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

John H. Cochrane
Hoover Institution, Stanford University

August 2016
Recent history:

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

- Effective Federal Funds Rate
- Civilian Unemployment Rate

- Same dynamics. Larger shock.
Recent Experience–US

- Growth is “too low” but low $\sigma$ at ZLB
Recent Experience – Japan

![Graph showing recent experience in Japan with lines for Discount Rate, Core CPI, and 10 year rate from 1992 to 2016.]
Recent Experience – Europe

FRED - Consumer Price Index of All Items in Germany ©
Immediate Rates: Less than 24 Hours: Call Money/Interbank Rate for Germany ©

(Percent Change from Year Ago, Percent)
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 $\delta_{t+1}$.

  Simple: $i_t = r + E_t \pi_{t+1}$
  General: $E_t \pi_{t+1} = \ldots i_t \ldots + (\lambda \leq 1) \pi_t$
  Both: $\pi_{t+1} = E_t \pi_{t+1} + \delta_{t+1} \leftarrow$ anything iid

- Taylor rule $\phi > 1$ brings *instability* hence determinacy.
- $\phi = 0$ ZLB predicts more $\sigma$ (as $\phi < 1$ 1970s). We see less.
- Epicycles here too. Or...
Multiple stable equilibria at zero bound! Taylor principle can’t help.
FTPL in NK models – frictionless

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

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

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

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

- (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. How does it work?
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 $\pi$ 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 $\pi$. 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

Eliminate \( y \): \( r_t = -(\kappa/a)(\pi_t - \pi_t^e) \)

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

\[ i_t = -\left(\frac{\kappa}{a}\right)\pi_t + \left(1 + \frac{\kappa}{a}\right)\pi_t^e \]

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

\[ i_t = -\left(\frac{\kappa}{a}\right)\pi_t + \left(1 + \frac{\kappa}{a}\right)E_t\pi_{t+1} \]

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

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

\[ \phi\pi_t = -\left(\frac{\kappa}{a}\right)\pi_t + \left(1 + \frac{\kappa}{a}\right)E_t\pi_{t+1} \]

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

- \( \phi > 1 \leftrightarrow \) 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

\[ i_t = -\left(\frac{\kappa}{a}\right)\pi_t + (1 + \frac{\kappa}{a}) E_t \pi_{t+1} \]

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

\[ \pi_{t+1} = i_t + \frac{\left(\frac{\kappa}{a}\right)}{1 + \frac{\kappa}{a}} \pi_t \]

\[ \pi_{t+1} = \frac{1}{1 + \frac{\kappa}{a}} i_t + \frac{1}{(1 + \frac{\kappa}{a})^2} i_{t-1} + \frac{1}{(1 + \frac{\kappa}{a})^3} i_{t-2} + \ldots \]

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

\[ x_t = E_t x_{t+1} - \sigma (i_t - E_t \pi_{t+1}) \]

\[ \pi_t = \beta E_t \pi_{t+1} + \kappa x_t. \]
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!

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

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

- \(Q_t^{(t+j)}\) = 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

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

- Perpetuity, \( B_{t-1}^{(t+j)} = B_{t-1} \)
- Permanent increase,

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

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

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

- \( i \) 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

\[ \sum_{j=0}^{\infty} \frac{Q_t^{(t+j)} B_t^{(t+j)}}{P_t} = E_t \sum_{j=0}^{\infty} \beta^j s_{t+j} \]

- 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.
- A huge balance sheet paying market interest is great.
- Friedman optimal quantity of (interest-paying) money, no $\pi$ fear.
- Low (0) interest rate, low tax distortions, cash tax, good financial stability.
- Fine tuning not needed / recommended.

The optimal quantity of money.
What should the Fed do?
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 $\pi$? Short run negative?
- How to study “monetary policy”? Key is long-term debt and fiscal/monetary interaction!
FTPL Warning: discount rates!

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

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

surplus/debt = \( r - g \)

▶ Why is \( \pi \) so low, with \( B \) so high and bad \( S \)? \( r \) is low!
▶ What if \( r \) rises? Small \( \Delta r \) 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”
4. “Stepping on a Rake: Replication and Diagnosis”
5. This one, soon.