The alternative shock measures are poorly correlated. (Figure 1) Doesn’t this indicate that at least two of them are seriously wrong?

A: see p. 24. CEE note the responses are the same. If each one is (true shock) + (error), and error is uncorrelated with subsequent stuff, we’re ok, they say. This is not quite right – errors on the right hand side of a regression are not irrelevant.

(I’m not going to review their review up to p. 31. Suffice it to say that you can put lots of other variables in the VAR and get interesting responses, and exchange rates show the wrong sign as they do in simple regressions.)

What happens if you put output or prices after ff in the orthogonalization?

A: p. 31 and figure 4. You get an output rise. This they dismiss on grounds of no theory produces this sign. No effect on prices. Price and shock are not correlated to start with so it doesn’t matter which goes first.

What is the “price puzzle”, how is it resolved?

A: p. 34. Without pcom in the system, mp shocks seem to raise prices. Their interpretation: this is a missing variable. The Fed sees inflation rising (it sees fast-moving pcom). It raises ff, and then we see the price rise. Putting in pcom solves this problem.

JC comment: A classic warning about the “third variable” problem in VARs. But how do we know it’s over? In particular The fed watches long term interest rates, and long term interest rates add a lot to the FF equation.

What happens if you follow Friedman and use M aggregates as the shock?

A: p. 34-35 and figure. Basically, it all disappears in standard errors; many signs are wrong. M2 looks ok.

What happens if you use fed funds futures to define the expected change in Fed funds rate?

A: you get a new shock series poorly correlated with ff shocks. Interest rates (ff futures) have substantial power to forecast ff changes!. The responses disappear. CEE: So do standard responses in this time period. JC: There is no evidence in this period that monetary policy affects anything! All the estimates seem to come from the 1980-1982 experience.

What about changes in the rule? ff = f(Ωt) + ε, f() changes?

They say: this is a source of shocks. LP: change in f is a response to events, forecasts in the economy!

One reason for ff = f(Ωt) + ε: private sector model of the fed must be of this form. Then, ε are shocks to agents information sets. This is what counts for lupos supply curve view of the world.
• What do we learn from subsamples?
  A: CEE (39, figures) Cee say they’re stable. Yes, inside one standard error from the same. JC: the standard errors are huge! Precious little evidence of anything! It’s being driven by a few data points!

• Do monetary policy shocks account for much variation in output? In inflation?
  A: p. 50 Tables missing, but report 21%, 44%, 38% of output variance at 4, 8 12 quarter horizon from ff shocks, but only 7%, 10% 8% using NBR. Very small for prices no matter what.

• Is the variance decomposition the right way to answer the question “how much of recessions and inflation are the Fed’s fault?”
  A: It’s not clear to what extent the VD is the right way to answer this question. For example, suppose there is an oil shock, the fed responds (predictably) by a wild loosening, and we get inflation. No shock, but isn’t monetary policy responsible for the inflation? The rule may be part of what is the “mistake” (Note the example needs expected MP to affect things, but that is true in many models, and certainly true for inflation.) (see last paragraph of p. 51).

• Changing expectations of future fed moves could be a shock!

• If you look at the fed funds rule in a VAR (the equation \( ff_t = b' stuff_{t-1} + \varepsilon_t \)) it looks completely nuts. The Fed responds marginally at \( t \) to the 11th lag of output – or ff, or m!!?? Isn’t this a big problem?
  A: CEE’s answer (p. 59).
  1. Measurement error; a “signal extraction” problem. If the Fed responds only to \( y_t, p_t \) but these are measured with error, in the final data it will seem to respond to \( x_{t-j} \) as well.
  2. If fed responds to \( f f_t = \alpha E_t y_{t+j} \) then everything that might forecast \( y \) enters in the rule.
  3. Note a big problem here. Taylor rules do interpret these estimates. “gaps” (say \( u \)) forecast inflation. Now, you see the fed respond to gaps \( f f_t = a + b \times u_t \).

Does this mean the fed is trying to stabilize output? Or does it just mean it’s responding to future inflation, which happens to be forecast by output?
VAR summary of issues and problems.

1. Included Variables? If there is a third variable \( z_{t-1} - m_t; z_{t-1} - y_{t+1} \) it will make \( m \) seem to affect \( y \). Example: weather forecast. We have already seen this go wrong with the price puzzle. Do we have all the right variables? What about long term interest rates!? 

2. What is a shock anyway? The Fed never says it shocks things. Can we make do with less than a pure coin flip to recover the output (price) response? (Some thoughts coming in Romer/Romer paper and JC comments)

3. “The Impulse response function measures average value of \( y \) \( k \) periods after a shock”. Precisely, you can recover (in population) the IR function by 1) finding the shocks 2) running single regressions of the variable in question on the history of shocks,

\[
y_t = a + b_j \varepsilon_{t-j} + \delta_t
\]

Thus, in one sense we are just capturing history. Beware causal interpretations of causation!

4. Followup: Is the estimate based on the experience of only a few episodes? Large \( \sigma \) suggest that is the case.

5. There is so much fishing (p. 6, p.47.) to get the right answer. Is anything really measured after so much fishing?

6. Should we ask models to produce these responses?
Cochrane and Piazzesi, “The Fed and Interest Rates – A High-Frequency Identification”

- Background: If you’re worried about omitted variables, long term interest rates are #1 on the list. By expectations logic, interest rates reveal market expectations of future short rates. They thus summarize a huge amount of information you can’t include in the VAR. If the Fed changes rule, interest rates will see that and still forecast. Solves the changing rule problem! We know the Fed watches long term rates and responds – they say they do, and long term rates show up strongly in ff regressions (Piazzesi).

- Orthogonalization is one big problem – you can’t say that the Fed does not watch rates, or that rates don’t respond to the Fed within the month. But daily data solves that problem.

- An economics question: can the Fed really control interest rates long enough to affect long rates? (and hence investment?)

- What’s the point of Figure 1?
  1. A: It’s bloody obvious what are shocks and what are expected! (And all of these are shocks to a VAR)
  2. Also, Can the Fed affect interest rates, or is it just pushing the ff cart in front of the horse? Figure 1 looks like most ff changes are either responses to markets or anticipated by markets. (You can’t tell which.) But the moves off FOMC dates seem to catch markets by surprise and really do suggest the Fed can control rates if it wants to.

- Figure 2?
  1. This has a big effect on impulse responses!
  2. The standard errors are huge!

- Figure 3?
  1. What is the effect of an ff shock on long term interest rates? Surprisingly large!

- Figure 4?
  1. The dynamic response of yields is surprisingly long! (At least long and large are consistent)

- Note: Rudebush used fed funds futures, and $\varepsilon_t = ff_{t} - fed\ funds\ future_{t-1}$, causing similar problems for CEE. We don’t impose this “expectations hypothesis” that the fed funds future is the conditional expectation.
Cochrane “What do the VARs mean”

Questions:

• Look at the M2 responses. How might we avoid the implication that a model needs to generate the long drawn out response of output to a shock?

• Why go through all this algebra rather than just estimate the ‘structural’ models directly?

• Suppose you run a old fashioned dynamic simulation,

\[ y_t = a_1 y_{t-1} + a_2 y_{t-2} + \ldots + b_0 m_t + b_1 m_{t-1} + \ldots + \varepsilon_{yt} \]

then compute the response of \( y \) to an \( m \) shock. Can this recover something interesting? How is this related to the impulse response function?

• Confining yourself to the anticipated/unanticipated model, which view does the data say is right?

• Does assuming more price stickiness in your model make you think monetary policy has longer or shorter effects?

• Why do the output and price lines in the sticky price models seem to move before the shocks?

Cochrane VARs lecture notes.

• Background: CEE “Lucas program” (I’m not sure Lucas would agree!). Get models to produce estimated i-rs from data.

• This is a big challenge for theory if taken literally: 1) Why are there any real responses to monetary policy? 2) Why are they so strung out (years!) 3) Why is the inflation response so weak and strung out? 2&3 combined are particularly hard price and output effects linked

• Examples: CIA models with various frictions (CEE). Neo-Keynesian sticky price models. “Credit channel” interest rates affect borrowing by credit-constrained agents. All are models in which a single shock (an unexpected blip in money) gives rise to a long and drawn out response.

• Q: Look at the M2 responses. How might we avoid the implication that a model needs to generate the long drawn out response of output to a shock?

A: This is the basic question: see figure 2 p. 280 of M2 responses. Would an M2 shock not followed by the same M2 response give rise to the same output response? Or do subsequent M2 rises, when they come push up output with very short and small lags? Can we explain the data with a “response” that is short and small?
• Read pp3, p. 278

• In bigger words: How much of IR is “structural” or “policy invariant”? What survives a “change in regime”, say to i.i.d money instead of very persistent money?

• Note CEE acknowledge this, p. 64. They say a model should fit the IR only if you feed it the protracted ff to ff shock. (Also the point of my paper) But most models including theirs feed an iid shock and expect to see the full responses. Models are perhaps full of unnecessary propagation mechanisms.

• Note 2. Already there is a contentious question: is it enough to feed a model the monetary policy shock and its reaction function, with all the other shocks (and the systematic mp response to them) turned off? This is not obvious if the systematic part of monetary policy matters. The general theorem is “the model should match the second moments of the data (autocorrelation and cross-correlation)” which means “the entire set of impulse-response functions.” CEE have another paper “modeling money” that claims the answer is “yes, just feed it the $m \rightarrow m$ resposne” but I don’t know “under what assumptions.”

• My story requires that expected movements matter. Thus, the paper makes an expected - unexpected distinction and recovers the “structural” quantity which models might recover.

• Bottom line, and a larger question: Is there really “persistence”? Do we really need persistence generated by the economy rather than just persistent shocks? This is a longstanding problem for RBC models, in which there is no “persistence” in the economy, but random walk technology shocks. (See Watson, JPE).

• Note: no disagreement (here) about the VAR. The question is, what would happen if another shock series were fed in?

• Goal: answer the question “what if the Fed did an unanticipated blip in money policy”?

• Big picture: Estimate a structural model, use that model to compute simulations. Here the “structural” models are exactly identified, so you can read the estimates off VAR coefficients.

1. Since the answer clearly hinges on “does anticipated money matter”, let’s try two “structural” models:

   (a) Only unexpected money matters. (Lucas)
   \[ y_t = a^*(L)(m_t - E_{t-1}m_t) + b^*(L)\delta_t \]

   (b) no expected-unexpected distinction. (Friedman, Romer-Romer)
   \[ y_t = a^*(L)m_t + b^*(L)\delta_t \]
2. VAR representation of the data:

\[ m_t = c_{mm}(L)\varepsilon_{mt} + c_{my}(L)\varepsilon_{yt} \]
\[ y_t = c_{ym}(L)\varepsilon_{mt} + c_{yy}(L)\varepsilon_{yt} \]

3. Goal: recover estimates of structural models \( a^*(L) \) (estimation) from the VAR

(a) Substitute var into the structure,

\[ c_{ym}(L)\varepsilon_{mt} + c_{yy}(L)\varepsilon_{yt} = a^*(L) [c_{mm}(0)\varepsilon_{mt} + c_{my}(0)\varepsilon_{yt}] + b^*(L) [d_m\varepsilon_{mt} + d_y\varepsilon_{yt}] \]

Since this holds for any value of the shocks, we get two equations,

\[ c_{ym}(L)\varepsilon_{mt} = a^*(L)c_{mm}(0)\varepsilon_{mt} + b^*(L)d_m\varepsilon_{mt} \]
\[ c_{yy}(L)\varepsilon_{yt} = a^*(L)c_{my}(0)\varepsilon_{yt} + b^*(L)d_y\varepsilon_{yt} \]

Need something more to solve for \( a^*, b^*, d \)

(b) \( \delta_t = \varepsilon_{yt} \), so \( d_m = 0 \). Normalize to \( d_y = 1 \) In this sense the VAR identification of shocks was successful. (We needed that assumption somewhere!)

\[ c_{ym}(L)\varepsilon_{mt} = a^*(L)c_{mm}(0)\varepsilon_{mt} \rightarrow \]
\[ a^*(L) = \frac{c_{ym}(L)}{c_{mm}(0)}. \]

The impulse response function is the structural estimate under these assumptions.

(c) Substitute var into model 2,

\[ y_t = a^*(L)m_t + b^*(L)\delta_t \]
\[ c_{ym}(L)\varepsilon_{mt} + c_{yy}(L)\varepsilon_{yt} = a^*(L) [c_{mm}(L)\varepsilon_{mt} + c_{my}(L)\varepsilon_{yt}] + b^*(L)\delta_t \]

Again, under assumption that \( \delta_t = \varepsilon_{yt} \),

\[ c_{ym}(L)\varepsilon_{mt} = a^*(L)c_{mm}(L)\varepsilon_{mt} \]
\[ a^*(L) = \frac{c_{ym}(L)}{c_{mm}(L)}. \]

divide y response by m response. Example: if \( c_{ym}(L) = c_{yy}(L), a^*(L) = 1 \).

(d) Ready to calculate, but what’s the interpretation?

i. Note we divide the output by the money response. If both responses the same, then the answer is 1, \( m \rightarrow y \). Money affects output with no lag at all; the drawn out response is only from the drawn out shock.
ii. It’s the “dynamic response” as Romer-Romer calculate. Suppose you ran
the regression
\[ y_t = a_1 y_{t-1} + a_2 y_{t-2} + \ldots + b_0 m_t + b_1 m_{t-1} + \ldots + \varepsilon_{yt} \]
\[ a(L)y_t + b(L)m_t = \varepsilon_{yt} \]  \hspace{1cm} (1)
and you calculated the “dynamic response to m”
\[ y_t = -\frac{b(L)}{a(L)} m_t. \]

**Theorem:** this would recover \( a^*(L) \).
\[ a^*(L) = \frac{c_{ym}(L)}{c_{mm}(L)} = -\frac{b(L)}{a(L)} \]

**Proof:** (1) is the first line of the autoregressive representation of the VAR.
\[
\begin{bmatrix}
    a(L) & b(L) \\
    c(L) & d(L)
\end{bmatrix}
\begin{bmatrix}
    y_t \\
    m_t
\end{bmatrix}
= \begin{bmatrix}
    \varepsilon_{yt} \\
    \varepsilon_{mt}
\end{bmatrix}.
\]

The VAR is the moving-average representation
\[
\begin{bmatrix}
    y_t \\
    m_t
\end{bmatrix}
= \begin{bmatrix}
    c_{yy} & c_{ym} \\
    c_{my} & c_{mm}
\end{bmatrix}
\begin{bmatrix}
    \varepsilon_{yt} \\
    \varepsilon_{mt}
\end{bmatrix}
\]
Thus,
\[
\begin{bmatrix}
    a(L) & b(L) \\
    c(L) & d(L)
\end{bmatrix}
= \frac{1}{c_{yy}c_{mm} - c_{ym}c_{my}}
\begin{bmatrix}
    c_{mm} & c_{ym} \\
    -c_{my} & c_{yy}
\end{bmatrix}
\]
and
\[ -\frac{b(L)}{a(L)} = \frac{c_{ym}(L)}{c_{mm}(L)} \]

• Question: Suppose you run a old fashioned dynamic simulation,
\[ y_t = a_1 y_{t-1} + a_2 y_{t-2} + \ldots + b_0 m_t + b_1 m_{t-1} + \ldots + \varepsilon_{yt} \]
then compute the response of \( y \) to an \( m \) shock. Can this recover something interesting? How is this related to the impulse response function?
A: We just answered it.

• Question: how have we avoided all the criticisms of dynamic response regressions? Reverse causality, third variables, etc.
A: By assumption. We assumed in particular that the VAR recovers monetary policy shocks and includes all necessary variables. (This needs proof!)
Question: Why go through all this algebra rather than just estimate the ‘structural’ models directly?
A: The estimate would give exactly the same thing since the models are exactly identified. More generally (overidentified models) you do have to estimate or handle the overidentification somehow.

Paper does an intermediate case, $\lambda$ of one, $1 - \lambda$ of the other, and an explicit forward-looking sticky-price model.

Results:
1. p. 290, Figure 3. “anticipated” model gives much shorter, smaller structural response to an unanticipated blip. It of course gives a larger (same) response to an anticipated blip.
2. p.292 Figure 4. Stickier prices = shorter structural responses in the sticky price model (graph is $a'(L)$.) p. 292 Note prices and output respond before an anticipated inflation. This is a big data issue for NK models. Note stickier prices gives a shorter response, because we’re fitting the same VAR
3. Figure 6. Same for FF var.

Question: Which view is right? Anticipated, Short and small? or unanticipated long and large lags?
A: data can’t tell. But data can give a tradeoff for theorists: you can construct models with small, short responses if you allow anticipated money to have effects. (Note nobody in the policy community thinks only unanticipated has effects.)

Read policy advice 296.
1. Fed wants answers now to what it regards as an empirical question. You can’t answer with “what’s the rule,” “time consistency blah blah”, “wait until we finish the deep structural model of money” etc.
2. But it’s not a purely empirical question! At least “do you think anticipated policy matters?” and “do you plan to follow up the policy change with the usual?”
3. we can say this: a 1.5 year large response and anticipated beliefs are contradictory.

TO DO LIST:
1. Across regimes! You should be able to identify which is right by estimating responses across different regimes – countries or times.
2. How do you match models with data? (CEE “modeling money”) (In what models is each OK?)
   (a) Simulate response to $m = \varepsilon_t$?
(b) Simulate responses of variables to $m = a(L)\delta$?
(c) Full set of response functions including feedback?

3. Construct a serious CIA / NK model that matches the data including the rule and persistence of policy. Show that the “structural” effects are small.