Michelson-Morley, Occam and Fisher: The radical implications of stable inflation at the zero bound

John H. Cochrane
Hoover Institution, Stanford University

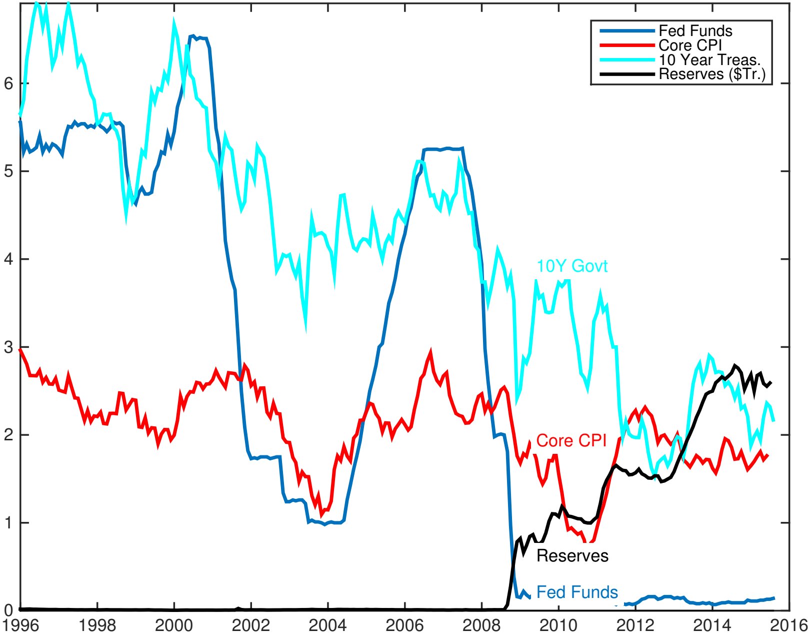
August 2016

Michelson-Morley

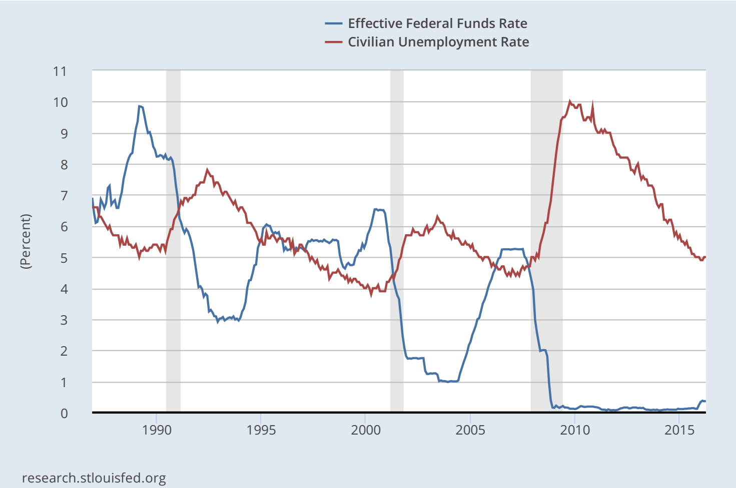
Recent history:

- Hit ZLB, nothing happened.
- Inflation, unemployment, etc. dynamics in and out of ZLB seem identical (or less σ at ZLB!)
- Huge increase in M / QE, nothing happened.
- Lower interest rates are not raising inflation.

Recent Experience–US

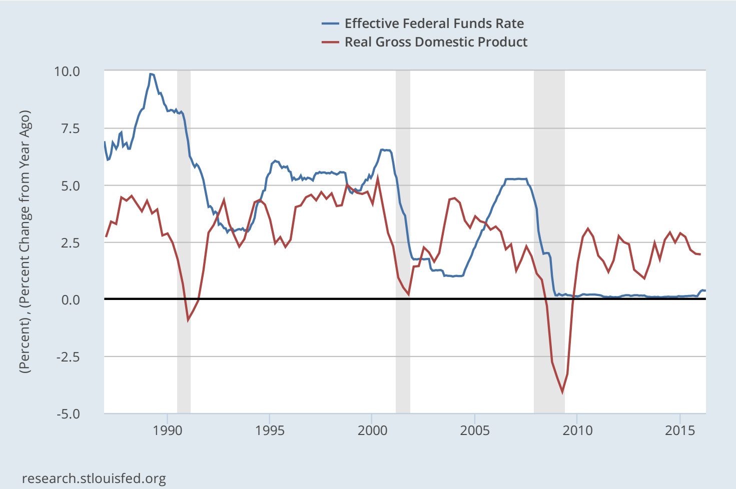


Recent Experience–US unemployment



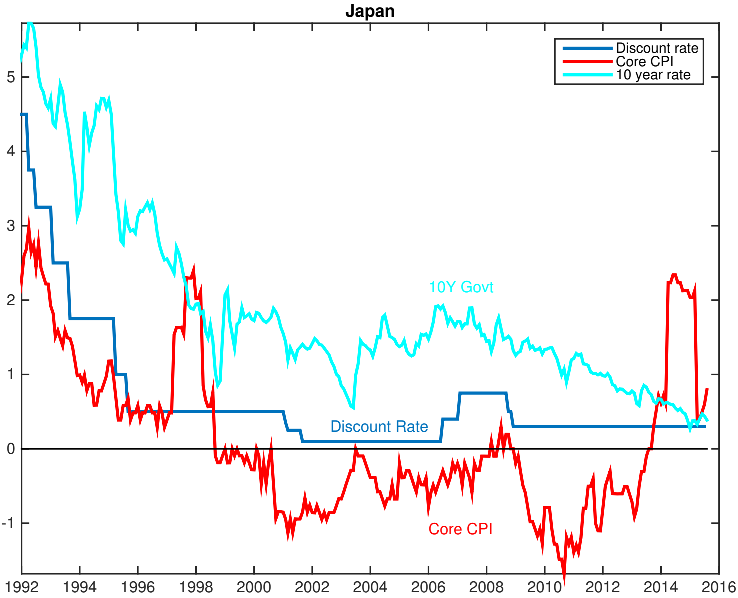
- Same dynamics. Larger shock.

Recent Experience–US

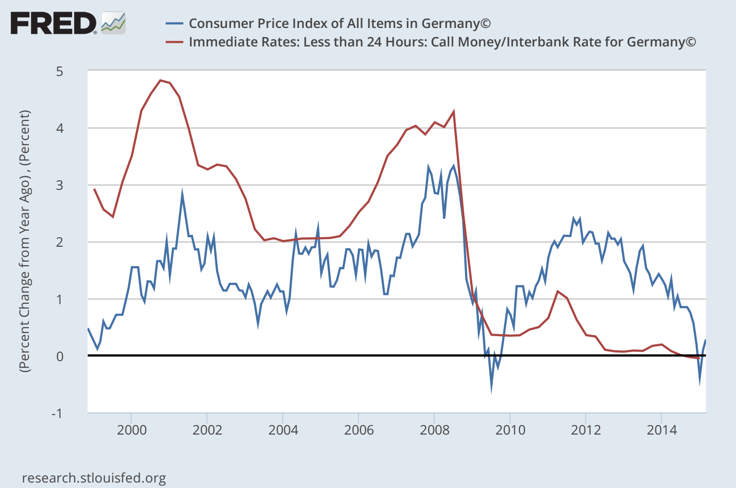


- Growth is “too low” but low σ at ZLB

Recent Experience – Japan



Recent Experience – Europe



Theories

- Classic Monetarist/Keynesian; current policy world. (Adaptive E)
  - Fisher $i_t = r_t + E_t \pi_{t+1}$. But stable or unstable?
  - i peg is *unstable, determinate*

$$\pi_{t+1} = ...i_t.. + (\lambda > 1)\pi_t + \text{struct. shocks.}$$

  - Taylor rule $i = r + \phi\pi$; $\phi > 1$ brings *stability* $\lambda < 1$.
  - $\phi = 0$ at ZLB. Predicts deflation spiral. Didn't happen.
- Classic Monetarism; MV=PY, V "stable."
  - Predicts huge inflation. Didn't happen.
- Occam: Adverse shocks, headwinds, epicycles, ether drag, or...
  - *An interest rate peg can be stable.*
  - *Arbitrary reserves paying market i are not inflationary.*

Theories

- Sargent/Wallace; Woodford; New-Keynesian. (Rational E)
  - i peg, $\phi < 1$ is *stable* (!)
  - But *indeterminate,* multiple equilibria δ_{t+1}.

$$\text{Simple: } i_t = r + E_t \pi_{t+1}$$

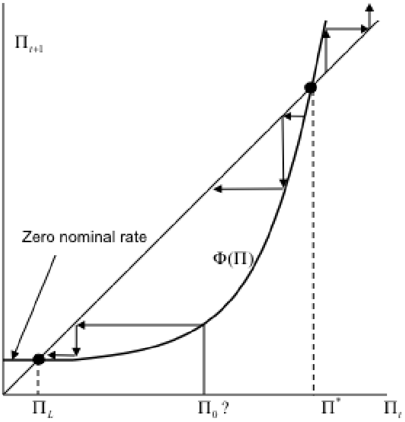
$$\text{General: } E_t \pi_{t+1} = ...i_t... + (\lambda \leq 1)\pi_t$$

$$\text{Both: } \pi_{t+1} = E_t \pi_{t+1} + \delta_{t+1} \leftarrow \text{anything iid}$$

  - Taylor rule $\phi > 1$ brings *instability* hence determinacy.
  - $\phi = 0$ ZLB predicts more σ (as $\phi < 1$ 1970s). We see less.
  - Epicycles here too. Or...

NK ZLB (BSGU)

$$\Pi_{t+1} = \Phi\left(\Pi_t\right)$$



- Multiple stable equilibria at zero bound! Taylor principle can't help.

FTPL in NK models – frictionless

$$i_t = r + E_t\pi_{t+1}; \quad \frac{1}{1+i_t} = E_t\left(\beta\frac{P_t}{P_{t+1}}\right)$$

$$\frac{B_{t-1}}{P_t} = E_t\sum_{j=0}^{\infty} M_{t,t+j}s_{t+j} = E_t\sum_{j=0}^{\infty}\frac{1}{R_{t,t+j}}s_{t+j} = E_t\sum_{j=0}^{\infty}\beta^j s_{t+j}.$$

$$\frac{B_{t-1}}{P_{t-1}}(E_t - E_{t-1})\left(\frac{P_{t-1}}{P_t}\right) = (E_t - E_{t-1})\sum_{j=0}^{\infty}\beta^j s_{t+j}. \qquad (1)$$

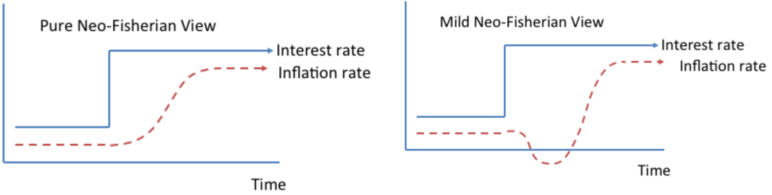
$$\frac{B_{t-1}}{P_{t-1}}E_{t-1}\left(\beta\frac{P_{t-1}}{P_t}\right) = \frac{B_{t-1}}{P_{t-1}}\frac{1}{1+i_{t-1}} = E_{t-1}\sum_{j=0}^{\infty}\beta^{j+1}s_{t+j}. \qquad (2)$$

- (1) Solves indeterminacy; "anchoring." $(E_{t+1} - E_t)\pi_{t+1} = \delta_{t+1}$.
- *Monetary policy by IOR (no fiscal policy) can set a nominal interest rate peg* and then expected inflation.
- Interest rate target can be *stable* (NK) and (now) *determinate*.
- "Can!" Past pegs fell apart from fiscal policy.
- MM, Occam: Only theory left standing. *H*ow does it work?

Fisher

- How does NK sticky-price model with FTPL determinacy work?
- Example: What if central banks raise rates? Does QE work & how?

- If a peg is stable, then *raising* rates can (can!) raise inflation.
- EU/JPN Pedal misapplication? US π rising because i rising?
- Classic view still ok in the short run?



- Frictionless:

$$i_t = r + E_t \pi_{t+1}$$

$$\frac{B_{t-1}}{P_t} = E_t \sum \beta^j s_{t+j} \rightarrow \pi_{t+1} = E_t \pi_{t+1}$$

- Higher $i \rightarrow$ immediately higher π. Need frictions? Sticky prices?

Simplest sticky-price model

Model

$$i_t = r_t + \pi_t^e \quad \text{Fisher}$$
$$y_t = \kappa(\pi_t - \pi_t^e) \quad \text{Phillips}$$
$$y_t = -ar_t \quad \text{IS}$$

Solve

$$\text{Eliminate y: } r_t = -(\kappa/a)(\pi_t - \pi_t^e)$$
$$\text{Eliminate r: } i_t = -(\kappa/a)(\pi_t - \pi_t^e) + \pi_t^e$$
$$\rightarrow i_t = -(\kappa/a)\pi_t + (1 + \kappa/a)\,\pi_t^e$$

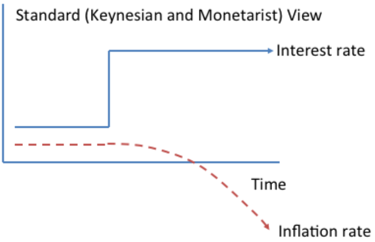
Old-Keynesian

$$i_t = -(\kappa/a)\pi_t + (1+\kappa/a)\,\pi_t^e$$

- Old: Adaptive $\pi_t^e = \pi_{t-1}$

$$\pi_t = -\frac{1}{\kappa/a} i_t + \frac{1+\kappa/a}{\kappa/a}\pi_{t-1}$$

- - sign, but *unstable*.



  - Taylor Rule *stabilizes*. But $\phi = 0 < 1$ at bound.

$$i_t = \phi\pi_t; \quad \phi > 1 \rightarrow \pi_t = \frac{1+\kappa/a}{\phi+\kappa/a}\pi_{t-1}$$

Rational expectations/New-Keynesian

$$i_t = -(\kappa/a)\pi_t + (1+\kappa/a)\,\pi_t^e$$

Rational expectations: $\pi_t^e = E_t\pi_{t+1} \neq \pi_{t-1}$

$$i_t = -(\kappa/a)\pi_t + (1+\kappa/a)\,E_t\pi_{t+1}$$

$$E_t\pi_{t+1} = \frac{1}{1+\kappa/a} i_t + \frac{\kappa/a}{1+\kappa/a}\pi_t$$

- *Stable on its own!*
- But only $E_t\pi_{t+1}$. *indeterminacy* ($\neq$ instability.)
- (Woodford) Add $i_t = \phi\pi_t$ to *this* model,

$$\phi\pi_t = -(\kappa/a)\pi_t + (1+\kappa/a)\,E_t\pi_{t+1}$$

$$E_t\pi_{t+1} = \frac{\phi+\kappa/a}{1+\kappa/a}\pi_t.$$

- $\phi > 1 \leftrightarrow$ inflation is unstable again... *unless* $\pi_t = 0$. "Determinacy."
- Fed $\phi > 1$ introduces *instability* into an otherwise *stable* world
- ? But $\phi = 0$ so can't work at ZLB.

NK price stickiness + FTPL

Rational expectations

$$i_t = -(\kappa/a)\pi_t + (1 + \kappa/a)\, E_t \pi_{t+1}$$

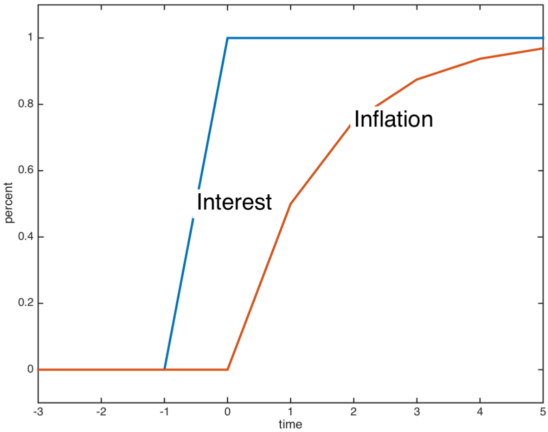
FTPL: with no fiscal news, $\pi_{t+1} = E_t \pi_{t+1}$. So,

$$\pi_{t+1} = i_t + \frac{(\kappa/a)}{1+\kappa/a}\pi_t$$

$$\pi_{t+1} = \frac{1}{1+\kappa/a} i_t + \frac{1}{(1+\kappa/a)^2} i_{t-1} + \frac{1}{(1+\kappa/a)^3} i_{t-2} + ...$$

$$\pi_t = \sum_{j=1}^{\infty} \frac{1}{(1+\kappa/a)^j} i_{t-j}$$

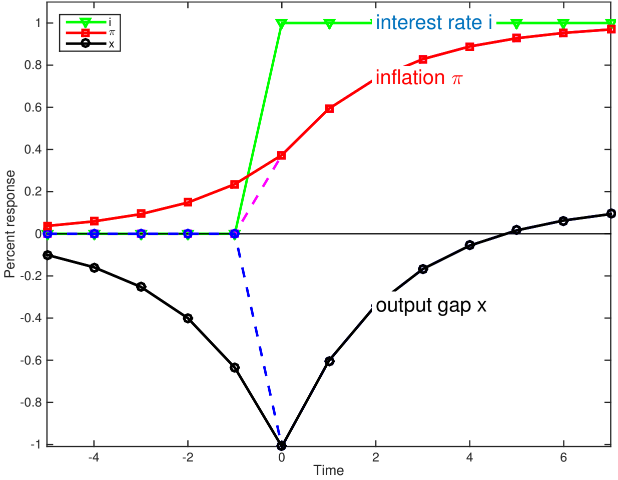
Effect of rate rise? NK + Fiscal



$$\pi_t = \sum_{j=1}^{\infty} \frac{1}{(1+\kappa/a)^j} i_{t-j}$$

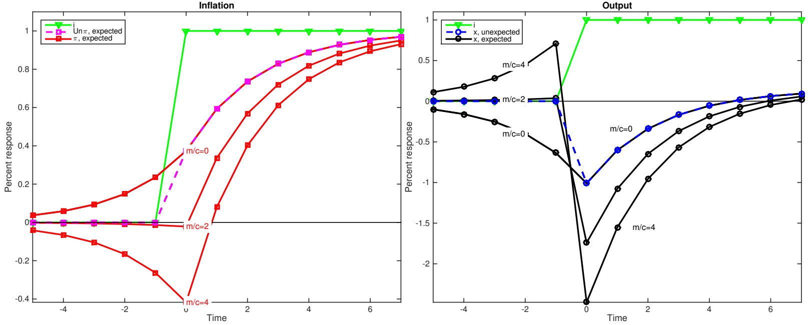
- Even with price stickiness, inflation *rises* uniformly.

Effects of rate rise – 3 equation model



$$x_t = E_t x_{t+1} - \sigma(i_t - E_t \pi_{t+1})$$
$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t.$$

Impulse-response functions with money



- Expected rate rise lowers inflation! But it needs *huge* m/c.
- Paper: many more lightbulbs that don't work

Long term debt works

- Simple fiscal theory and long-term debt *does* deliver negative short run sign, positive long-run sign, and QE works!

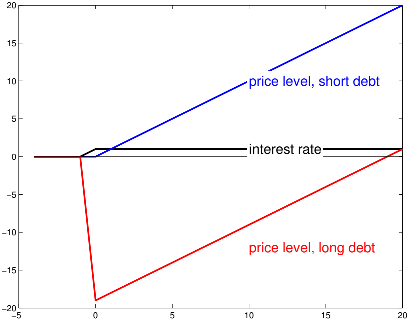
$$\text{Was} \quad \frac{B_{t-1}}{P_t} = E_t \sum_{j=0}^{\infty} \beta^j s_{t+j}$$

$$\text{Now} \quad \frac{\sum_{j=0}^{\infty} Q_t^{(t+j)} B_{t-1}^{(t+j)}}{P_t} = E_t \sum_{j=0}^{\infty} \beta^j s_{t+j}$$

- $Q_t^{(t+j)}$ = nominal price of zero coupon nominal bond due at $t+j$.
- $B_{t-1}^{(t+j)}$ = number of zero coupon bonds outstanding
- Frictionless, $i_t = r + E_t \pi_{t+1}$, $\frac{1}{1+i_t} = \beta E_t \frac{P_t}{P_{t+1}}$
- $\{i_{t+j}\}$ rises $\rightarrow \pi_{t+j}$ rises
- $\{i_{t+j}\}$ rises $\rightarrow Q_t^{(t+j)}$ falls $\rightarrow$ (fixed B_{t-1}, s_{t+j},) P_t falls.

Long term debt example

$$\frac{\sum_{j=0}^{\infty} Q_t^{(t+j)} B_{t-1}^{(t+j)}}{P_t} = E_t \sum_{j=0}^{\infty} \beta^j s_{t+j}$$



- Perpetuity, $B_{t-1}^{(t+j)} = B_{t-1}$
- Permanent i rise,

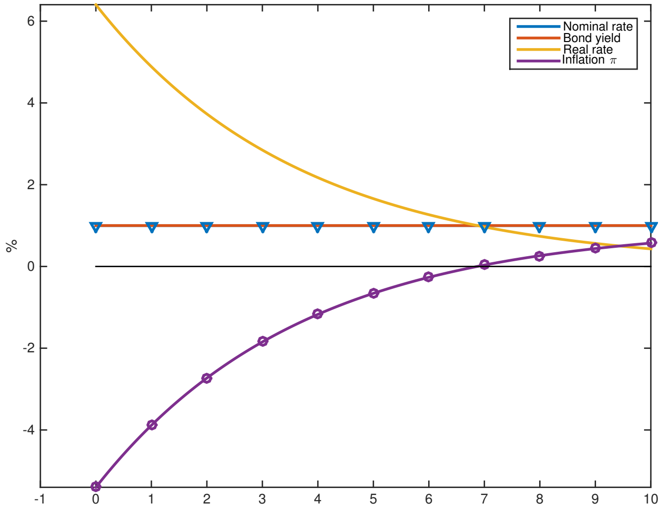
$$Q_t^{(t+j)} = \frac{1}{(1+i)^j}$$

$$\sum_{j=0}^{\infty} Q_t^{(t+j)} = \frac{1}{1-\frac{1}{1+i}} = \frac{1+i}{i}$$

$$\frac{1+i}{i} \frac{B_{t-1}}{P_t} = E_t \sum_{j=0}^{\infty} \beta^j s_{t+j}$$

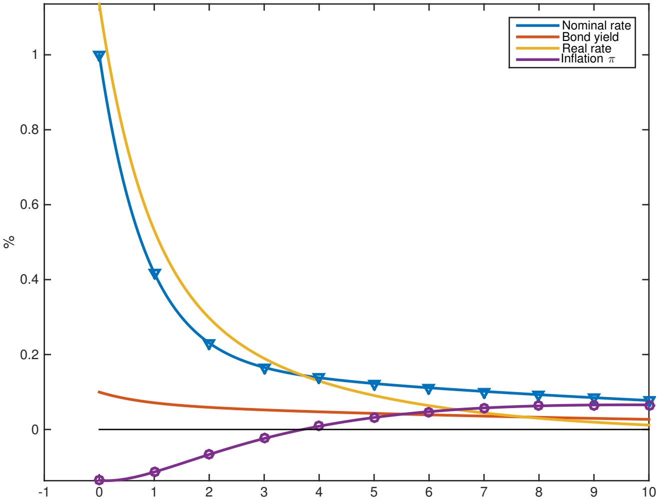
- i from 5% to 6% means 20% price decline, then 1% more inflation.

Long term debt; three-equation model



Response to permanent interest rate shock, NK with long-term debt

A “realistic” model with long-term debt



Response to interest rate shock in Sims's (2011) model; price stickiness, habits, Fed reaction to output and inflation, fiscal reaction to recessions.

Directions

$$\frac{\sum_{j=0}^{\infty} Q_t^{(t+j)} B_{t-1}^{(t+j)}}{P_t} = E_t \sum_{j=0}^{\infty} \beta^j s_{t+j}$$

- Long term debt mechanism
  - "Fed" raises $\{i_{t+j}\}$. $\{E_t \pi_{t+j}\}$ rises. Nominal bond prices fall.
  - Gov't can pay long bonds with cheap currency!
  - Treasury stubbornly insists on raising the same surpluses. $\rightarrow$ bonds more valuable
  - Lower price level now, higher price later.
- Treasury.... really? If the Treasury responds with lower taxes/ more spending, disinflation goes away.
- Future: The response of inflation (etc) to monetary policy is all in the hands of how the Treasury is expected to respond to inflation - induced bond devaluation.
- (FTPL) Hooray. But a profound change in "monetary policy."

The conventional path

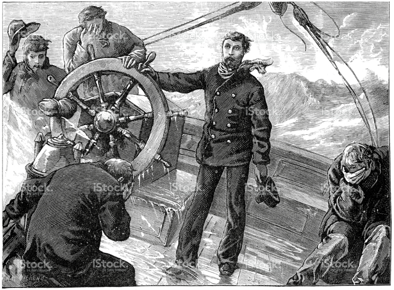
- This is as radical as simple.
- Conventional: DSGE soup. borrowing or collateral constraints, hand-to-mouth consumers, irrational expectations or other irrational behavior, lending channel, labor/leisure, production, capital, variable capital utilization, adjustment costs, informational, market, payments, monetary frictions; selection by off-equilibrium threats, stochastic bound exit
- Necessary as well as sufficient. If so Monetary policy must have complex / noneconomic ingredients. There is no simple, modern, economic baseline.
- Occam.

Other implications

- Inflation can be stable with an interest rate peg. $\rightarrow$
- A huge balance sheet paying market interest is great.
- Friedman optimal quantity of (interest-paying) money, no π fear.
- Low (0) i, $=$ low tax distortions, cash tax, good financial stability.
- Fine tuning not needed / recommended.

The optimal quantity of money.

What should the Fed do?



CAPTAIN LYON AND HIS CREW OFFERING PRAYERS FOR THEIR PRESERVATION.

Review, Relax, then Worry.

- Michelson-Morley: ZLB, QE, nothing happened.
- Occam: *i* peg can be stable, determinate. (Sorry, Friedman 68.)
- Classic, adaptive-E "spiral" and MV=PY wrong.
- Rational-E NK model is ok.
- FTPL solves indeterminacy, other weirdness of NK models
- Stable $\rightarrow$ raise i to raise π? Short run negative?
- How to study "monetary policy"? Key is long-term debt and fiscal/monetary interaction!

FTPL Warning: discount rates!

$$\frac{B_t}{P_t} = E_t \int_{j=0}^{\infty} e^{-rj} S_{t+j} dj = E_t \int_{j=0}^{\infty} e^{(g-r)j} dj S_t = \frac{S_t}{r-g}$$

$$\frac{B_t}{P_t S_t} = \frac{1}{r-g}$$

$$\text{surplus/debt} = r - g$$

- Why is π so low, with B so high and bad S? r is low!
- What if r rises? Small Δr has a big effect! (Flow: $r\times$ 100% Debt/GDP is a lot.)
- r and g rise together is not dangerous. But $r = \delta + \gamma g$ says r likely to dominate, Fiscal Phillips curve.
- r alone is dangerous. Sovereign debt/rate spiral.
- "i peg *can* be stable" because it depends on fiscal policy!
- Historic pegs fell apart from fiscal problems. Ours can too.

Papers

1. "Do Higher Interest Rates Raise or Lower Inflation?"
2. "Monetary Policy with Interest on Reserves"
3. "The New-Keynesian Liquidity Trap"
4. "Stepping on a Rake: Replication and Diagnosis"
5. This one, soon.