

## START HERE FOR LECTURE 4.

Romer and Romer

Questions on Romer and Romer

- What does their reading of the FOMC minutes say about the Greenbook forecasts?
- Admitting that some regression errors are not completely random shocks, what property do they think such errors need to have to be valid in impulse response functions?
- What kind of events do they think cause valid shocks in the data?
- What kind of events do they think cause bad shocks in the data, and what do they do to avoid them?

Romer and Romer lecture notes:

- What's a shock? Big point.
- Romer and Romer are famous for the “narrative method.” Identify shocks by reading the minutes of the FOMC. Of course, what's a “shock” – the Fed never says “and now, 25 bp for fun.”
- What they do:
  1. Produce “intended funds rate” which extends “target” back in time.
  2. Produce shocks by running this on Greenbook forecasts of output and inflation (1)
$$\Delta f f_t = a + \beta f f_{t-1} + (\text{output forecasts at } t) + (\text{price forecasts at } t) + \text{shock}_t$$
  3. Plot responses to these shocks by running regressions of output on shock time series (see (2)).
- Results. They say different, to me it looks exactly like CEE. See Figures.
- Points for us
  1. What does their reading of the FOMC minutes say about the Greenbook forecasts?

A: The Greenbook seems to be a complete summary of the Fed's y, p forecasts! (p. 1060, narrative evidence important here)

2. Admitting that some regression errors are not completely random shocks, what property do they think such errors need to have to be valid in impulse response functions?

A: p. 1062 “ 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. ”

3. What kind of events do they think cause valid shocks in the data?

A: tastes goals, anything not related to output. rule changes.

The paper has good thoughts on “what is a shock?” p. 1064. (All are potential causes for a regression error. But which are valid shocks?)

- (a) “Influences on policy not captured..” I.e. *responses*
  - (b) Claim that “control for Fed Forecasts of output and inflation” makes a shock ok “for estimating the impact of monetary policy on the economy [output and inflation]
  - (c) “Evolution of operating procedures.” (money targeting example)
  - (d) 1065 Changes in “Policy maker’s beliefs about the workings of the economy”
  - (e) “tastes and goals”
  - (f) Politics.
  - (g) Pursuit of other objectives. (exchange rate)
  - (h) Random. Personalities, moods and idiosyncratic views. (I’d add, random outcomes of any committee decision!)
4. What kind of events do they think cause bad shocks in the data, and what do they do to avoid them?

A: moves based on information about future output and price level. That’s why they run ff on greenbook forecasts and use the residual.

- Basic theme: Greenbook forecasts are *sufficient statistics*.

$$\text{Greenbook forecast} = E(y_{t+k} | \text{Fed Info at } t)$$

- Big point (why both papers are on the reading list): I think these papers advance our understanding of “what is a shock?”
- **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.*
- Is this true? It seems right; consider the exchange rate or mood example. RR say it’s true. Prove it!! (Good paper topic)
- *In what class of model is this true?* What about models in which only unexpected monetary policy matters? I suspect the proposition is not model-free.
- What if the central bank is pegging an exchange rate? All policy is endogenous. Can we measure output effects of r changes? Same, if the bank is targeting inflation?
- Why do greenbooks help?

A: *If the greenbook is a sufficient statistic, then*

$$\begin{aligned} \text{JC } \Delta f f_m &= \alpha + \sum_{i=0}^2 \gamma_i \Delta \tilde{y}_{mi} \quad (+\beta f f_{m-1} + \delta \Delta f f_{m-1}) + \varepsilon_t^y \\ \Delta f f_m &= \alpha + \sum_{i=0}^2 \gamma_i \tilde{\pi}_{mi} \quad (+\beta f f_{m-1} + \delta \Delta f f_{m-1}) + \varepsilon_t^\pi \end{aligned}$$

gives the shocks. We *do not need* to model the “reaction function” (possibly this is what CEE were getting at in saying we shouldn’t interpret the FF equation as a Fed rule.) We *do not need* other variables in the VAR! (If proposition 1 is true)

- Why is this better than a VAR? The theorem is that the answers are the same  
A: The same in population, yes, but not in sample. This keeps more shocks, and lets you estimate fewer parameters, which is good in sample. (see RR quote above)
- If you have a shock series and not all the other variables, how do you estimate an impulse-response function? You can’t run the VAR without the other variables.

A: Then, you can get responses by running output (prices) on the shocks.

$$\begin{aligned} \text{JC} \quad \tilde{y}_{t+1} - \tilde{y}_t &= a_0 + c_1 \varepsilon_t^y + e_{t+1}^1 \\ \tilde{y}_{t+2} - \tilde{y}_t &= a_0 + c_2 \varepsilon_t^y + e_{t+1}^2 \\ \tilde{y}_{t+3} - \tilde{y}_t &= a_0 + c_3 \varepsilon_t^y + e_{t+1}^3 \\ &\dots \end{aligned}$$

Much simpler than VAR! (This is also a very useful trick for extending VARs. For example, finding the response of exchange rates to the CEE shocks.)

- Does the JC version of RR procedure make a big difference?
  1. Results (see JC figure 1) They look about the same to me. Yes, I get more price puzzle, but standard errors are huge.
  2. This is good! Much simpler more robust procedure gives the “right” answer.
  3. All evidence is weak – see the remaining figures!
  4. A nice feature of scatterplots. “An impulse response is the average output (price level) change x months after a shock” Yes, and this is what 1-2  $\sigma$  looks like. I think this displays the uncertainty more clearly than an IR with standard error lines.

Still more VAR thoughts. (Paper topics!)

- The question “what are the shocks?” and “when is it ok to use these regression errors to measure output effects of monetary policy?” is still not answered.

1. Prove proposition 1!
2. Go through the list. Which of these sources of shocks is valid, really?
3. What about agent’s information sets? Does it matter at all whether shocks are a surprise to agents?

- Suppose

$$\Delta f f_t = f(y_t, p_t, \dots) + \delta_t$$

In all our empirical procedures, we treat (1) an *expected policy change that did not happen*,  $f(\cdot) = 1\%$  but  $\Delta f f_t = 0$ , as exactly the same thing as (2) an *unexpected policy shock*,  $f(\cdot) = 0$  but  $\Delta f f_t = -1\%$ . My bet: In the data type 1 events have no response, type 2 events completely drive the IR function.

- Bayesian, Fed learning as we go along? (Sargent, “Conquest of inflation”)
- A cab driver drops Greenspan off at the FOMC meeting, and finds his PDA which says “note to self: raise rates 5% today.” He calls his broker, the news leaks, it hits the newswires, and all interest rates go up 5% before the meeting. Then, at the meeting, the Fed raises rates 5%. Is this really no longer a “shock”? (In reality, market rates adjust 2 days in advance. Are these shocks anyway?)
- Related, do changes in interest rates in anticipation of future Fed funds moves count as shocks? (Return to above bet – I bet they have opposite signs)
- Interest rates need to be fully integrated in to VARs! They provide lots of information about expected moves. If your model says “surprise to agent’s information set” is what matters, you can make a strong case that you should use *only* interest rates as your right hand variables in the rule.
- Shock to information sets or orthogonal to output forecasts? Which is the right definition of a shock?
- I’m going to end with a list of things that bother me about VARs, issues we have not satisfactorily resolved, and “paper topics” on what to do next. Come prepared with an item to add to this list.

Doubts.

- Where are we? Very self-satisfied “consensus view”  $M_d$  and  $M_s$  intersect to determine interest rates. Lowering  $M_s$  = raising interest rates has all the effects Friedman said, with about the time horizon. The Fed is in principle very powerful. Less at fault than we thought – much  $\sigma(y)$  is in fact real, not monetary, but still very powerful.
- My doubts. Where is the *economics* that gives the Fed such great power? The next set of readings are designed to express these doubts.

Money demand overview. (Akerlof background)

(Lucas Carnegie Rochester is a good paper to start with if you want to read deeper.)

- Big picture:

1. “Stable” money demand?
2. Interest and income elasticities (used to be important in “multipliers”; “liquidity trap” if the interest elasticity is small.)

- Bigger picture – Does the whole  $M_s(r) / M_d(Y,r)$  framework make any sense? Does this “determine” the interest rate even though  $r$  enters in many other decisions?

- Money demand economics. Money for transactions, bonds for interest. *Money is an inventory.*

1. Old fashioned inventory theory.. Baumol-Tobin: A fixed flow of purchases, how often do you go to the bank? It gives a 1/2 income elasticity and a 1 interest elasticity.
2. Miller and Orr. s-S policies for random inflows and outflows.
3. Now,  $U(M/P)$ , CIA. Much easier to write explicit general equilibrium models, but assumes the answers. CIA cash management: get cash in morning, use all up during the day. Period. No interesting inventory management.
4. “Deep.” (Randy Wright) Trading frictions. Objective is still  $M(Y,P,r)$ .

- All models:

1. Money: necessary for transactions, interest cost
2. Bonds (Bank) pays interest, cannot be used for transactions.

- Baumol-Tobin model:

1. Withdraw cash from bank, spend it steadily. (Sawtooth money holdings) There is a fixed cost to withdraw (ATM fee, lost time). Cash pays no interest.
2. Get  $Q$  each time. Pay  $c$  fixed cost (ATM fee) .  $PY$  nominal income per period..  $M = Q/2 =$  average money holdings. Interest cost is  $rM$ . Number of trips to the bank =  $PY/Q = 2Y/M$ . Thus

$$\min(\# \text{ trips}) \times c + r \times M$$

$$\min \frac{2PY}{M}c + rM$$

$$\frac{2cPY}{M^2} - r = 0$$

$$M = \sqrt{\frac{2cPY}{r}}$$

$$m = \ln \sqrt{2} + \ln \sqrt{c} + \frac{1}{2} \ln PY - \frac{1}{2} \ln r$$

3. Result: 1/2 income and interest elasticity.

- Facts: 1 income elasticity in the long run, though low in short run. Much lower (0.1-0.2) interest elasticity  $r$  in the short run.

- How can we get a 1 income elasticity?

1.  $c$  should not be invariant to  $P$  for sure,  $Y$  probably. If  $c = \alpha PY$ , then

$$M = \sqrt{\frac{2\alpha P^2 Y^2}{r}} = \sqrt{\frac{2\alpha}{r}} PY.$$

2. The elasticities depend a lot on these little changes

3. Why is the short-run interest elasticity low?

4. How often do you change your habits of ATM frequency because of interest rate changes? Maybe 0!

5. Interest elasticity of reserves should be much better, because banks do a good job of it!

6. Miller Orr: income elasticity = 1/3

- Empirical work consists of regressions of  $M$  on  $P$ ,  $Y$ ,  $r$  and is sort of a mess.

1. Levels vs. first differences – makes a huge difference.

2. To fit better, models include “lagged adjustment”  $m^* = f(P, Y, r)$ , then  $m = \rho m_{t-1} + (1 - \rho)m^*$ . This just admits economics is not working in short run!

3. Which aggregate? M2 is “most stable” but least money! Which rate of return? Theory says short, empirical work uses long to get better results. Which  $Y$ ? Theory says transactions, empirical work uses income, then permanent income to get a better fit.

4. Even so, it falls apart in the 80s with huge “velocity shocks” just as (perhaps) the Fed started to push on  $M$ . The “stable aggregate” (e.g. do we include/exclude money market mutual funds?) keeps changing ex-post.

Akerlof, “Irving Fisher on His Head” :

- JC stories:

1.  $M_d(Y,r) = M_s$  is an equilibrium condition
2. Peanut butter inventory =  $a*Y - b*r$ . Control quantity of peanut butter to control  $Y$ ,  $r$ ? (Note PB inventory is probably larger than reserves!)
3. Price of chewing gum at gate C21 =  $f(Y, \text{other prices})$ . Can the Fed control  $Y$  and  $P$  by insisting on the price of chewing gum at gate C21 O’hare?
4. Hold the hair on the dog’s tail fixed. Does the Dog wag?
5. “Decoupled”; these “demand curves” fall apart if you push on them?

- Background. “Stability” of money demand. Fell apart in Sept 1979. Is this “velocity shocks” or another Lucas-Critique, Phillips curve “unstable parameter” – one that falls apart when you push on it?

- Akerlof: latter. Another called home run. I think it should be more famous, like Friedman. Perhaps it’s because it’s hidden in silly ISLM stuff

Akerlof Questions:

- What’s the difference between an “autonomous” and an “induced” payment?

A: autonomous = buy stuff. Induced = cash-management, i.e. go to the bank.

- Akerlof says Irving Fisher (and Milton Friedman) thinks that the “average lag” is constant. Where does this come from? We haven’t heard of “average lags” before.

A:  $MV = PY$ . If  $PY$  goes up,  $M$  stays in your hands the same length of time, so  $M$  goes up the same amount. This is a way to get a unit income elasticity, zero interest elasticity (i.e. fixed velocity).

- How does Akerlof’s underlying model for generating money demand differ from Baumol-Tobin?

A: BT have this fixed rule; take money out every so often and then spend it. Akerlof allows stochastic inflow and outflow. You go to the bank when you hit an upper or lower boundary on cash holdings. Really, it’s the same model but Akerlof has stochastic buying and selling.

- p. 170 Akerlof shows that holding 20% too much money only costs you \$2 per year – and that if the transaction cost is \$10. What’s the point?

A: Note in BT people change frequency of bank trips as  $Y$ ,  $r$ , change. The point is that failing to make this adjustment carries trivial costs – so don’t be surprised if people don’t do it.

I think this is an incredibly important point – so much so that I wrote a whole paper about it. (“The Sensitivity of Tests of the Intertemporal Allocation of Consumption

to Near-Rational Alternatives” AER79 (1989) Tops of hills are flat. If we regard, say, the region of 5% utility losses as our “economic standard error” then lots of economics (and especially behavioral anti-economics) is testing silly predictions with tiny utility losses. Example: Do social security recipients spend \$20 when they get the check or a month earlier when news comes? *There are pennies on the sidewalk* even in Chicago. Also these predictions are sensitive to small model misspecifications like small transactions costs.

- p.172. What is the point of Akerlof’s “cinematographic analogy”?

A: if you speed up the film, income (flow) doubles, but money demand stays the same. This suggests a 0 interest elasticity of money demand – until people change the upper and lower barriers. The point then, is

1. A non-zero elasticity depends on getting people to change the upper and lower limits.
2. In the meantime *velocity is passive*. In this case velocity went up.

- If a consumer spends money at a constant rate, what are the implications if he or she a) goes to the bank once per week vs. b) goes to the bank every time he or she runs out of money, and then gets a set (\$200) amount?

A: p. 172. Constant *time* leads to  $V$  constant, and unit income elasticity. Constant *target* leads to zero income elasticity and passive velocity.

- p. 173. He thinks the point is the fiscal policy multiplier which comes from the ratio of interest to income elasticities  $I_r/I_y$ . His point:  $I_r$  is low, but so is  $I_y$ . I think the points of the paper transcend 1960s era ISLM models!

- p. 174. Notation:  $h$  = upper bound.  $z$  = target.

- Q: if you have  $m$  in the bank today, what can happen tomorrow?

A:  $m + 1$  with probability  $p$ . no change with probability  $q$ .  $m - 1$  with probability  $s$ .

- Where are the typo(s) in equation 10? Explain the intuition of the right equation.

$$f(m) = pf(m + 1) - sf(m) + qf(m + 1)$$

A:

$$f(m) = pf(m - 1) + sf(m) + qf(m + 1)$$

- Why does the probability of no change  $s$  not matter in (15)-(16)?

A:  $s$  just slows things down. Note we would now do this continuously, and then solve a differential equation.

- This is one heck of a silly model. Where's the max? What's the choice variable?  
A: The underlying model chooses  $h$  and  $z$  optimally, and these will change (slowly, in Akerlof's view) as  $Y$  ( $p, q$ ) or  $r$  change. (A point of the paper: introduce you to a typical inventory theory model)
- What adjusts to make money supply = money demand?  
A: p. 175 Akerlof says  $p, q$ , and  $s$  will change; as  $Y$  increases for example,  $p$  and  $q$  may increase. In his view  $h$  and  $z$  are fixed (in the short run) but in standard models or the long run, they would also adjust.
- If the target and threshold  $h$  and  $z$  stay constant, what effect does doubling  $p$  and  $q$  have on money demand? What is the interpretation of this?  
A: Micro proposition 1: none. Thus, a zero "income" elasticity.
- What do you think would happen in Akerlof's model if the Fed dropped money from a helicopter, so everybody gets an extra dollar?  
A: Needs to be worked out. My guess: only the people near the thresholds are affected. Thus, there is very little immediate effect of a "helicopter drop" – only the people at the boundaries put extra "demand" for bonds or goods. But the people who do show up will on average want to get rid of their extra money, so things like  $Y, R$ , etc. have to adjust to keep them from doing so. If they are as inertial as Akerlof says, you might have big ( $r$  especially) effects to make the people who show up at the bank hold on to their extra  $m$ . But again, they don't really care, so perhaps they can be persuaded to hold the extra money with little change in  $R$ .
- What would happen in Akerlof's model if instead the Fed insists that it will inject the same amount of money by open market operation?  
A: Only the people at the bank at any time can even be tempted to trade. In this model, they trade mechanically, so no interest rate change is enough to get them to hold more or less money. Models like this (Alvarez and Atkeson) have a subset of agents at the bank at one time, so there are large but finite effects until everyone gets a chance to go to the bank.  
But.. it's a bit internally inconsistent. If you get a big effect because only a few people are at the bank at any one time, then the interest rate in that market is not allocative for everyone else! So you can get big interest rate effects *only* if they really don't matter!  
Note that helicopter drops and open market operations may have quite different effects!  
This is a good direction for paper topics!
- Akerlof emphasizes income elasticity and a flat LM curve. I learn different lessons.

1. “Elasticity” may make no sense at all. In the range of near-rational you smear the curve, you don’t change its slope. There might be no such thing as a money demand curve. I.e. it might “shift” a lot.
  2. Velocity might be passive to M increases too, though it depends on how it is injected.
  3. *Trivial utility costs* This may be behind my questions about peanut butter, chewing gum at OHare, Tail of Dog, etc.
  4. Money is like an inventory. Can we really control Y by controlling an inventory? (USAF example)
  5. Going to bank habits must change or M constant. Nominal targets must change. An interesting and finally explicit notion of “short run” vs. “long run”
- Money demand people always impose a unit price elasticity;  $M/P = f(Y, r)$ . Why?  
A: I don’t know. In Akerlof’s world, poeple might react slowly to a change in  $P$  as well.

Ben Friedman: The Central Bank as an Army with Only a Signal Corps?

- Apology: words, not models. What course is about though - - models formalize words. Words come first. Does no good to write CIA model if does not address facts at all. Need to build new models around many of the words here.
- How does this paper fit in the big picture?
  1. How can the Fed affect  $y$ ,  $p$ ,  $r$  as Milton Friedman, CEE, RR says it does? Maybe it can't (anymore) when you look at mechanism.
  2. "Decoupling" as my stories about chewing gum suggest.
  3. Financial innovation makes our economy much different from the money vs. bonds abstraction.
- Fact background. Open mouth operation story in NZ-Meeting with the Governor. p. 322 quotes on "public utterances" and "familiar fictions".
- Ben Friedman notes that reserves and OM are trivial relative to bond supply, so how can small purchases/sales of bonds affect interest rates. See numbers p. 324. What would Milton say about this analysis?

A: It's the M side that matters not the B side.  $M(r) = M_s$  determines  $r$ . Fed is the "monopoly supplier" of reserves. p. 325. (M = reserves here) Reserves control M1 via controlling checking accounts, so small size doesn't matter.