatrix} 1 & -\kappa & 0 & \kappa & 0 & 0 \\ 0 & 1 & \sigma & 0 & -\sigma & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \rho_\pi & 0 & 0 \\ 0 & 0 & 0 & 0 & \rho_y & 0 \\ 0 & 0 & 0 & 0 & 0 & \rho_i \end{bmatrix}
\begin{bmatrix} \pi_t \\ y_t \\ i_t \\ y^n_t \\ r^n_t \\ \nu_t \end{bmatrix}
$$

$$
+ \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}
\begin{bmatrix} \epsilon_{1,t+1} \\ \epsilon_{2,t+1} \\ \epsilon_{3,t+1} \end{bmatrix}
+ \begin{bmatrix} 1 & 0 \\ \sigma & 1 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}
\begin{bmatrix} \eta_{\pi,t+1} \\ \eta_{y,t+1} \end{bmatrix}
$$

- Have assumed that y^n_t, r^n_t, and ν_t are AR(1)
- System comes with only three initial conditions (for y^n_t, r^n_t, and ν_t)

Solving Linear Rational Expectations Models

- State space representation:

$$AY_{t+1} = BY_t + C\epsilon_{t+1} + D\eta_{t+1}$$

- Solution:

$$Y_t = GY_{t-1} + R\epsilon_t$$

- How to solve?
  - Blanchard-Kahn 80. See, e.g., Sims 00 or lecture notes by Den Haan
- Notice: Solution of a linear RE model is a VAR

Impulse Response Functions

- Suppose we are interested in effect of $\epsilon_{3,0}$ on y_t for $t \geq 0$

  (Recall that $\epsilon_{3,0}$ is the innovation to the monetary shock)

- Iterate forward the VAR starting at time 0:

$$Y_t = G^t Y_{-1} + G^{t-1} R \epsilon_0$$

- Suppose for simplicity that we start off in a steady state $Y_{-1} = 0$:

$$Y_t = G^{t-1} R \epsilon_0$$

- If we can estimate G and R, then we can calculate dynamic causal effect of all structural shocks

VAR Estimation: Empirical Challenges

$$Y_t = GY_{t-1} + R\epsilon_t$$

1. Some variables in true VAR may be unobservable
   - In NK model example, (y_t^n, r_t^n, and ν_t) are unobservable
   - How about solving out for these variables?
   - This typically transforms a VAR(p) into a VARMA(∞,∞) in the remaining variables
   - Implicit assumption in VAR estimation that true VARMA(∞,∞) in observable variables can be approximated by a VAR(p)

     (Problem Set 3 will have you think more about this)

VAR Estimation: Empirical Challenges

$$Y_t = GY_{t-1} + R\epsilon_t$$

2. How do we get from reduced form errors to structural errors?
   - Suppose you estimate a VAR (i.e., estimate n OLS regressions)
   - You will get:

     $$Y_t = GY_{t-1} + u_t$$

     where u_t are reduced form errors with variance-covariance matrix Σ
   - Unfortunately, Σ not enough to identify R
   - **Structural** VARs make additional assumptions to be able to identify R
     - Two ways of thinking about it: Identification of R or identification of structural shocks ϵ_t
   - Example: Short-run restrictions (see Stock-Watson 01)

Dynamic Causal Inference

Objective:

- Causal effect of change in monetary policy at time t
  on output / prices / etc. at time $t + j$

Two steps:

1. Identify shocks (exogenous variation in (say) monetary policy)
2. Estimate effects of shocks on output / prices / etc.

- Important to consider these two steps separately

- Common approach:
  - Regress fed funds rate on output, inflation, etc. + a few lags of fed funds rate, output, inflation, etc.

$$i_t = \alpha + \phi_y y_t + \phi_\pi \pi_t + [\text{four lags of } i_t, y_t, \pi_t] + \epsilon_t$$

  - View residual as exogenous variation in monetary policy
- Equivalent to performing a Cholesky decomposition on reduced form errors from VAR, ordering fed funds rate last (See Stock-Watson 01)

SVARs: Identifying the Shocks

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What can go wrong?

1. Reverse causation:
   - Assumption begin made: Correlation between i_t and (π_t, y_t) is due to (π_t, y_t) influencing i_t but not the other way around
   - If i_t influences (π_t, y_t) (contemporaneously), we have a "simultaneous equation problem" (ϵ_t correlated with (π_t, y_t))
   - Assumption being made: i_t is "fast-moving" variable, while π_t and y_t are slow moving. So i_t doesn't affect π_t and y_t contemporaneously

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Often, the discussion of identification stops here and seems surprisingly inocuous. Where did the rabbit go into the hat?

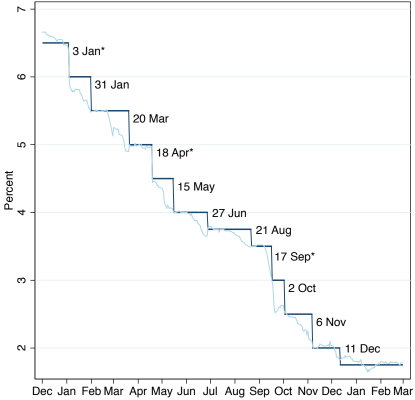
SVARs: Identifying the Shocks

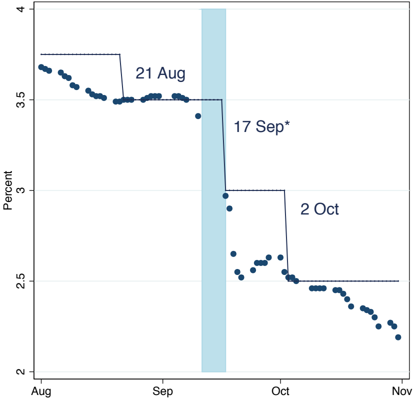
$$i_t = \alpha + \phi_y y_t + \phi_\pi \pi_t + \text{[four lags of } i_t, y_t, \pi_t, \text{etc.]} + \epsilon_t$$

What can go wrong?

2. Omitted variables bias:
    - There may be other variables that affect i_t and also y_{t+j}
    - Fed bases policy on huge amount of data
        - Banking sector, stock market, foreign developments, commodity prices, terrorist attacks, temporary investment tax credit, Y2K, etc., etc.
    - Too many variables to include in regression!
    - Any information used by Fed and not sufficiently controlled for by included controls will result in endogenous variation in policy being viewed as exogenous shock to policy

WAS 9/11 A MONETARY SHOCK?





Dark line: Fed funds target. Light line/dots: 1-month eurodollar rate. * indicates unscheduled meeting.
Sample period: Dec 2000 - Feb 2002. Source: Nakamura and Steinsson (2018)

WAS 9/11 A MONETARY SHOCK?

- According to structural VARs: Yes!?!
  - Nothing had yet happened to controls in VAR
  - Drop in rates cannot be explained, therefore an exogenous shock
- In reality: Obviously not!
  - Fed dropped rates in Sept 2001 in response to terrorist attack, which affected Fed's assessment of future output growth and inflation
- Any unusual (from perspective of VAR) weakness in output growth after 9/11, perversely, attributed to exogenous easing of monetary policy
- Highly problematic

News Shocks and VARs

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News Shocks and VARs

- 9/11 an example of a news shock
  - Almost nothing happened to contemporaneous output
  - But event contains news about future output
- Why not just include fast moving variables like stock/bond prices in interest rate equation to capture news?
  - Only makes sense if these variables not affected by contemporary monetary policy
  - But that is clearly not the case
  - Post-treatment controls (endogenous or “bad” controls)

Identifying Assumptions in SVARs

- "The" identifying assumption in a monetary VAR often described as:
  - Fed funds rate does not affect output, inflation, etc. contemporaneously
- Seems like magic:
  - You make one relatively innocuous assumption
  - Violá: You can estimate dynamic causal effects of monetary policy

Identifying Assumptions in SVARs

- Timing assumption not only identifying assumption being made
- Timing assumption rules out reverse causality
  - Contemporaneous correlation assumed to go from output to interest rates
  - Not other way around
- Bigger concern: Omitted variables bias
  - Monetary policy and output may be reacting to some other shock
  - If not sufficiently proxied by included controls, this shock will cause omitted variables bias (e.g., 9/11)

Romer-Romer 04

- Hopeless to control individually for everything in Feds information set
- Alternative approach:
  - Control for Fed's own forecasts (Greenbook forecasts)
- Key idea:
  - Endogeneity of monetary policy comes from **one thing only**: What Fed thinks will happen to the economy
  - Controlling for this is sufficient

Constructing the Shocks Series

Romer-Romer's shock series addresses two problems:

1. Fed has imperfect control over fed funds rate
    - More of a problem before Greenspan era
    - Movements in FFR relative to FOMC target are endogenous (FFR rises relative to target in response to good news about future output)
    - Romer-Romer construct FFR target series

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     (FFR rises relative to target in response to good news about future output)
   - Romer-Romer construct FFR target series
2. Movements in FOMC's FFR target are endogenous
   - "Anticipatory effects" important
     (e.g., Fed lowers rates in anticipation of economic weakness)
   - Use of Fed's Greenbook forecasts control for such endogeneity
     (Greenbook typically prepared six days before meeting)

Controlling for Greenbook Forecast

Romer-Romer's specification:

$$\begin{aligned} \Delta ff_m &= \alpha + \beta ffb_m + \sum_{i=-1}^{2} \gamma_i \Delta \tilde{y}_{mi} + \sum_{i=-1}^{2} \lambda_i (\Delta \tilde{y}_{mi} - \Delta \tilde{y}_{m-1,i}) \\ &\quad + \sum_{i=-1}^{2} \phi_i \tilde{\pi}_{mi} + \sum_{i=-1}^{2} \theta_i (\tilde{\pi}_{mi} - \tilde{\pi}_{m-1,i}) + \rho \tilde{u}_{m0} + \epsilon_m \end{aligned}$$

- Δff_m change in intended FFR at meeting
- ffb_m level before meeting
- $\tilde{y}$, $\tilde{\pi}$, $\tilde{u}$ forecasts of output, inflation, and unemployment
- Both forecasts and change in forecasts since last meeting included

Does this Make Sense?

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  It is important to note that the goal of this regression is not to estimate the Federal Reserve's reaction function as well as possible. What we are trying to do is to purge the intended funds rate series of movements taken in response to useful information about future economic developments. Once we have accomplished this, it is desirable to leave in as much of the remaining variation as possible.

Cochrane (2004)

> ***Proposition 1:*** *To measure the effects of monetary policy on* ***output*** *it is enough that the shock is orthogonal to* ***output*** *forecasts. The shock does not have to be orthogonal to price, exchange rate or other forecasts. It may be predictable from time t information; it does not have to be a shock to agent's or the Fed's entire information set.*

(no proof provided)

> *All the shock has to do is remove the reverse causality from output forecasts.*

COCHRANE (2004)

Preferred specification for effects on output:

$$\Delta ff_m = \alpha + \sum_{i=-1}^{2} \gamma_i \Delta \tilde{y}_{mi} + \beta ff_{m-1} + \delta \Delta ff_{m-1} + \epsilon_m^y$$

Preferred specification for effects on inflation:

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- Lagged FFR only included to make shocks serially uncorrelated, which simplifies interpretation
- No need to include other controls
- In fact, better not to, since this keeps more shocks

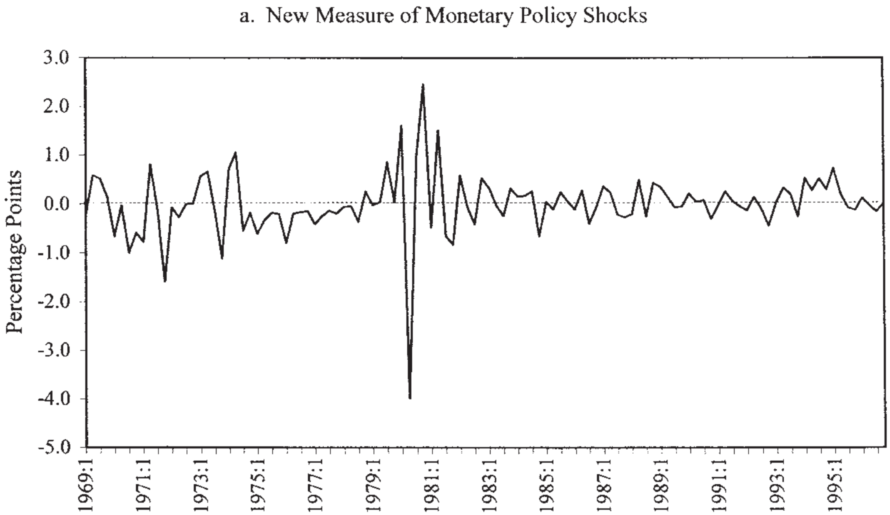
Romer-Romer 04 / Cochrane 04: What Is a Monetary Shock?

- Fed does not roll dice
- Every movement in intended fed funds rate is a response to something
- Some are responses to something that directly affects outcome variable of interest
  - These are endogenous
- Reactions to anything else (exchange rate, political pressure, etc) **conditional on output forecast** count as a shock

What Are the Shocks?

1. Variation in Fed operating procedure important
   - E.g., emphasis on monetary quantities in 1979-1982
2. Variation in policy makers' beliefs about workings of economy
   - In early 1970's Fed believed inflation highly unresponsive to slack (Romer-Romer 02)
3. Variation in policy maker preferences/goals
   - E.g., time-varying distaste for inflation
4. Political influences
   - E.g., Arthur Burns set loose policy in 1977 to get re-appointed
5. Pursuit of other objectives
   - At some times, Fed concerned about exchange rate

Romer-Romer Shocks



Source: Romer and Romer (2004).

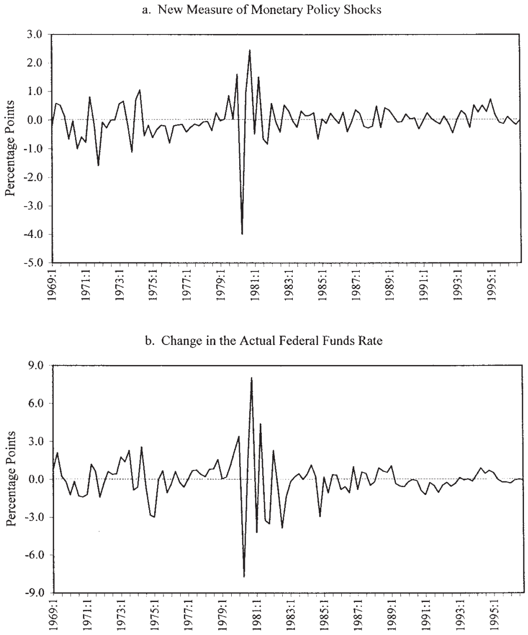


FIGURE 1. MEASURES OF MONETARY POLICY

Source: Romer and Romer (2004).

Predictable Monetary Shocks?

- Cochrane (2004) argues monetary shocks can be predictable
- Does this make sense?

Predictable Monetary Shocks?

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- Does this make sense?

- It does not in and of itself cause endogeneity concerns
- It does complicate interpretation
- Shocks can have effects both upon announcement and when they are implemented
  - Upon announcement: Yield curve will move
  - Upon implementation: Short rates themselves move

What Do We Do with These Shocks?

- Dynamic causal inference involves two steps:
    1. Identifying exogenous variation in policy (the shocks)
    2. Estimating an impulse response given the shocks

- Three methods to construct impulse response:
    1. Directly regress variable of interest on shock (Jorda 05)
    2. Iterate forward VAR
    3. Iterate forward univariate AR specification (Romer-Romer 04)

Direct Regressions – Jorda Specification

- Simple approach: Regress variable of interest directly on shock: (perhaps including some pre-treatment controls)

$$y_{t+j} - y_{t-1} = \alpha + \beta\nu_t + \Gamma X_{t-1} + \epsilon_t$$

  - Variable of interest: $y_{t+j} - y_{t-1}$
  - Monetary shock: ν_t
  - Pre-treatment controls: X_{t-1}
- Separate regression for each horizon j
- This imposes minimal structure (other than linearity)
- Specification advocated by Jorda 05 (often called "local projection")

VAR Impulse Responses

- Construct impulse response by iterating forward entire estimated VAR system
- Embeds whole new set of strong identifying assumptions
  - Not only interest rate equation that must be correctly specified
  - Entire system must be correct representation of dynamics of all variables in the system
  - I.e., whole model must be correctly specified (including number of shocks, number of lags, relevant variable observable)
  - Recall earlier discussion of true VARMA(∞,∞) in observed variables being approximated by VAR(p)
  - See discussion in Plagborg-Moller and Wolf 19

Romer-Romer 04 Impulse Response

$$\Delta y_t = a_0 + \sum_{k=1}^{11} a_k D_{kt} + \sum_{i=1}^{24} b_i \Delta y_{t-i} + \sum_{j=1}^{36} c_j S_{t-j} + e_t$$

- Δy_t monthly change in industrial production
- D_{kt} month dummies (they use seasonally unadjusted data)
- S_t monetary shocks
- Assume money doesn't affect output contemporaneously
  (No contemporaneous monetary shock)
- Impulse response:
  - Effect on y_{t+1} is c_1
  - Effect on y_{t+2} is $c_1 + (c_2 + b_1 c_1)$

Lagged Dependent Variables

$$\Delta y_t = a_0 + \sum_{k=1}^{11} a_k D_{kt} + \sum_{i=1}^{24} b_i \Delta y_{t-i} + \sum_{j=1}^{36} c_j S_{t-j} + e_t$$

- Inclusion of lagged dependent variables may induce bias
- b_is are estimated off of dynamics of output to **all shocks**
- If dynamics after monetary shocks are different, inclusion of lagged output terms will induce bias

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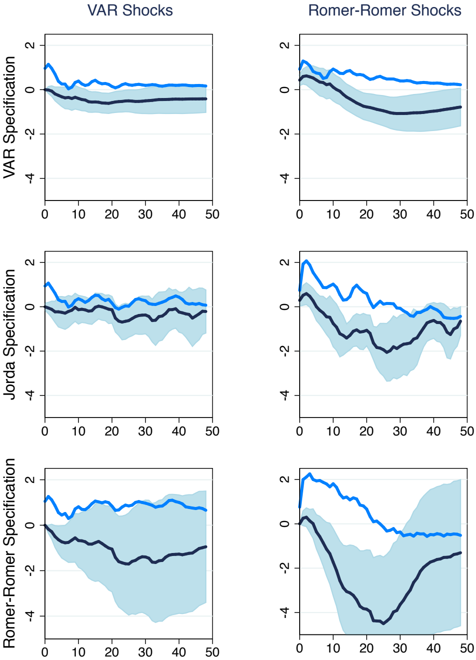
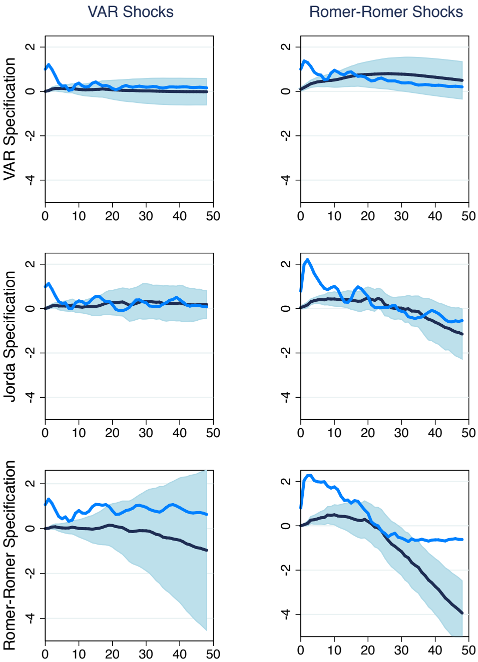
- Inclusion of lagged dependent variables may induce bias
- b_is are estimated off of dynamics of output to **all shocks**
- If dynamics after monetary shocks are different, inclusion of lagged output terms will induce bias
- Extreme example:
  - Two shocks: money and weather
  - Weather i.i.d. while money is persistent
  - Weather shocks induce negative autocorrelation in output
  - Estimated effects of monetary shocks will be affected by this



Black line: Industrial production. Blue line: Real interest rate



Black line: CPI. Blue line: Nominal interest rate

High Frequency Identification

High Frequency Identification

- A substantial amount of monetary news is released at the end of each FOMC meeting
- Possible to use a "discontinuity" based identification approach
- Look at changes in interest rates during a narrow window around FOMC meeting
  - One-day window or 30-minute window
- Basic idea: Changes in interest rates at these times dominated by monetary announcement

Cook and Hahn 89

- Policy indicator: Change in fed funds rate target
- Variables of interest: Longer-term nominal rates

  (One-day windows, Sept 74 - Sept 79)
- Question: Can the Fed control *nominal* interest rates?

Table 3

The effect of funds rate target changes on market interest rates.[a]

$$\Delta R_t = b1 + b2\,\Delta R\,FF_t + u_t$$

ΔR_t	$b1$	$b2$	R^2	SER	DW
3-month bill rate	0.016 (1 04)	0.554 (8.10)[b]	0.47	0.13	1.89
6-month bill rate	0.017 (1.44)	0.541 (10.25)[b]	0.59	0.10	1.82
12-month bill rate	0.024 (2.02)[c]	0.500 (9.61)[b]	0.56	0.10	1.94
3-year bond rate	0.018 (2.16)[c]	0.289 (7.87)[b]	0.46	0 07	1.59
5-year bond rate	0.012 (1.66)	0.208 (6.43)[b]	0.36	0.06	1.59
7-year bond rate	0.009 (1.47)	0.185 (6 78)[b]	0.39	0 05	1.89
10-year bond rate	0.012 (2.34)[c]	0 131 (5.85)[b]	0.32	0.04	1.94
20-year bond rate	0.007 (1.73)	0.098 (5.46)[b]	0.29	0.03	2.04

[a] Includes 75 changes in the federal funds rate target from September 1974 through September 1979. Bill and bond rate changes are calculated over the day of the target changes. t-statistics are in parentheses.

[b] Significant at the 1% level, using a two-tailed test.

[c] Significant at the 5% level, using a two-tailed test.

Source: Cook and Hahn (1989).

Cook and Hahn 89

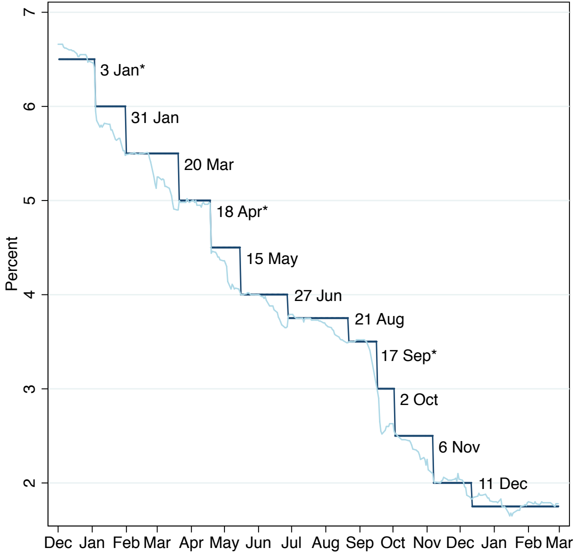
- 100bp change in fed funds target moves 3M Tbill rate by only 55bp
- Suggests that Fed can't move nominal interest rates very effectively

- Really?
- What concern might arise with this approach?

Cook and Hahn 89

- 100bp change in fed funds target moves 3M Tbill rate by only 55bp
- Suggests that Fed can't move nominal interest rates very effectively

- Really?
- What concern might arise with this approach?
  - Some changes in funds rate target might be anticipated



Source: Nakamura and Steinsson (2018). Fed funds target and 1 month Eurodollar rate in 2001.

* indicates move at unscheduled meeting of FOMC

KUTTNER 01

- Policy indicator: Change in fed funds future for current month
- Variables of interest: Longer-term nominal rates

  (One-day window, June-89 - Feb-00)

- Able to distinguish between anticipated and unanticipated movements in fed funds rate

Table 2
Actual, expected and unexpected changes in the Fed funds target

Date		FOMC	Actual	Expected	Unexpected
1989	6/6		− 25	− 24	− 1
	7/7	√	− 25	− 22	− 3
	7/27		− 25	− 25	0
	10/18		− 25	− 25	0
	11/6		− 25	− 29	+4
	12/20	√	− 25	− 8	− 17
1990	7/13		− 25	− 11	− 14
	10/29		− 25	+6	− 31
	11/14	√	− 25	− 29	+4
	12/7		− 25	+2	− 27
	12/18	√	− 25	− 4	− 21
1991	1/8		− 25	− 7	− 18
	2/1		− 50	− 25	− 25
	3/8		− 25	− 9	− 16
	4/30		− 25	− 8	− 17
	8/6		− 25	− 10	− 15
	9/13		− 25	− 20	− 5
	10/31		− 25	− 20	− 5
	11/6	√	− 25	− 13	− 12
	12/6		− 25	− 16	− 9
	12/20		− 50	− 22	− 28
1992	4/9		− 25	− 1	− 24
	7/2	√	− 50	− 14	− 36
	9/4		− 25	− 3	− 22
1994	2/4	√	+25	+13	+12
	3/22	√	+25	+28	− 3
	4/18		+25	+15	+10
	5/17	√	+50	+37	+13

Source: Kuttner (2001)

Table 3
The 1-day response of interest rates to the Fed funds surprises[a]

Maturity	Intercept	Response to target change: Anticipated	Response to target change: Unanticipated	R^2	SE	DW
3 month	– 0.7	4.4	79.1	0.70	7.1	1.82
	(0.5)	(0.8)	(8.4)			
6 month	– 2.5	0.6	71.6	0.69	6.3	2.06
	(2.2)	(0.1)	(8.5)			
12 month	– 2.2	– 2.3	71.6	0.64	6.9	2.10
	(1.8)	(0.5)	(7.8)			
2 year	– 2.8	– 0.4	61.4	0.52	7.8	2.25
	(2.0)	(0.1)	(6.0)			
5 year	– 2.4	– 5.8	48.1	0.33	8.6	2.37
	(1.6)	(0.9)	(4.3)			
10 year	– 2.4	– 7.4	31.5	0.19	7.8	2.37
	(1.8)	(1.3)	(3.1)			
30 year	– 2.5	– 8.2	19.4	0.13	6.5	2.46
	(2.2)	(1.7)	(2.3)			

[a] *Note*: Anticipated and unanticipated changes in the Fed funds target are computed from the Fed funds futures rates, as described in the text. Parentheses contain t-statistics. See also notes to Table 1.

Source: Kuttner (2001). Responses in basis points to 100 basis point change.

Table 1
The 1-day response of interest rates to changes in the Fed funds target[a]

Maturity	Intercept	Response	R^2	SE	DW
3 month	– 3.6	26.8	0.42	9.8	2.04
	(2.3)	(5.4)			
6 month	– 5.2	21.9	0.37	9.0	2.04
	(3.6)	(4.6)			
12 month	– 5.1	19.8	0.29	9.5	2.07
	(3.3)	(4.1)			
2 year	– 5.2	18.2	0.26	9.6	2.28
	(3.4)	(3.7)			
5 year	– 4.5	10.4	0.10	9.8	2.40
	(2.9)	(2.1)			
10 year	– 4.0	4.3	0.02	8.5	2.50
	(2.9)	(1.0)			
30 year	– 3.6	0.1	0.00	6.9	2.47
	(3.2)	(0.0)			

[a] *Note*: The change in the target Fed funds rate is expressed in percent, and the interest rate changes are expressed in basis points. The sample contains 42 changes in the target Fed funds rate from 6 June 1989 through 2 February 2000. Parentheses contain *t*-statistics.

Source: Kuttner (2001). Responses in basis points to 100 basis point change.

Summing Up

- Crucial to distinguish between anticipated and unanticipated movements in fed funds rate
- Increasingly important in an era of greater monetary policy transparency
  (where markets anticipate much of the monetary policy action)

Do Actions Speak Loader Than Words?

FOMC Meeting on January 28, 2004:

- No change in Fed Funds Rate, fully anticipated
- Unexpected change in Fed Funds Rate: -1 bp
- Kuttner's monetary shock indicator implies essentially no shock

Do Actions Speak Loader Than Words?

FOMC Meeting on January 28, 2004:

- No change in Fed Funds Rate, fully anticipated
- Unexpected change in Fed Funds Rate: -1 bp
- Kuttner's monetary shock indicator implies essentially no shock
- However, FOMC statement dropped the phrase:

  "policy accommodation can be maintained for a considerable period"
- Two- and five-year yields jumped 20-25 bp

  (largest movements around an FOMC announcement for years)

FORWARD GUIDANCE

- January 28, 2004 FOMC meeting example of forward guidance
- Forward guidance: Statements by central bank meant to manage market expectations about what it is going to do in the future

Forward Guidance

- January 28, 2004 FOMC meeting example of forward guidance
- Forward guidance: Statements by central bank meant to manage market expectations about what it is going to do in the future
- Has become a major part of how monetary policy is conducted (especially at zero lower bound)
- Implies that unexpected changes in fed funds rate are poor indicator for size monetary shock
  - In past 15 years, Fed has usually managed expectations to the point that there is no surprise about action at meeting
  - Main news about adjustments to language in post-meeting statement containing information about future moves

Gurkaynak-Sack-Swanson 05

- Consider changes in 5 fed funds and eurodollar futures:
  - Fed Funds future for current month (scaled)
  - Fed Funds future for month of next FOMC meeting (scaled)
  - 3-month Eurodollar futures at horizons of 2Q, 3Q, 4Q
- These span first year of term structure

Gurkaynak-Sack-Swanson 05

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  - Fed Funds future for month of next FOMC meeting (scaled)
  - 3-month Eurodollar futures at horizons of 2Q, 3Q, 4Q
- These span first year of term structure
- They then ask: Are effects of monetary policy announcements adequately characterized by a single factor?
  (i.e., unexpected changes in current fed funds rate)

Path Factor

- GSS 05 perform principle component analysis on
  the 5 fed funds and eurodollar futures
- Two factors needed to characterize effect of FOMC announcements:
  - Target factor (unexpected changes in current fed funds rate)
  - Path factor (changes in future rates orthogonal to changes in current rate)

Path Factor

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- Two factors needed to characterize effect of FOMC announcements:
  - Target factor (unexpected changes in current fed funds rate)
  - Path factor (changes in future rates orthogonal to changes in current rate)
- Bulk of response of longer-term rates is to path factor

Table 5. Response of Asset Prices to Target and Path Factors

	One Factor			Two Factors			
	Constant (*std. err.*)	*Target Factor* (*std. err.*)	R^2	*Constant* (*std. err.*)	*Target Factor* (*std. err.*)	*Path Factor* (*std. err.*)	R^2
MP Surprise	–0.021*** (0.003)	1.000*** (0.047)	.91	–0.021*** (0.003)	1.000*** (0.048)	0.001 (0.026)	.91
One-Year-Ahead Eurodollar Future	–0.018*** (0.006)	0.555*** (0.076)	.36	–0.017*** (0.001)	0.551*** (0.017)	0.551*** (0.014)	.98
S&P 500	–0.008 (0.041)	–4.283*** (1.083)	.37	–0.008 (0.040)	–4.283*** (1.144)	–0.966 (0.594)	.40
Two-Year Note	–0.011** (0.005)	0.485*** (0.080)	.41	–0.011*** (0.002)	0.482*** (0.032)	0.411*** (0.023)	.94
Five-Year Note	–0.006 (0.005)	0.279*** (0.078)	.19	–0.006** (0.002)	0.276*** (0.044)	0.369*** (0.035)	.80
Ten-Year Note	–0.004 (0.004)	0.130** (0.059)	.08	–0.004* (0.002)	0.128*** (0.039)	0.283*** (0.025)	.74
Five-Year Forward Rate Five Years Ahead	0.001 (0.003)	–0.098** (0.049)	.06	0.001 (0.003)	–0.099** (0.047)	0.157*** (0.028)	.34

Note: Sample is all monetary policy announcements from July 1991–December 2004 (January 1990–December 2004 for S&P 500). Target factor and path factor are defined in the main text. Heteroskedasticity-consistent standard errors reported in parentheses. *, **, and *** denote significance at 10 percent, 5 percent, and 1 percent, respectively. See text for details.

Source: Gurkaynak-Sack-Swanson (2005). Window length: 30-minutes.

Table 4. Ten Largest Observations of the Path Factor

Date	Z_1 (Target Factor)	Z_2 (Path Factor)	Statement	Financial Market Commentary
Jan. 28, 2004	–1.1	42.7	√	Statement drops commitment to keep policy unchanged for "a considerable period," bringing forward expectations of future tightenings
Jul. 6, 1995	–8.7	–38.4	√	First easing after long (seventeen-month) series of tightenings raises expectations of further easings; statement notes that inflationary pressures have receded
Aug. 13, 2002	8.1	–37.2	√	Statement announces balance of risks has shifted from neutral to economic weakness
May 18, 1999	0.5	32.8	√	Statement announces change in policy bias going forward from neutral to tightening
May 6, 2003	5.2	–27.0	√	Statement announces balance of risks now dominated by risk of "an unwelcome substantial fall in inflation"
Dec. 20, 1994	–15.1	26.6		Surprise that FOMC not tightening considering recent comments by Blinder on "overshooting"; some fear Fed may have to tighten more in 1995 as a result
Oct. 5, 1999	–2.7	25.8	√	Statement announces change in policy bias going forward from neutral to tightening
Oct. 28, 2003	3.9	–24.4	√	Statement leaves the "considerable period" commitment unchanged, pushing back expectations of future tightenings
Jan. 3, 2001	–32.3	22.8	√	Large surprise intermeeting ease reportedly causes financial markets to mark down probability of a recession; Fed is perceived as being "ahead of the curve" and as needing to ease less down the road as a result
Oct. 15, 1998	–24.0	–22.6	√	First intermeeting move since 1994 and statement pointing to "unsettled conditions in financial markets... restraining aggregate demand" increases expectations of further easings

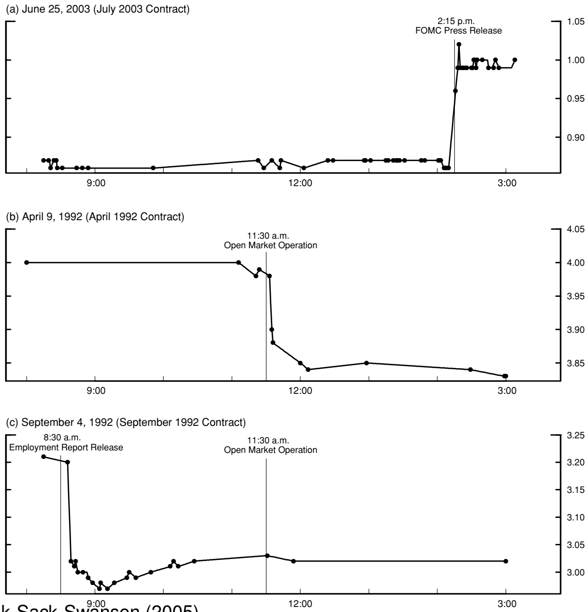
Source: Gurkaynak-Sack-Swanson (2005)

Threats to Identification

1. If there are other shocks during window:
   - Policy indicator will be contaminated by these shocks because Fed may respond (now or in the future)
   - These same shocks may directly affect future variables
   - No longer estimating a causal effect of monetary shocks
2. If entire response of interest rates doesn't occur in narrow window:
   - Estimate of monetary shock biased because shock size biased
   - Might be over-reaction or under-reaction

Key Question: How long should the window be?

Figure 1. Intraday Trading in Federal Funds Futures Contracts



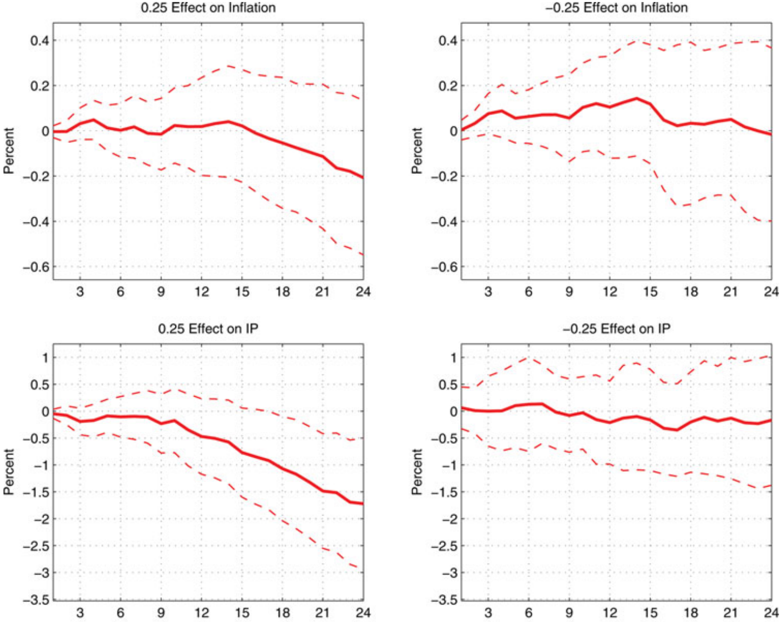
Source: Gurkaynak-Sack-Swanson (2005)

The Power Problem

- HFI arguably the cleanest way to identify monetary shocks

  ... but shocks are small and sample short
- Regressions on future output very imprecise

  (Cochrane-Piazzesi 02, Angrist-Jorda-Kuersteiner 17)
- Angrist-Jorda-Kuersteiner 17
  - Policy indicator: unexpected fed funds target changes
  - Window: one-day (although slightly unusual methods)
  - Outcome variable: inflation, industrial production
  - Allow for different effects of increases and decreases



Source: Angrist-Jorda-Kuersteiner (2017). 90% confidence bands. Vertical axis is in months.

The Power Problem

Why are effects on output and inflation so imprecise?

- Shocks are small: High frequency method leaves out lots of shocks (perhaps vast majority)
  - All news about monetary policy on non-FOMC days not captured
- Sample period is short (only back to late 1980's)
- Outcomes are noisy
  - Many other shocks affect output and inflation over a 1 year horizon

The Power Problem

Potential solution:

- Focus on outcome variables that move **contemporaneously**

  e.g., real yields and forwards (from TIPS)

  (Hanson-Stein 15, Nakamura-Steinsson 18)

- Essentially a discontinuity based identification strategy

Nakamura-Steinsson 2018

- Policy indicator: Policy news shock
  - First principle component of change in GSS 05's 5 interest rate futures over narrow window around scheduled FOMC announcements
  - Similar to GSS 05 path factor, but simpler (no 2nd factor)
- Variables of interest: Nominal and real yields and forward rates

  (30-minute window, 2000-2014)

TABLE 1

Response of Interest Rates and Inflation to the Policy News Shock

	Nominal	Real	Inflation
2Y Treasury Yield	1.10	1.06	0.04
	(0.33)	(0.24)	(0.18)
5Y Treasury Yield	0.73	0.64	0.09
	(0.20)	(0.15)	(0.11)
10Y Treasury Yield	0.38	0.44	-0.06
	(0.17)	(0.13)	(0.08)
2Y Treasury Inst. Forward Rate	1.14	0.99	0.15
	(0.46)	(0.29)	(0.23)
3Y Treasury Inst. Forward Rate	0.82	0.88	-0.06
	(0.43)	(0.32)	(0.15)
5Y Treasury Inst. Forward Rate	0.26	0.47	-0.21
	(0.19)	(0.17)	(0.08)
10Y Treasury Inst. Forward Rate	-0.08	0.12	-0.20
	(0.18)	(0.12)	(0.09)

Source: Nakamura-Steinsson (2016). Window: 30-minutes.

Large Effects on Real Rates

Main take-away:

- Nominal and real rates move one-for-one several years out into term structure
- Response of break-even inflation is delayed and small

Challenges:

- Background noise
- Risk Premia
- Fed information effects