

# Empirical Effects of Monetary Policy and Shocks

Valerie A. Ramey

## Monetary Policy Shocks: Let's first think about what we are doing

- Why do we want to identify shocks to monetary policy?
  - Necessary to establish causal effect on output, etc.
  - Can they explain part of business cycles?
- What does it mean if we find that monetary shocks account for little of the variance of output?
  - It could mean that monetary policy doesn't matter or it could mean that monetary policy matters but that most changes are due to the systematic component rather than random shocks to the rule.
  - But this gets back to whether "anticipated vs. unanticipated" money matters (see Cochrane (1998) JME).

# Brief History of Thought: Through 1999

- Friedman and Schwartz (1963) “A Monetary History of the United States”
  - Historical case studies and analysis of historical data.
  - Presented evidence that changes in the money supply could have **real** effects.
- James Tobin (1970) QJE “Money and Income: Post Hoc Ergo Propter Hoc?”

*Post hoc ergo propter hoc* (Latin: "after this, therefore because of this") is a logical fallacy (of the questionable cause variety) that states "Since event Y *followed* event X, event Y must have been *caused* by event X."

  - Argues that the well-known positive correlation between money and income does not imply causality.

Milton Friedman asserts that changes in the supply of money  $M$  (defined to include time deposits) are the principal cause of changes in money income  $Y$ . In his less guarded and more popular expositions, he comes close to asserting that they are the unique cause.<sup>1</sup> In support of this position Friedman and his associates and followers have marshaled an imposing volume of evidence, of several kinds.

- Tobin presents a Keynesian model in which the central bank supplies reserves to keep interest rates constant and banks supply credit and deposits according to the “needs of trade.” In this model, income causes money.

## Brief History of Thought: Through 1999

- Sims (1972) AER “Money, Income, and Causality”
  - Answers Tobin using Granger-Causality.
  - Introduces Granger-Causality to macroeconomists.

This study has two purposes. One is to examine the substantive question: Is there statistical evidence that money is “exogenous” in some sense in the money-income relationship? The other is to display in a simple example some time-series methodology not now in wide use. The main methodological novelty is the use of a direct test for the existence of unidirectional causality. This test is of wide im-

The main empirical finding is that the hypothesis that causality is unidirectional from money to income agrees with the postwar *U.S.* data, whereas the hypothesis that causality is unidirectional from income to money is rejected. It follows

Question: Do Granger-Causality tests really answer the Post Hoc Ergo Propter Hoc fallacy?

## Brief History of Thought: Through 1999

- Anticipated vs. Unanticipated Money
  - Lucas (1972) JET constructed a model in which money shocks could have real effects if they were *unanticipated*. (The idea was that agents confused general and relative price movements.)
  - Barro (1977, 1978) tested this and found that only unanticipated money affected real output.

# Brief History of Thought: Through 1999

- Sims (1980) *Econometrica* “Macroeconomics and Reality”
- Argued against the standard identification assumptions used in the big macro models, saying : “It is my view, however, that rational expectations is more deeply subversive of identification than has yet been recognized.”

- Introduced Vector Autoregressions.

- Estimated a system and found that shocks to money accounted for a significant fraction of forecast error variance of output.

TABLE III  
PROPORTIONS OF FORECAST ERROR  $k$  QUARTERS AHEAD PRODUCED BY EACH INNOVATION: U.S. 1949–1975<sup>a</sup>

Forecast error in:	$k$	Triangularized innovation in:					
		$M$	$Y/P$	$U$	$W$	$P$	$PM$
$M$	1	1.00	0	0	0	0	0
	3	.96	0	.03	0	0	0
	9	.73	0	.24	.02	0	0
	33	.54	0	.27	.09	0	.09
$Y/P$	1	.15	.85	0	0	0	0
	3	.35	.59	.04	.01	.01	0
	9	.30	.18	.37	.13	.00	.02
	33	.28	.15	.33	.16	.02	.06
$U$	1	.02	.35	.63	0	0	0
	3	.14	.49	.32	0	.03	0
	9	.26	.20	.41	.09	.02	.02
	33	.34	.14	.34	.13	.03	.03
$W$	1	.08	.05	.04	.84	0	0
	3	.17	.06	.07	.55	.09	.06
	9	.45	.02	.05	.25	.08	.16
	33	.64	.02	.19	.07	.02	.07
$P$	1	0	.04	.15	.24	.56	0
	3	.04	.01	.14	.36	.33	.12
	9	.14	.02	.12	.25	.11	.36
	33	.60	.02	.20	.07	.02	.09
$PM$	1	0	0	.06	.05	.08	.81
	3	.01	.01	.02	.13	.10	.75
	9	.06	.02	.13	.08	.03	.68
	33	.54	.03	.20	.04	.01	.18

# Brief History of Thought: Through 1999

- Sims (1980) *AER* and Litterman and Weis *Econometrica* (1985)
- Inclusion of nominal interest rates in the VAR significantly reduces the importance of shocks to money for explaining output.

Sims: (interest rate is 4-6 month commercial paper)

TABLE 1—THREE-VARIABLE INNOVATION ACCOUNTING:  
PERCENTAGES OF 48-MONTH FORECAST-ERROR  
VARIANCE EXPLAINED  
(Interwar/Postwar)

Variables Explained	By Innovations in		
	<i>M1</i>	<i>IP</i>	<i>WPI</i>
<i>M1</i>	92/97	4/2	4/1
<i>IP</i>	66/37	28/44	6/18
<i>WPI</i>	38/14	19/7	43/80

Note: *M1* = Money Stock; *IP* = Industrial Production; *WPI* = Wholesale Price Index.

TABLE 2—FOUR-VARIABLE INNOVATION ACCOUNTING  
PERCENTAGES OF 48-MONTH FORECAST-ERROR  
VARIANCE EXPLAINED  
(Interwar/Postwar)

Variables Explained	By Innovations in			
	<i>R</i>	<i>M1</i>	<i>WPI</i>	<i>IP</i>
<i>R</i>	63/50	28/19	7/4	1/28
<i>M1</i>	39/56	58/42	1/1	1/1
<i>WPI</i>	1/2	54/32	43/60	3/6
<i>IP</i>	16/30	58/4	7/14	18/52

Note: See Table 1. *R* = Short-Term Interest Rate.

## Brief History of Thought: Through 1999

- Litterman and Weiss *Econometrica* (1985)

### MONEY, REAL INTEREST RATES, AND OUTPUT: A REINTERPRETATION OF POSTWAR U.S. DATA<sup>1</sup>

BY ROBERT B. LITTERMAN AND LAURENCE WEISS<sup>2</sup>

This paper reexamines U.S. postwar data to investigate if the observed comovements between money, interest rates, inflation, and output are compatible with the money to real interest to output links suggested by existing monetary theories of the business cycle, which include both Keynesian and equilibrium models. We find these theories are incompatible with the data, and in light of these results, we propose an alternative structural model which can account for the major dynamic interactions among the variables. This model has two central features: (i) output is unaffected by the money supply, and (ii) the money supply process is influenced by policies designed to achieve short-run price stability.



# Brief History of Thought: Through 1999

## Rebuttals

1. Romer and Romer (1989) “Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz.”

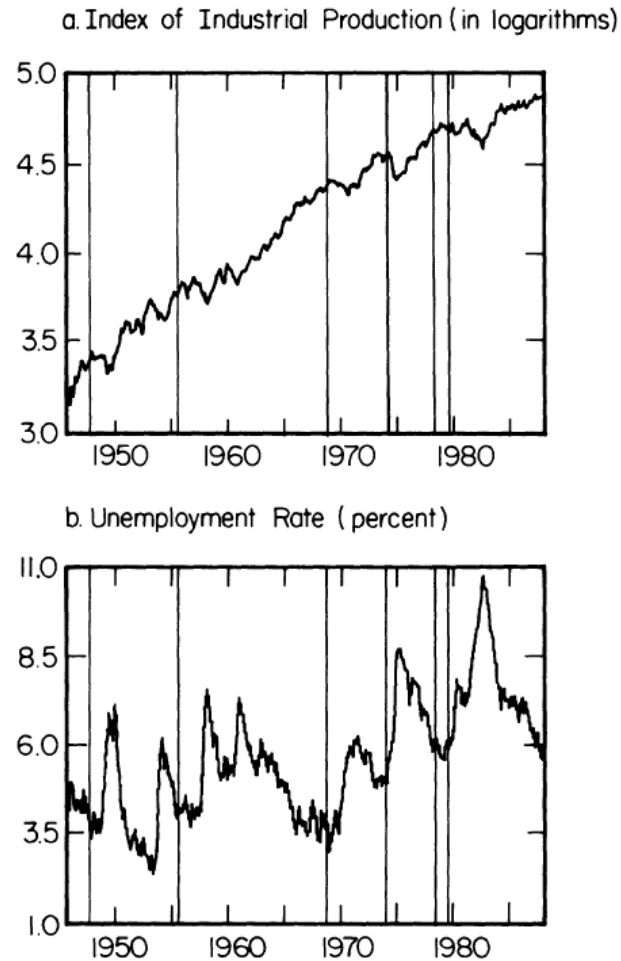
- Used a narrative approach like Friedman and Schwartz, but for post-WWII period.

### 3.1 THE IDENTIFICATION OF MONETARY SHOCKS

*3.1.1 Definition.* Like Friedman and Schwartz, we use the historical record to identify monetary shocks. We employ, however, a much narrower definition of what constitutes a shock. In particular, we count as a shock only episodes in which the Federal Reserve attempted to exert a contractionary influence on the economy in order to reduce inflation. That is, we focus on times when the Federal Reserve attempted not to offset perceived or prospective increases in aggregate demand but to actively shift the aggregate demand curve back in response to what it perceived to be “excessive” inflation. Or, to put it another way, we look for times when concern about the current level of inflation led the Federal Reserve to attempt to induce a recession (or at least a “growth recession”).

# Brief History of Thought: Through 1999

Figure 1 ECONOMIC ACTIVITY AND MONETARY SHOCKS.



Romer-Romer (1989)

*Notes:* Vertical lines are drawn at the dates of monetary shocks. The actual dates are October 1947, September 1955, December 1968, April 1974, August 1978, and October 1979. The sources of the data are described in the text. The data have been seasonally adjusted by a regression on monthly dummy variables.

# Brief History of Thought: Through 1999

## Rebuttals

### 2. McCallum (1983), Bernanke-Blinder (1992)

- Turned the money supply vs. interest rate evidence on its head by arguing that interest rates, and in particular the federal funds rate, were *the* key indicators of monetary policy.

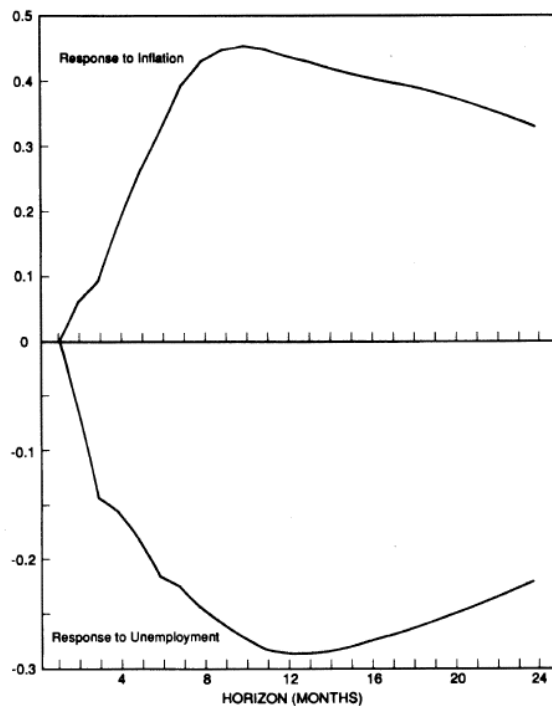


FIGURE 2. RESPONSES OF FUNDS RATE TO INFLATION AND UNEMPLOYMENT SHOCKS

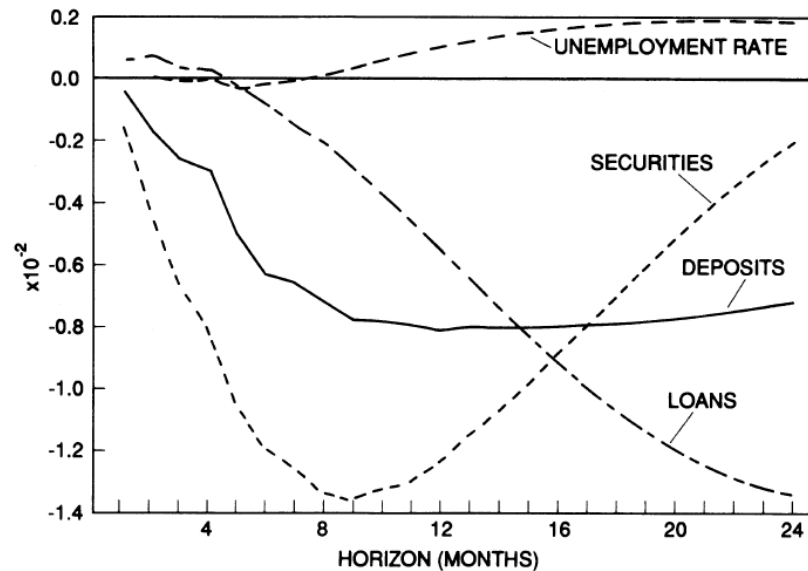


FIGURE 4. RESPONSES TO A SHOCK TO THE FUNDS RATE

## Brief History of Thought: Through 1999

Christiano, Eichenbaum and Evans (1999): “Monetary Policy Shocks: What Have We Learned and To What End?”

- Explore a variety of specifications (federal funds rate, nonborrowed reserves, etc.)
- The result that monetary policy shocks had significant effects on output is robust across almost all specifications.
- Discuss Price Puzzle.

Sims (1992) noted that in many specifications, prices *rose* in the short-run after a contractionary monetary policy shock. (Eichenbaum (1992) called this “the price puzzle.”) Sims argued that the Fed was reacted to news about future inflation. To control for this, he included an index of commodity prices in the VAR.

CEE (1999) often found a price puzzle, even with commodity prices included.

# Challenges to Identification

A. Recursiveness assumption.

B. Foresight.

1. Policymaker foresight.

2. Private agent foresight.

## A. Recursiveness assumption

Recall the simple trivariate model from Part I, written in terms of the innovations:

$$\eta_{1t} = b_{12}\eta_{2t} + b_{13}\eta_{3t} + \varepsilon_{1t} \quad \eta_{1t} = \text{output}$$

$$\eta_{2t} = b_{21}\eta_{1t} + b_{23}\eta_{3t} + \varepsilon_{2t} \quad \eta_{2t} = \text{price level}$$

$$\eta_{3t} = b_{31}\eta_{1t} + b_{32}\eta_{2t} + \varepsilon_{3t} \quad \eta_{3t} = \text{federal funds rate}$$

Recursiveness assumption sets  $b_{13} = b_{23} = 0$ .

## A. Recursiveness assumption (cont.)

- Most methods make this assumption
  - Christiano, Eichenbaum, Evans (1999)
  - Romer and Romer (2004)
  - Coibion (2012)
  - Barakchian and Crowe (2013)
- Exceptions: Those who impose sign restrictions

Uhlig (1997, 2005), Faust (1998), Faust, Swanson, Wright (2004), Arias, Caldara, Rubio-Ramírez (2015) and Amir and Uhlig (2015)

## A. Recursiveness assumption (cont.)

- Estimated DSGE models, such as Smets and Wouters, show that variables such as output respond immediately to a change in the federal funds rate.
- However, in SVARs, the methods that don't impose recursiveness often find **expansionary effects of monetary contractions**.



## B. Foresight problems: 1. Policymaker foresight

- Suppose the Fed follows a **simple policy rule**:

$$ff_t = \alpha_1 E_t(\Delta_h y_{t+h}) + \alpha_2 E_t(\Delta_h \pi_{t+h}) + \varepsilon_{ft},$$

where  $ff$  is the fed funds rate,  $y$  is log output, and  $\pi$  is inflation.

$\Delta_h$  is the change in the variable from  $t$  to  $t+h$ . The Fed **sets interest rates based on its expectations of the future path** of output and inflation because it is aware of the lags in the effects of monetary policy.

- Typically, the Fed has superior information (Sims (1993), Romer-Romer (2000))

## B. Foresight problems: 1. Policymaker foresight

Rewrite the equation on the previous page:

$$\begin{aligned} ff_t &= \alpha_1 E_t^p(\Delta_h y_{t+h}) + \alpha_2 E_t^p(\Delta_h \pi_{t+h}) + \alpha_1 [E_t^f(\Delta_h y_{t+h}) - E_t^p(\Delta_h y_{t+h})] \\ &\quad + \alpha_2 [E_t^f(\Delta_h \pi_{t+h}) - E_t^p(\Delta_h \pi_{t+h})] + \varepsilon_{ft}, \end{aligned}$$

$E_t^p$  = expectations based on private agent information

$E_t^f$  = denotes expectations based on the Fed's information.

If the Fed has superior information, the terms in brackets will not be zero and an SVAR or FAVAR will produce an incorrectly identified monetary policy shock,  $\tilde{\varepsilon}_{ft}$  that consists of two components, the true shock as well as a component based on the informational superiority of the Fed:

$$\tilde{\varepsilon}_{ft} = \varepsilon_{ft} + \alpha_1 [E_t^f(\Delta_h y_{t+h}) - E_t^p(\Delta_h y_{t+h})] + \alpha_2 [E_t^f(\Delta_h \pi_{t+h}) - E_t^p(\Delta_h \pi_{t+h})],$$

## B. Foresight problems: 1. Policymaker foresight

Further complication:

- If the Federal Reserve has **superior information**, then any action or announcement by the Fed presents **a signal extraction problem for private agents**.
- Private agents observe  $\tilde{\varepsilon}_{ft}$  in equation on previous slide, but they know that it is composed of the true shock as well as the systematic component of the Fed's rule based on the Fed's informational advantage.

Thus, agents' response incorporates **the effects of two distinct forces**.

## B. Foresight problems: 2. Private agent foresight

- Campbell, Evans, Fisher, and Justiniano (2012) argue that the Fed has been using **forward guidance** since the early 1990s. This means that many changes in the federal funds rate are in fact *anticipated in advance*.
- Fortunately, the literature has developed a very good way to deal with this. They use the movements of **federal funds and other interest rate futures** in small windows around FOMC announcements to identify unexpected Fed policy actions. Exploiting the information in interest rate futures is an ideal way to construct **“news” series**.

e.g. Kuttner (2001), Cochrane and Piazzesi (2002), Gürkaynak, Sack and Swanson (2005)

# Leading Identification Methods

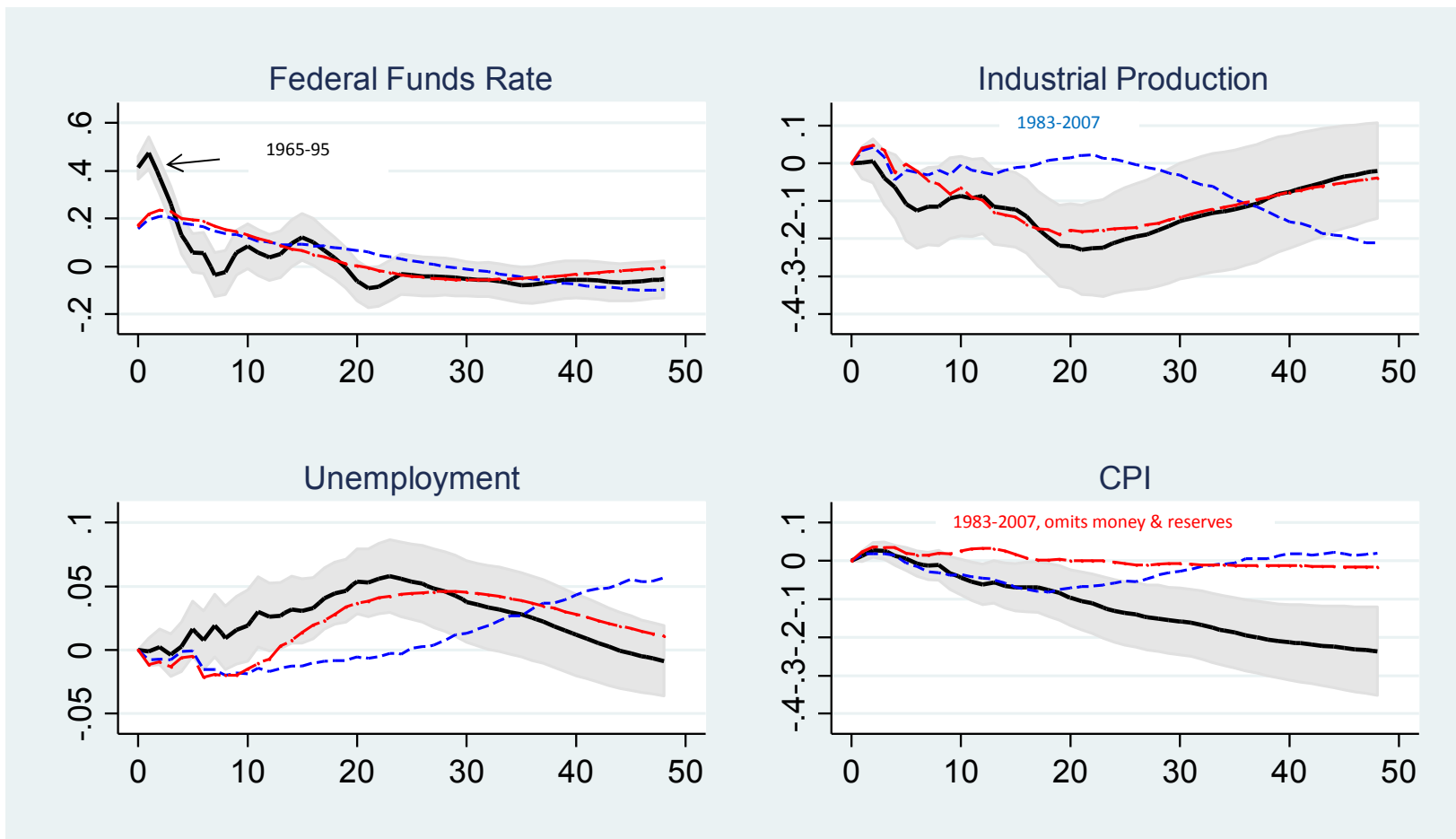
- Cholesky Decomposition
  - Discussed at length in Christiano, Eichenbaum, Evans (1999) Handbook of Macroeconomics chapter.
  - Most common: order federal funds rate last.
- Sign Restrictions (Uhlig (2005))
- Romer-Romer (2004) Narrative/Greenbook measure
  - Use narrative to derive intended target changes, use Greenbook forecasts in policy regression.
- High Frequency Identification (Kuttner (2001))
  - Use movements in fed funds futures around FOMC dates.

## Summary of Some Effects of Identified Monetary Shocks

Paper	Method, sample	Impact of 100 basis point increase in funds rate	% of output explained by shock	Price Puzzle?
<b>Christiano, Eichenbaum, Evans (1999) – FFR identification</b>	SVAR, 1965q3 – 1995q3	-0.7% at 8 quarters.	44% at 2 years	Yes, but very small
<b>Faust, Swanson, Wright (2004)</b>	HFI, 1991m2 – 2001m7	-0.6% at 10 months		
<b>Romer and Romer (2004)</b>	Narrative/Greenbook 1970m1 – 1996m12	-4.3% at 24 months	Major part	No, but prices don't change for 22 months
<b>Uhlig (2005)</b>	Sign restrictions, 1965m1 – 1996m12	Positive, but not statistically different from 0	5 – 10% at all horizons.	No (by construction)
<b>Bernanke, Boivin, and Elias (2005)</b>	FAVAR, 1959m1 – 2001m7	-0.6% at 18 months	5% at 5 years	Yes
<b>Smets-Wouters (2007)</b>	Estimated DSGE model 1966Q1 – 2004Q4	-1.8 at 4 quarter trough	10% at 1 year (trough)	No
<b>Boivin, Kiley, Mishkin (2010)</b>	FAVAR, 1962m1-79m9, 1984m1-2008m12	-1.6% at 8 months in early period, -0.7% at 24 months in later period		Only in the early period.
<b>Coibion (2012)</b>	“Robust” Romer-Romer methods, 1970m1 – 1996m12	-2 % at 18 months	“Medium” part	Yes, sometimes
<b>Barakchian-Crowe (2013)</b>	HFI, Romer hybrid VAR, 1988m12-2008m6	-5 % at 23 months	50% at 3 years	Yes
<b>Gertler-Karadi (2015)</b>	HFI-Proxy SVAR, 1979m7 – 2012m6 (1991m1-2012m6 for instruments)	-2.2 % at 18 months	?	No

### Christiano, Eichenbaum, and Evans (1999) Identification

1965m1–1995m6 full specification: solid black lines; 1983m1-2007m12 full specification: short dashed blue lines; 1983m1–2007m12, omits money and reserves: long dashed red lines)



# Romer-Romer (2004) Monetary Shocks

## Motivation

- A hypothesis for the price puzzle is that the Fed has more information than we typically include in a VAR.
- Romer-Romer (2000) showed that the Fed has superior information even compared to the professional forecasters.

In this paper they construct a new measure of monetary shocks based on 2 innovations:

1. Use Fed **intentions** – changes in federal funds rate targets.
  2. Condition on Greenbook forecasts: estimate shock as the residual from regression of target changes on :
    - pre-meeting level of intended funds rate
    - Quarter -1, 0, +1, +2 current Greenbook forecasts for % change in GDP and inflation
    - Change in Greenbook forecasts (from last time to this time) of -1,0,+1,+2 % change in GDP and inflation
    - Greenbook forecast of unemployment rate in the current quarter.
- 1969 – 1996.



# Romer-Romer (2004) Monetary Shocks

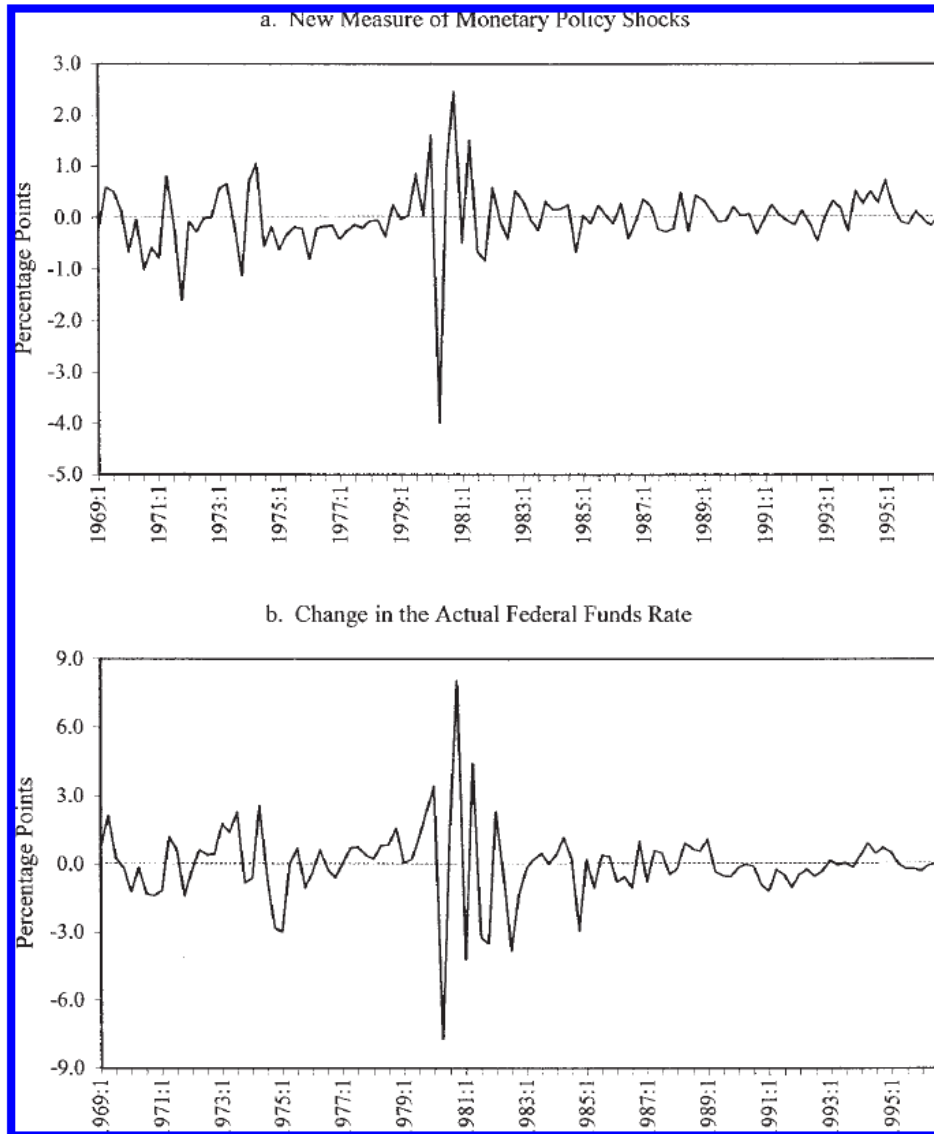


FIGURE 1. MEASURES OF MONETARY POLICY

Our baseline regression is therefore:

$$(2) \quad \Delta y_t = a_0 + \sum_{k=1}^{11} a_k D_{kt} + \sum_{i=1}^{24} b_i \Delta y_{t-i} + \sum_{j=1}^{36} c_j S_{t-j} + e_t,$$

where  $y$  is the log of industrial production,  $S$  is our new measure of monetary policy shocks, and the  $D_k$ 's are monthly dummies. Our sample period is 1970:1–1996:12, with the values of  $S_t$  before 1969:3 set to zero. The end date is the

# Romer-Romer (2004) Monetary Shocks

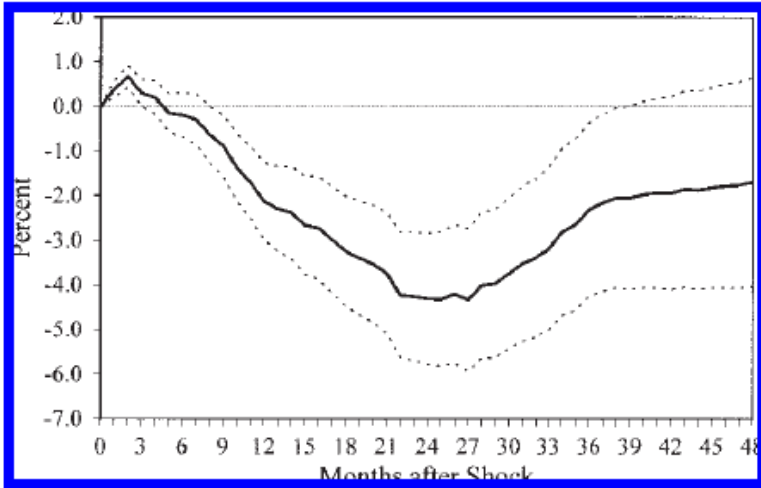


FIGURE 2. THE EFFECT OF MONETARY POLICY ON OUTPUT

Effect of a 100 basis point shock to the federal funds rate.

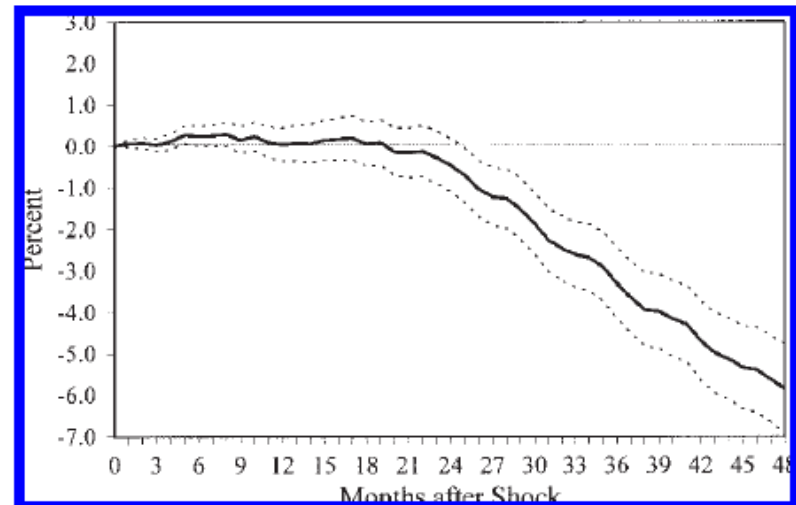


FIGURE 4. THE EFFECT OF MONETARY POLICY ON THE PRICE LEVEL

# Cochrane's Discussion of Romer-Romer (2004) Monetary Shocks

## 2. From target to policy shocks.

Our first step is to take the target or intentions series and create policy shocks. Christina and David use the following regression

$$\begin{aligned} \text{RR } \Delta f f_m &= \alpha + \beta f f b_m + \sum_{i=-1}^2 \gamma_i \Delta \tilde{y}_{mi} + \sum_{i=-1}^2 \lambda_i (\Delta \tilde{y}_{mi} - \Delta \tilde{y}_{m-1,i}) \\ &\quad + \sum_{i=-1}^2 \phi_i \tilde{\pi}_{mi} + \sum_{i=-1}^2 (\pi_{mi} - \pi_{m-1,i}) + \rho \tilde{u}_{m0} + \varepsilon_t \end{aligned}$$

I'll simplify this a bit, with the following proposition.

**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.*

All the shock has to do is remove the reverse causality from output forecasts. Example: If the Fed “responded” to weather forecasts, that movement would be a fine shock for output measurement.

# Cochrane's Discussion of Romer-Romer (2004) Monetary Shocks

## 3: Measuring output response.

The second step is measuring the response of output to the monetary policy shocks. Christina and David run the following regression.

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

They calculate the response by dynamic simulation; they cumulate the responses to find the response of the level of output, and they calculate standard errors by Monte Carlo.

I'll simplify again, and show the essence of the procedure with

**Proposition 2 :** *One can measure the output (price) response by running **single** regressions of output (price) on the shocks, with no other variables.*

Why? In the end we're looking for the MA representation for output.

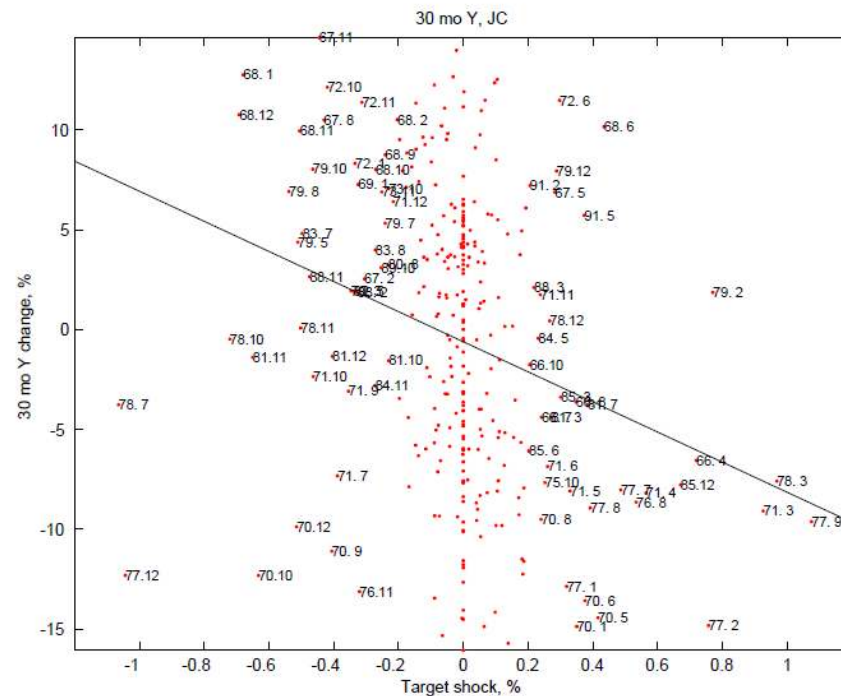
$$\Delta y_t = \sum_j a_j \varepsilon_{t-j} + \sum_j b_j v_{t-j} = a_k \varepsilon_{t-k} + w_t$$

All right hand variables are uncorrelated, so single = multiple regressions (in population.)

# Cochrane's Discussion of Romer-Romer (2004) Monetary Shocks

The scatterplots may seem depressing, but that's what  $t$  just above 2 in 30 years of data looks like!

Here is a plot with dates, so we can see what historical episodes drive the results – which output surges were preceded by a series of shocks.



I think the plots make the point that even the output evidence is extraordinarily weak. How easily the output plot could have looked like the price plot. (I will admit that it is there, though, and somewhat more robust than it seems. A few hours of outlier-removing did not change the output sign from negative to positive.)



# Cochrane's Discussion of Romer-Romer (2004) Monetary Shocks

## *Reflections on responses.*

These responses, like those of the VAR literature, may seem simple but to me they are profoundly troubling.

First, there is a 30 month output delay, and the output effect is still going at 48 months. this is awfully long for any theory!

Second, the *absence* of much price response – the dog that did not bark – seems to me a huge puzzle for the following reasons.

1. The data say “price puzzle.” This is strong in my evidence, and the 30 month delay in the Romer-Romer shocks amounts to the same thing. This “fact” can be removed a bit by adding commodity prices to the shock regression, as shown in the paper. But the evidence for the Greenbook sufficient statistic property is strong, and if the Fed is not responding to commodity prices, we should not orthogonalize our shocks with commodity prices. Reading the minutes, there is *no* evidence of “well these nerds are wrong, commodity prices are going up, we need to tighten to stop this inflation.” *This just does not happen.* Either RR give a dreadfully wrong reading of FOMC minutes, or adding commodity prices to fix the price puzzle is just a mistaken fishing expedition to make the data give the preordained right answer.

## Cochrane's Discussion of Romer-Romer (2004) Monetary Shocks

2. All theories tie output and price responses together. You can't have one without the other; its like ordering eggs sunny side down and don't turn it over. The data say otherwise. if you take the data seriously, you need a theory that interest rate policy affects  $y$  *with no effect on  $p$  at all.*
3. Current policy wisdom is that the Fed should control price level alone. Yet *there is no evidence that fed interest rate policy has any effect on the price level.* (I say "interest rate policy" deliberately. Of course the Fed could print money – though this is in fact a fiscal move. The question is whether interest rate policy of the sort practiced in sample has any effect on the price level.) *We must regard the "fact" that the Fed controls the price level by interest rate policy, and the consequent policy advice that it should do so, as matters of faith, a-priori beliefs, rather than matters supported by the historical experience. .*

# Cochrane's Discussion of Romer-Romer (2004) Monetary Shocks

## 5. Long-delayed responses?

There is one way around the finding of long-delayed responses. The last time I had the pleasure of discussing a Romer-Romer paper led me to think about this a lot, so I'll present the results here. Notice that after a target rise, the target keeps rising for quite a while.

Now, does the *initial* FF shock cause output to change 2 years later, or does the *later increase* in ff, when it happens, cause output to rise? We can allow the latter view, but it requires that we believe that anticipated target rises can also affect output and prices.

This is clearly in the philosophy of what we are doing. Nothing in what I have done, or in what RR do, imposes the view that “only unanticipated ff matters.” In particular, we have made no effort to make shocks orthogonal to agent's information sets.

Most theories allow for anticipated effects. (Though it usually is not the case that there is no difference, as we are implicitly assuming. For example, if prices are sticky, firms will start raising them ahead of an anticipated loosening.) All theories allow anticipated money to affect prices.

Thus, perhaps we should characterize the “effects of monetary policy” by “what if Fed increases ff *for only one month*” not “what if Fed increases ff and *keeps increasing it as it usually does?*”



## Practical Issues with Romer-Romer Monetary Shocks

- **Coibion** (2012) finds:
  - Romer estimation produces much larger effects on output than standard VAR methods.
  - Their results are very sensitive to the inclusion of nonborrowed reserve targeting from 1979-1982.
  - The magnitude of their estimated effects is increasing in the number of lags of shocks they include in their single equation specification.
  - Embedding their shocks in a VAR produces “medium” effects.

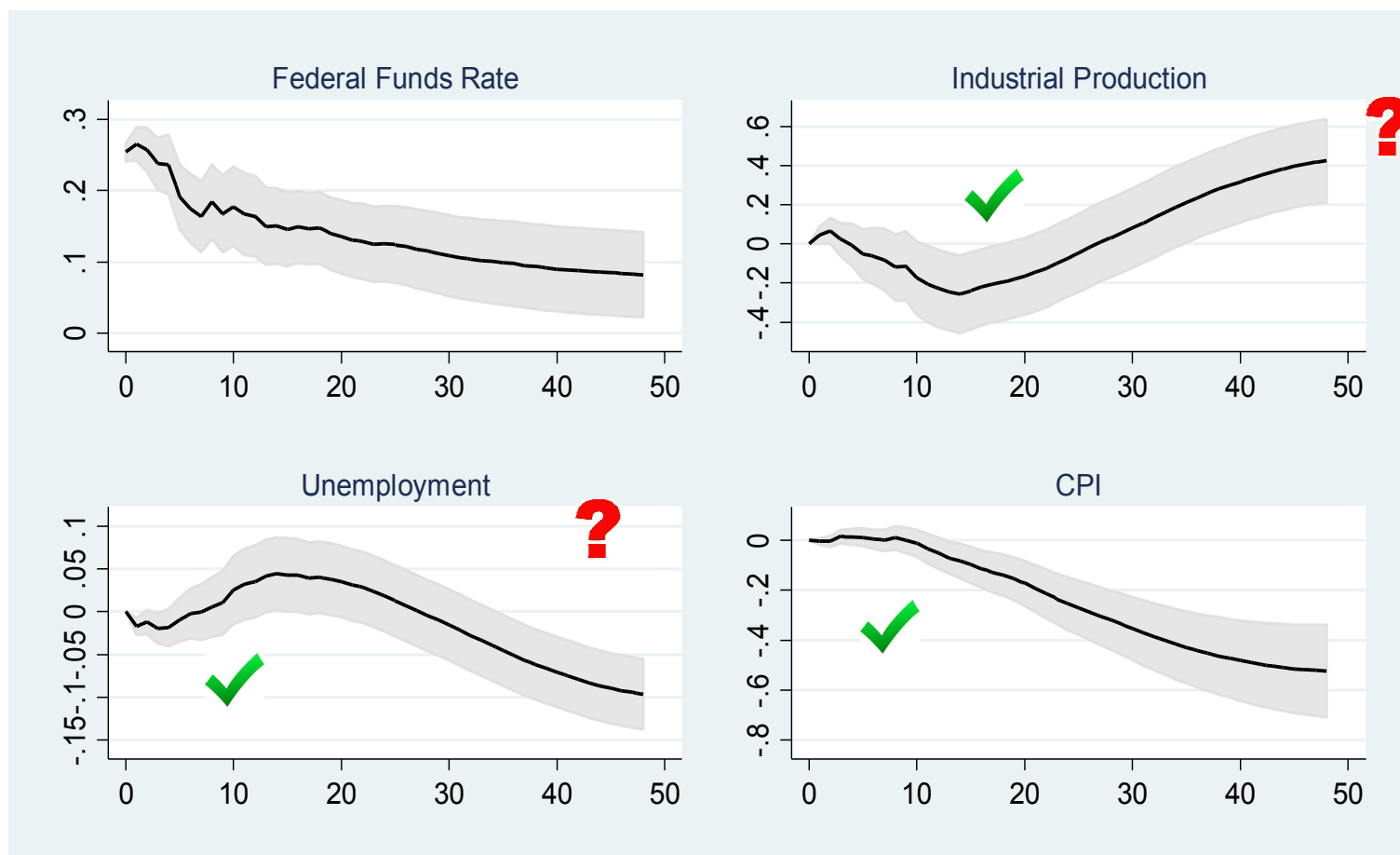
# Some Explorations with the Romer-Romer Monetary Shocks

1. Coibion version of the Romer-Romer Hybrid VAR, updated through 2007
  - Monthly, 1969m1 – 2007m12
  - Contains (log) industrial production, CPI, commodity prices, unemployment rate, and the cumulative Romer shock ordered last.
  - Romer-Romer shock update from Wieland and Yang (2015)

# Romer Hybrid Monetary VAR, 1969m1 – 2007m12

(90% confidence intervals)

## Cumulative Romer Shock, ordered last



## Some Explorations with the Romer-Romer Monetary Shocks

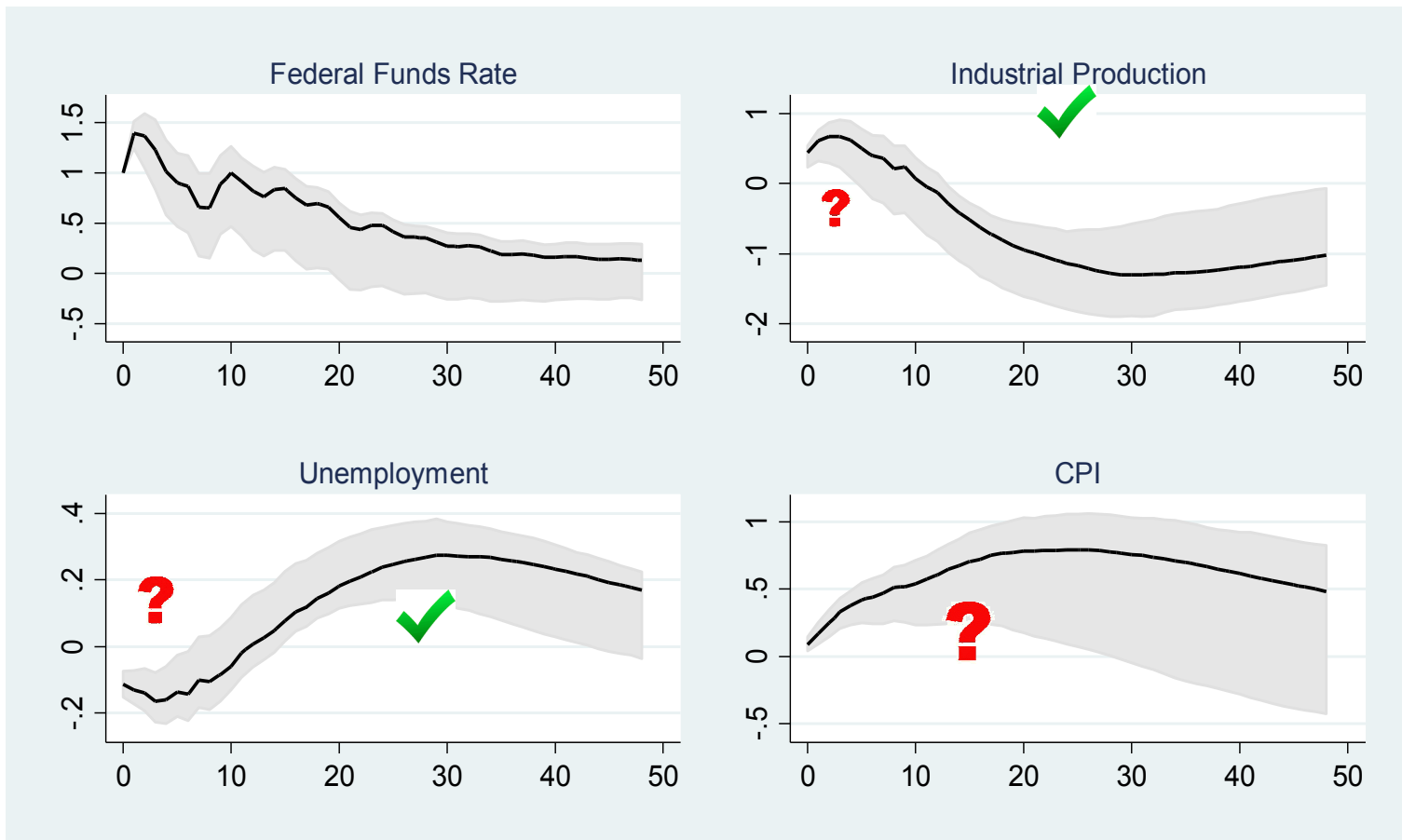
2. The Romer's hybrid VAR imposes an unnecessary restriction by ordering their shock last - **recursiveness**.

If we believe they have identified an exogenous shock, we don't need to assume that output, etc. don't respond within the month to the shock.

What happens if we relax that restriction and instead use a Proxy SVAR? That is, we use the Romer shock as an instrument in the VAR.

# Proxy Monetary SVAR, Romer, 1969m1 – 2007m12

(90% confidence intervals)



In fact, Romer-Romer hybrid VAR zero-restriction is rejected by their own instrument. The contemporaneous effects of the IV-federal funds rate on unemployment and IP are significantly different from 0.

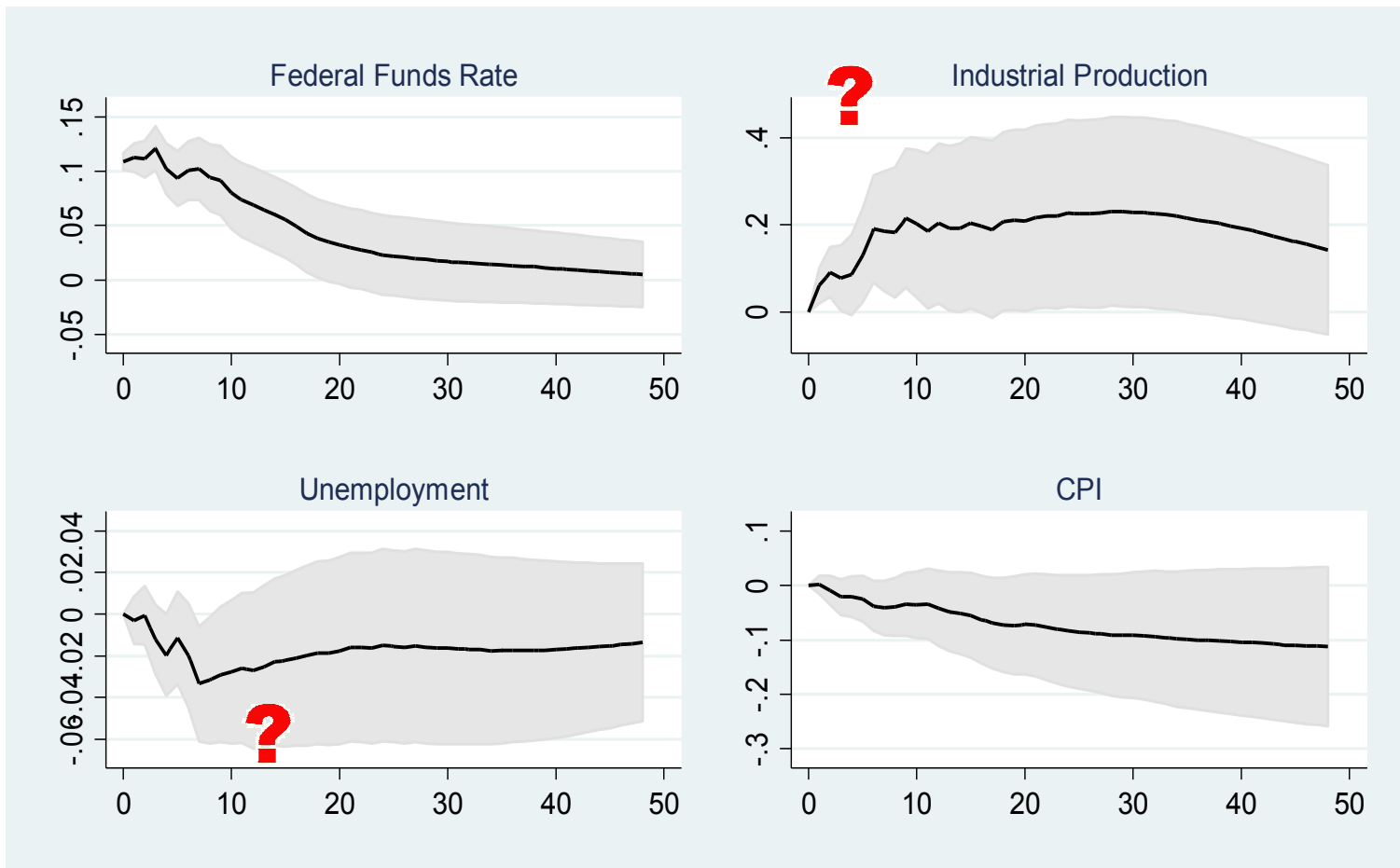
## Some Explorations with the Romer-Romer Monetary Shocks

3. Many have argued that the monetary policy rule changed in the early 1980s.

To see how the results change, I re-estimated Romer-Romer's variable from 1983 – 2007 to create a new series of shocks and then ran their hybrid VAR.

# Romer Hybrid Monetary VAR, 1983m1 – 2007m12

(90% confidence intervals)

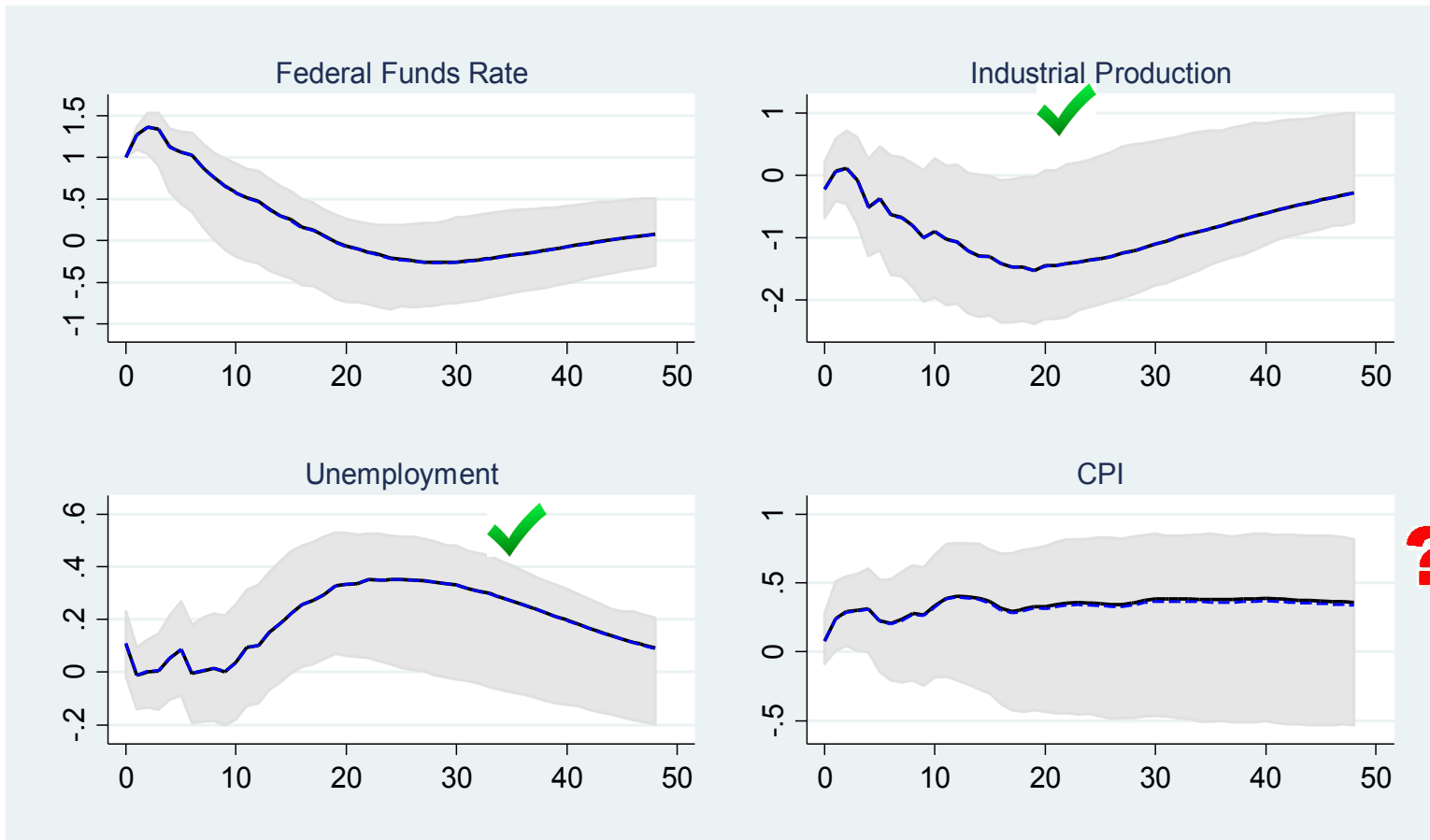


## Some Explorations with the Romer-Romer Monetary Shocks

4. How about the Proxy SVAR on the 1983 – 2007 sample?



# Proxy Monetary SVAR, Romer, 1983m1 – 2007m12 (90% confidence intervals)



## Some Explorations with the Romer-Romer Monetary Shocks

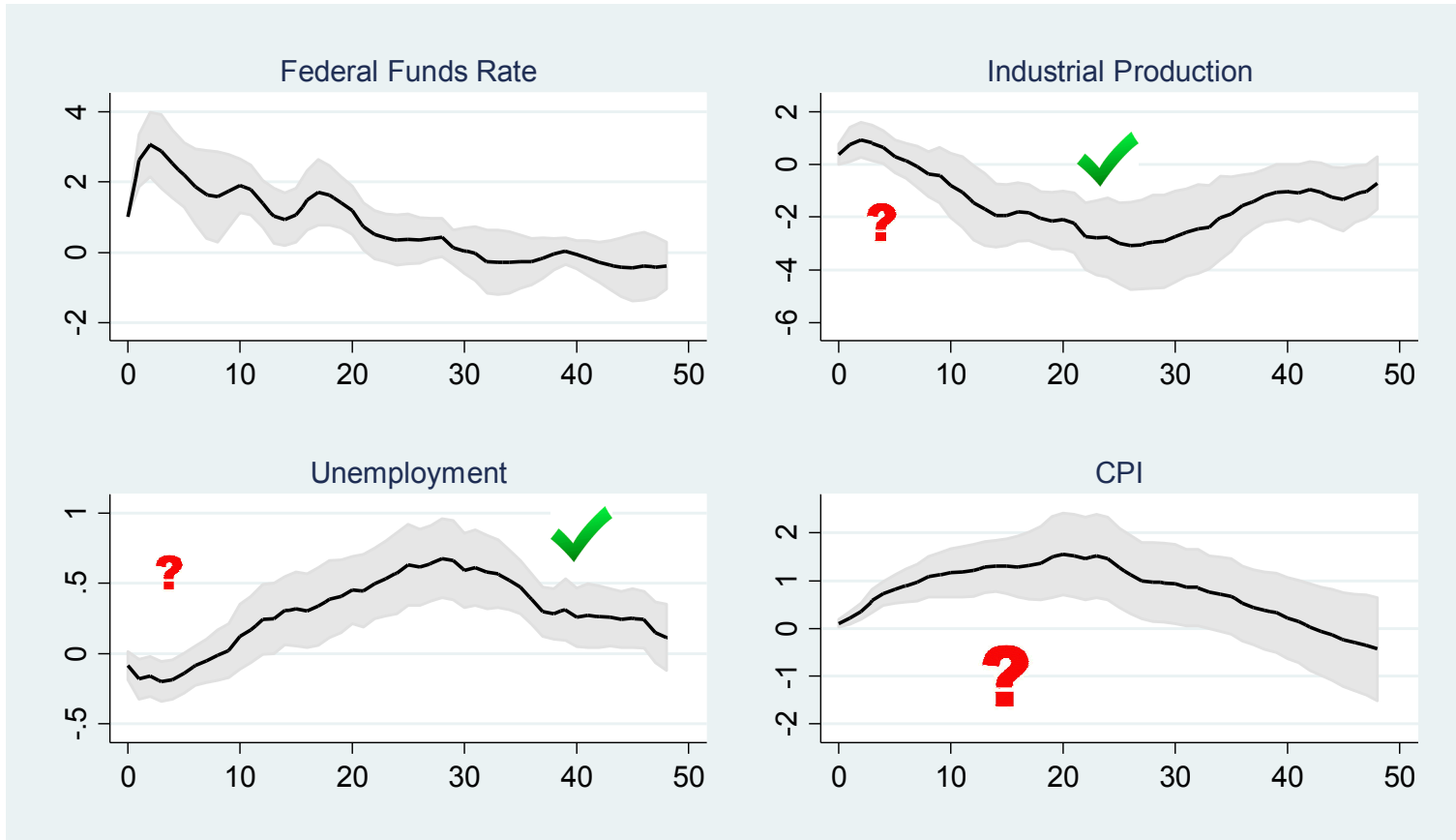
5. The **Jordà method** is an alternative method for calculating impulse responses that imposes fewer restrictions. Ramey-Zubairy (2014) extend this method to an IV method.

$$X_{i,t+h} = \theta_{i,h} \cdot X_{p,t} + \text{control variables} + \zeta_{t+h}$$

**Use Romer shocks as instruments** for  $X_p$  (the federal funds rate).

IV for the 1969 – 2007 sample

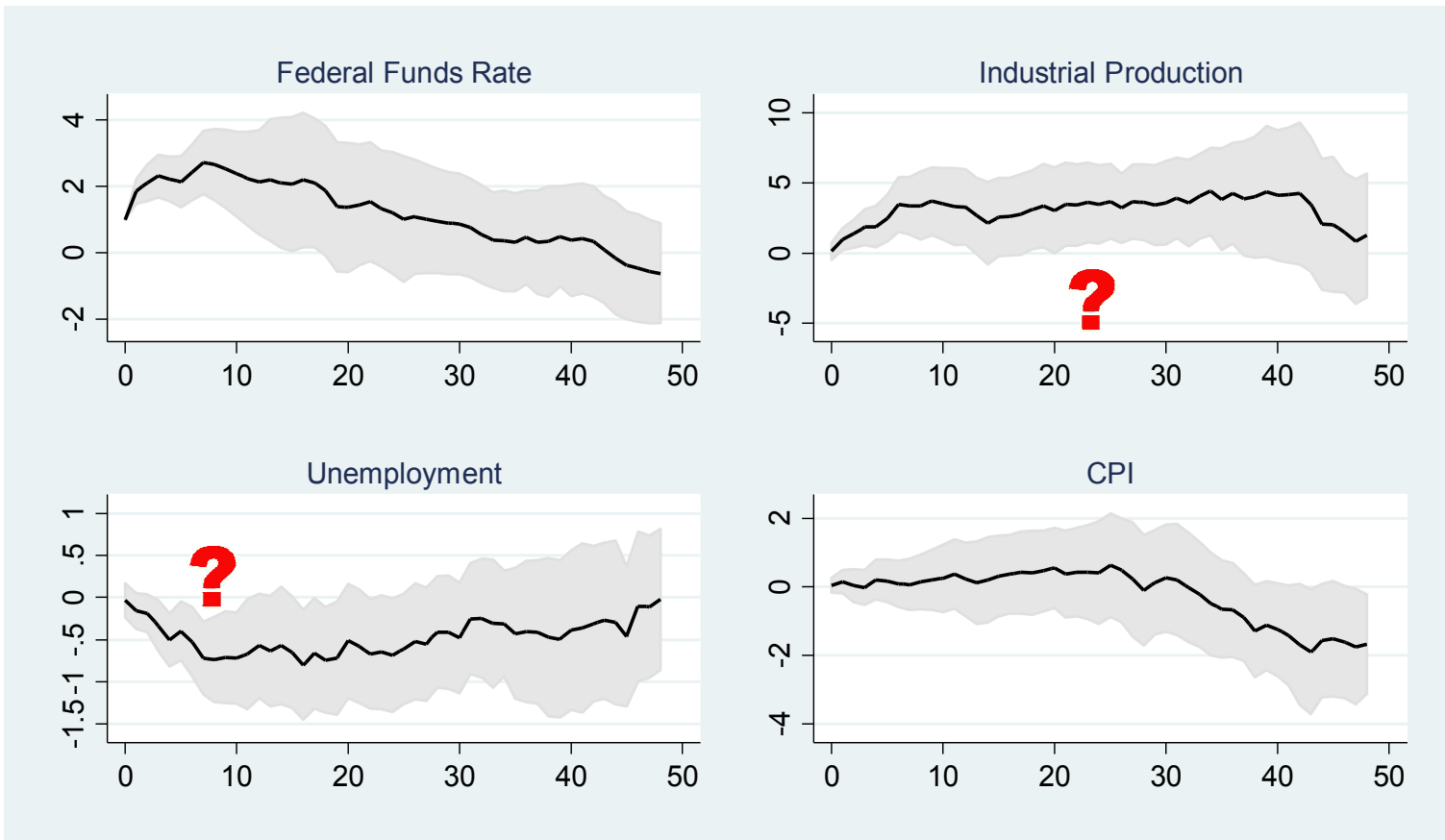
# Monetary Jordà IV, Romer, 1969m1 – 2007m12 (90% confidence intervals)



## Some Explorations with the Romer-Romer Monetary Shocks

6. How about the Jordà IV on the 1983 – 2007 sample?

# Monetary Jordà IV, Romer, 1983m1 – 2007m12 (90% confidence intervals)



# Summary and interpretation of results

- Without the additional recursiveness assumption, even narrative methods can produce puzzling results.
- Many of the methods that produce classic monetary shock results in samples through the mid-1990s produce puzzles when estimated over later samples.
- In particular, contractionary monetary shocks seem to have expansionary effects in the first year and the price puzzle is pervasive.
- A plausible explanation for the breakdown in results in the later sample is an identification problem: because monetary policy has been conducted so well in the last several decades, true monetary policy shocks are rare. Thus, it is difficult to extract meaningful monetary shocks that aren't contaminated by problems with foresight on the part of the monetary authority.

# High Frequency Identification

- First used by Kuttner (2001)
  - Used HFI to disentangle anticipated vs. unanticipated monetary policy shocks.
  - Used change in futures on that FOMC day
  - looked only at effects on interest rates
  - Follow-up work: Gürkaynak, Sack, and Swanson 2005; Hamilton 2008; Campbell et al. 2012

One issue is that they don't necessarily identify exogenous shocks.

- Incorporation of HFI into VARs: Cochrane and Piazzesi 2002; Faust, Swanson, and Wright 2004; and Barakchian and Crowe 2013
- Nakamura and Steinsson (2013) – Use Rigobon's method to identify incorporating heteroscedasticity.

Table 2 suggests it matters for one-day windows, but not for 30 minute windows.

## Gertler-Karadi (2015) Monetary Shocks

- Use federal funds futures to identify high frequency surprises around FOMC announcements (30 minute window).
- Avoid recursive identification by using the external instruments (proxy SVAR) method.

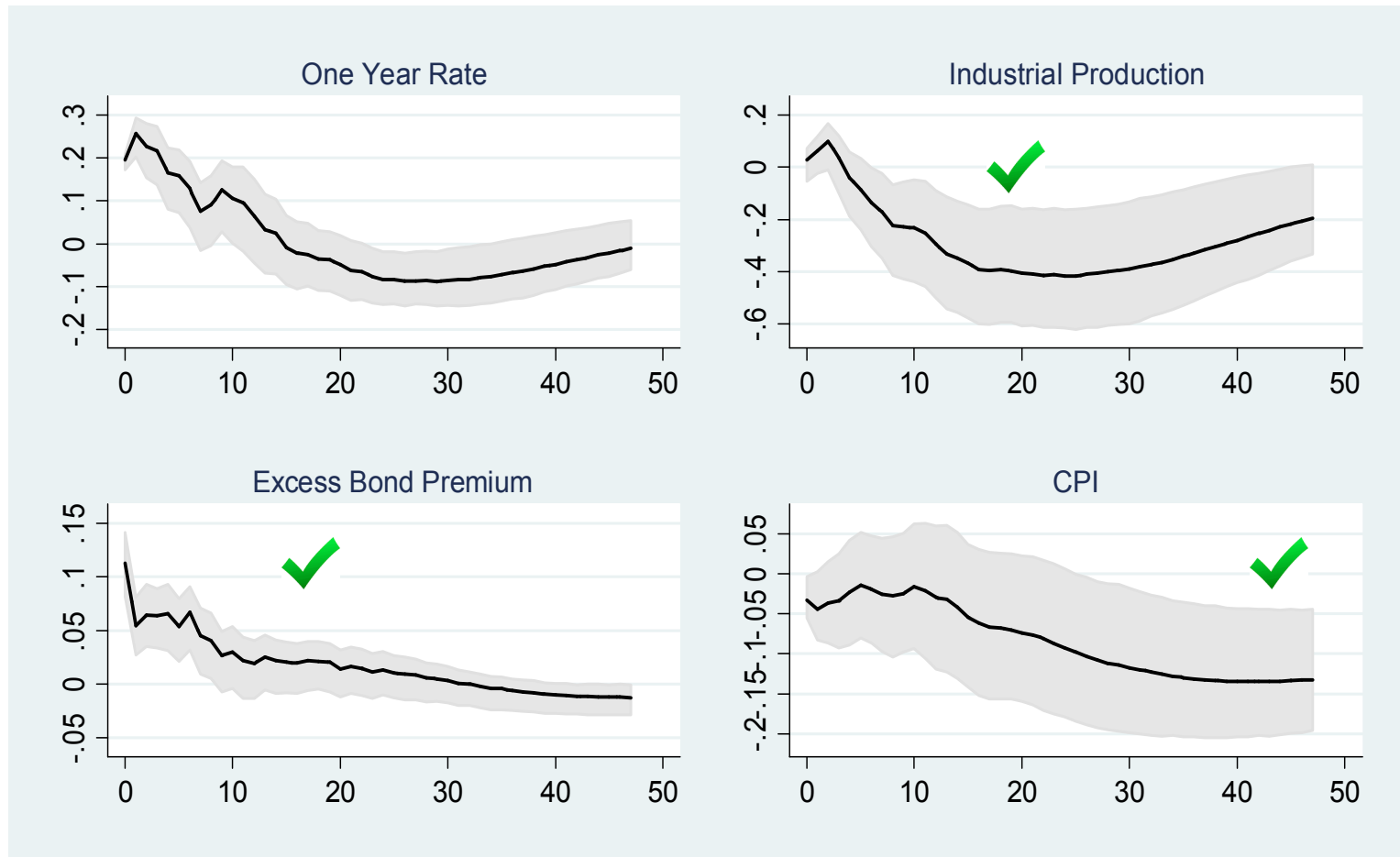
Particularly important since they include financial variables such as spreads in their SVAR.



# Monetary Proxy SVAR, Gertler-Karadi, 1990m1 – 2012m6

(they estimated their reduced form residuals on data from 1979-2012)

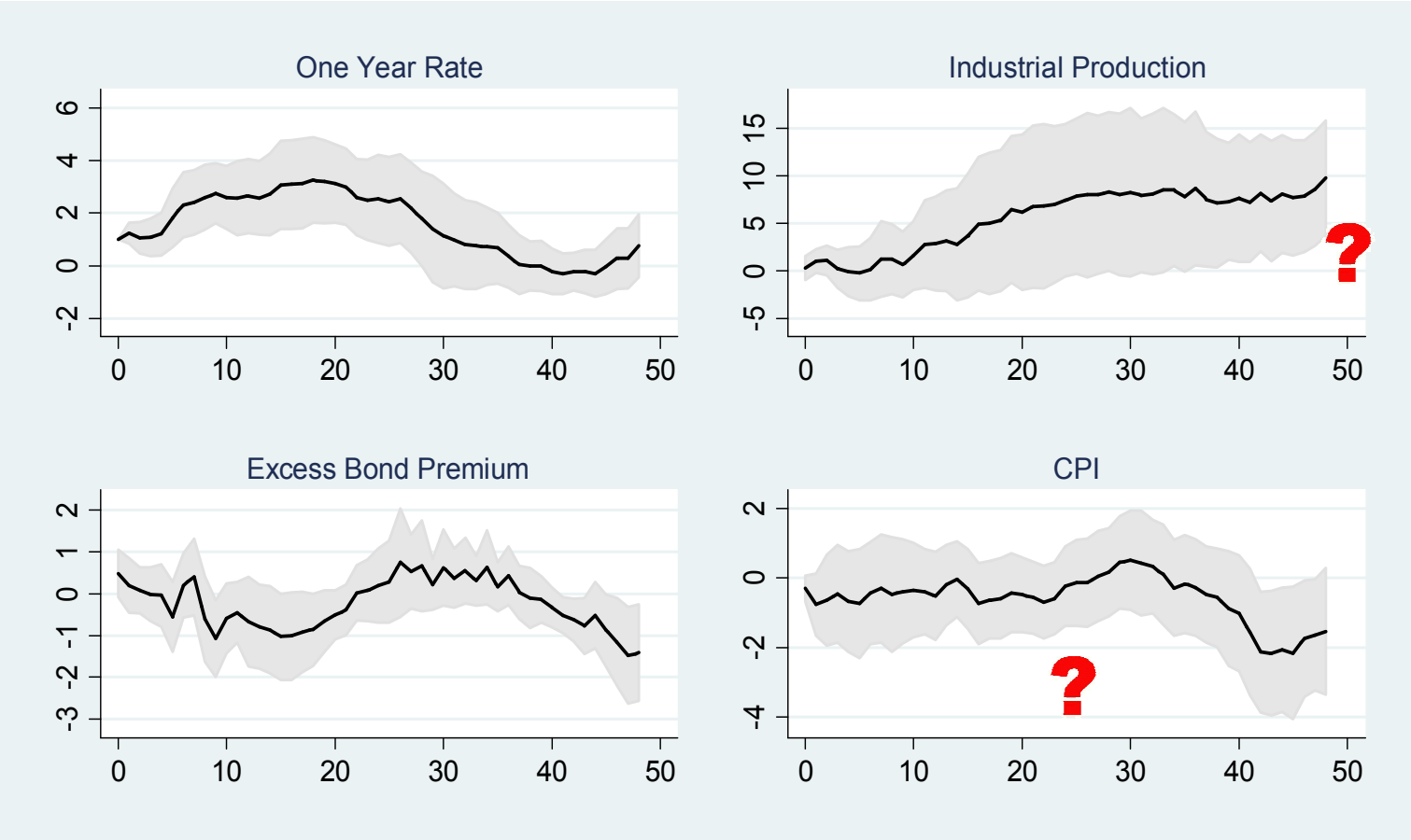
(90% confidence intervals)



# Explorations with Gertler-Karadi (2015) Monetary Shocks

1. What if we use their shocks in a Jordà local projection framework?

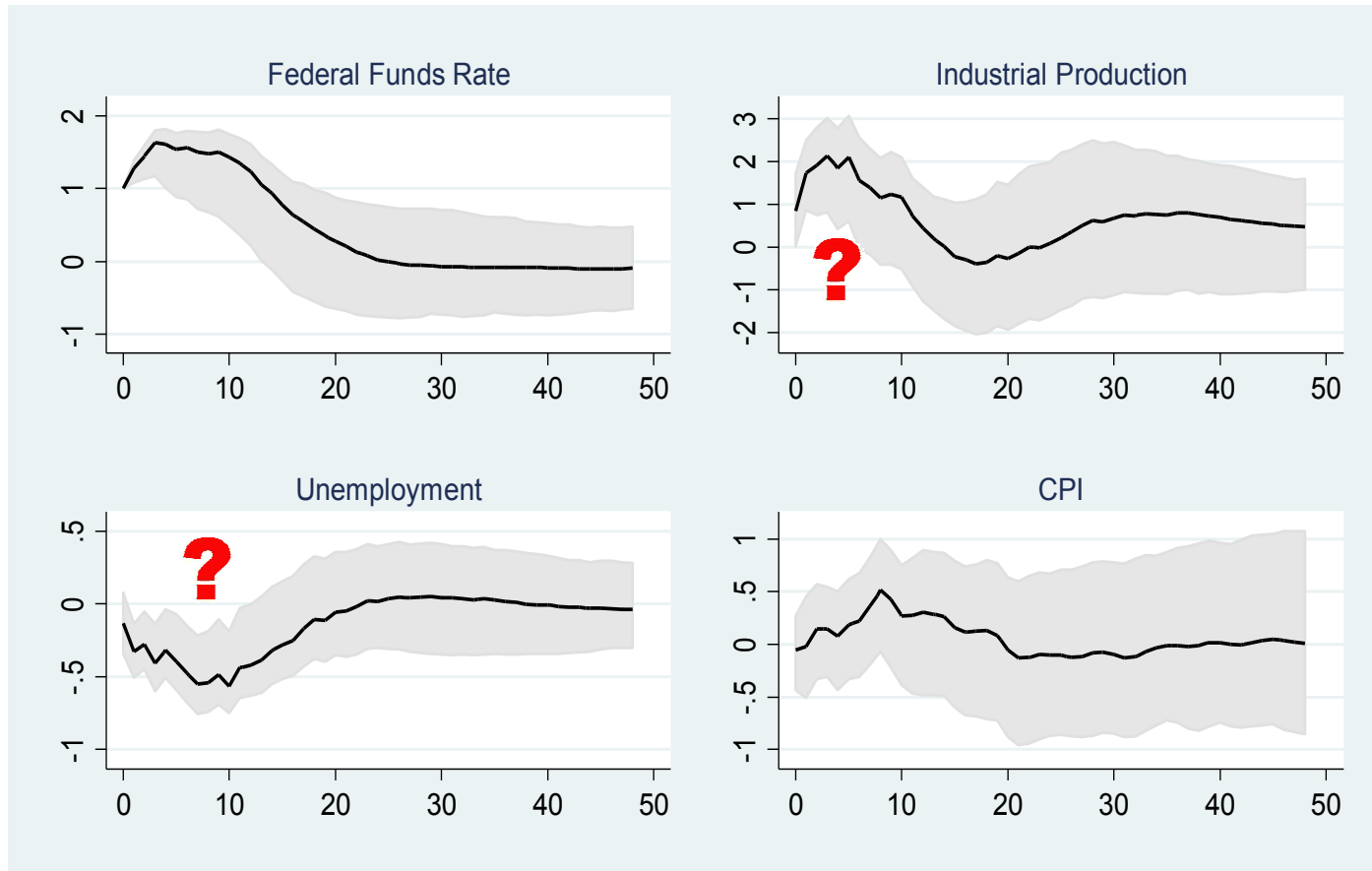
# Monetary Jordà IV, Gertler-Karadi, 1990m1 – 2012m6 (90% confidence intervals)



# Explorations with Gertler-Karadi (2015) Monetary Shocks

2. What if we use their shocks in a proxy SVAR using Coibion's variables?

## Gertler-Karadi, Proxy SVAR in Coibion System, 1990m1 – 2007m12 (90% confidence intervals)

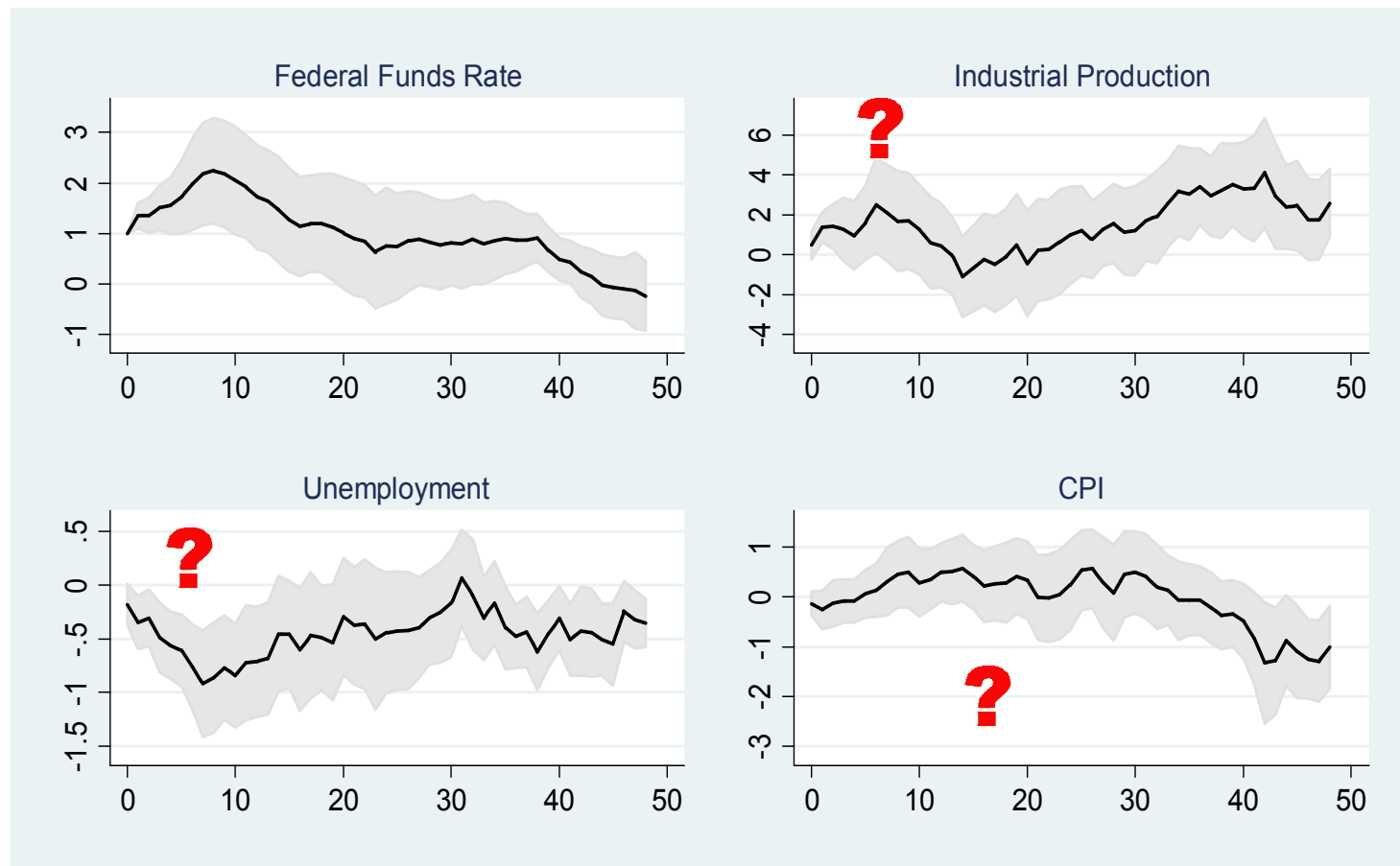


# Explorations with Gertler-Karadi (2015) Monetary Shocks

## 2. Other features of Gertler-Karadi shock

- Predicted by its own past value: AR(1) coefficient is 0.31 with a robust standard error of 0.11.
- Correlation with Romer shock (using my version of the Romer shock estimated from 1983-2007) is 0.25.
- Regression of Gertler-Karadi FOMC shock on Romer Greenbook forecasts of output and inflation yield an R-squared of 0.21 and significant joint coefficients.
- If I use both Gertler-Karadi shock and Romer shock as instruments in the Jordà local projection, I cannot reject the over-identifying restrictions.

# Monetary Jordà IV, Romer and Gertler-Karadi Instruments, 1990m1 – 2012m6 (90% confidence intervals)



# Explorations with Gertler-Karadi (2015) Monetary Shocks

## Possible explanations:

- Gertler and Karadi's impulse responses functions are constructed as nonlinear functions of the reduced-form VAR parameters estimated on data from **1979 through 2012**; the Jordà method estimates are for the 1991 to 2012 sample and are direct projections rather than functions of reduced-form VAR parameters. Since the estimates of the impact effects on industrial production are near zero for both methods, the entire difference in the impulse responses is due to the differences in the dynamics implied by Gertler and Karadi's reduced form VAR parameter estimates.
- A second possible explanation for the difference is that the rising importance of **forward guidance** starting in the mid-1990s means that the VAR underlying the proxy SVAR is misspecified. Gertler and Karadi's fed funds futures variable captures news well, but they do not include it directly in the SVAR; they only use it as an instrument.



## 3 Departures from time-invariant linear models

### 1. Regime Switching Models

- Owyang and G. Ramey (2004) JME - hawk vs. dove regimes
- Primiceri (2005), Sims and Zha (2006) – investigate roles of changes in systematic monetary policy vs. shocks. Find evidence of regime switches, but they do not explain much of economic fluctuations.

### 2. Time-Varying Effects of Monetary Policy

- Faust (1998), Barth and Ramey (2001) found that effects of monetary policy shocks were less post 1982.
- Boivin, Kiley and Mishkin (2010) – Handbook of Macro chapter find similar results.
- Barakchian and Crowe (2013) show that impulse responses change dramatically in specifications estimated 1988-2008.

## 3 Departures from Time-Invariant Linear Models

### 3. State- or sign-dependent monetary policy

- Cover (1992) - negative shocks have bigger effects than positive shocks.
- Thoma (1994), Weisse (1999) found similar results.
- Angrist, Jorda, Kuersteiner (2013) – monetary policy more effective at slowing economic activity than stimulating it.
- Tenreyro and Thwaites (2014) – monetary policy less powerful in a recession.

# Conclusion about Monetary Shock Results

- There has been **significant progress** in the availability of **data** and **tools** for analyzing the effects of monetary policy shocks.
- The results are not as robust as one would like:
  - The **pesky price puzzle** keeps popping up.
  - Many specifications suggest that contractionary monetary policy is expansionary!
- **Conclusion:** Monetary policy is being conducted so well now in the U.S. that it is difficult to identify true monetary policy shocks.