A New Approach to Monetary Policy

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Papers

1. “Do Higher Interest Rates Raise or Lower Inflation?”
2. “Monetary Policy with Interest on Reserves”
4. “Understanding fiscal and monetary policy in the great recession: Some unpleasant fiscal arithmetic.”
5. “Determinacy and Identification with Taylor Rules”
6. “Money as Stock”
7. ...
Recent Experience–US
Recent Experience – Japan

[Graph showing Discount Rate, Core CPI, and 10 year rate for Japan from 1992 to 2016]
Recent Experience – Europe

[Graph showing 3-Month London Interbank Offered Rate (LIBOR), based on Euro© and Harmonized Index of Consumer Prices: All Items for Euro area (19 countries)© over the years 2008 to 2016.]

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Implications and objective

**Lesson:**
- \( i \) hits zero. Massive \((\$50B \rightarrow \$3,000B)\) QE. Inflation does little.
- An interest rate peg can be stable.
- \( \rightarrow \) Raising rates eventually raises inflation. Short run?

**Implication:** Standard monetary theories fail.
- Old-Keynesian / Monetarist: Peg is unstable. "Deflation spiral?"
- Monetarist: \( MV=PY \). Hyperinflation?
- New-Keynesian: Peg is stable, but indeterminate. Standard solutions predict huge deflation / depression and "Topsy-turvy" policy.
  1. Far-off expectations have larger effects. 1 bp in 2050.
  2. Less stickiness makes matters worse. Infinite effects for \( \epsilon \) stickiness.
  3. Structural reform is bad. Hurricanes are good. Wasted G is good.

**Objective:**
- Sensible simple, economic theory consistent with recent evidence.
- What will happen if central banks raise rates?

**Outline:**
- My answer first, NK and Old K review later.
- Result: Small change to NK structure, but large change to results.
To monetary policy; Fisher / IS

Rebuild:

▶ Start very simple. Constant (or exogenous) r, c. No monetary or pricing frictions.

▶ → The (forward-looking) Fisher (IS) equation.

\[ i_t = r + E_t \pi_{t+1} \]

▶ Stable. Peg OK. \( \pi \) follows \( i \). But

1. Dynamics? Story? Lower \( \pi \) in the short run?
2. How does Fed / ECB set \( i \) with huge excess reserves?
3. Indeterminacy? (NB Indeterminacy \( \neq \) instability).

\[ \pi_{t+1} - E_t \pi_{t+1} = \delta_{t+1}; \ E_t \delta_{t+1} = 0 \]

Add ingredients...

▶ NK adds Taylor-type rule \( i_t = \phi \pi_t; \ \phi > 1 \). But

1. Doesn't work at \( i = 0 \).
2. Lots of theoretical problems.
3. Leads to deflation/depression and topsy-turvy predictions.

▶ Instead...
FTPL lite

So far,

\[ i_t = r + E_t \pi_{t+1}; \pi_{t+1} - E_t \pi_{t+1} = \delta_{t+1} =? \]

Next step:

▶ Add 1 period debt, valuation equation.

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

▶ (Notes: Part of any model. No need for exogenous surpluses. Low \( R \) is a big part of the story for low \( P \).)

▶ Take \( E_t - E_{t-1} \)

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

▶ Unexpected inflation is determined entirely by changing expectations of the PV of fiscal surpluses.

▶ → Solves determinacy. Each equilibrium \( \delta_{t+1} \) is indexed by fiscal policy. If there is no fiscal policy change, \( \delta_{t+1} = 0 \).
Interest rate targets

To Monetary Policy?

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

Take \( E_{t-1} \),

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

▶ “Monetary policy” – nominal bond sales \( B_{t-1} \), with no s change – can completely determine expected inflation. (Share split).

\[
Q_{t-1} = \frac{1}{1 + i_{t-1}} = \beta E_{t-1} \left( \frac{P_{t-1}}{P_t} \right).
\] (3)

\[
\frac{B_{t-1}}{P_{t-1}} \frac{1}{1 + i_{t-1}} = E_{t-1} \sum_{j=0}^{\infty} \beta^{j+1} s_{t+j}.
\] (4)

▶ “Monetary policy” (B, no s) can set a nominal interest rate target.
▶ Story: Fed, Treasury basically fix \( i_t \), not \( B_t \) in bond auction.
▶ MP can control \( i \) with IOR, and fixed, large, balance sheet.
▶ Interest rate targets completely control expected inflation.
Progress so far

Bottom line: Fisher + fiscal foundations →

\[ i_t = \text{set by Fed} \approx r + E_t \pi_{t+1} \]

\[ \pi_{t+1} - E_t \pi_{t+1} = - (E_{t+1} - E_t) \sum_{j=0}^{\infty} \beta^j s_{t+j} / b_t \]

\((b_t = B_t / P_t)\)

- Rehabilitates even fixed nominal interest rate peg / targets!
- No indeterminacy. (Sargent-Wallace, Woodford.)
- No instability. (Friedman 1968, old-Keynesian policy establishment.)
- No money needed at all, not even to implement \(i\) control.
- Compelling story for recent experience: \(i = 0, \pi\) declines as \(r\) rises.

But, dynamics? ...
Interest rate targets – impulse-response

Model \( i_t = r + E_t \pi_{t+1}; \pi_{t+1} - E_t \pi_{t+1} = -(E_{t+1} - E_t) \sum \beta^i s_{t+j} / b_t \).

Left: Shock announced at \( t = 0 \). Right: Shock announced at \( t = -3 \).

- Standard NK model produces decline with a negative fiscal shock.
- Agenda: Standard prediction of (temporarily) lower \( \pi \) without fiscal shock? And realistic dynamics?
- Pricing frictions? Monetary frictions? Other frictions?
- Important: minimal model, not DSGE soup.
i targets, pricing frictions – simplest example

Model

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

\[ \pi_t = \kappa c_t \]

To solve,

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

So solution:

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

\[ \pi_{t+1} - E_t \pi_{t+1} = - (E_{t+1} - E_t) \sum_{j=0}^{\infty} \beta^j s_{t+j} / b_t \]

- IR \( \{E_t \pi_{t+j}\} \) does not depend on expected vs. unexpected \( i \)
- \( \pi \) response is stable, hence follows \( i \).
- Note: \( \{i_t\} \) is not (necessarily) a peg. Conditional on equilibrium \( \{i_t\} \), even if produced by Taylor rule. “If equilibrium \( \{i_t\} \) is a step, here is equilibrium \( \{\pi_t\}, \{x_t\} \).”
Impulse-response, simple price stickiness model

$c_t = E_t c_{t+1} - (i_t - E_t \pi_{t+1})$

$\pi_t = c_t$

$\pi_{t+1} - E_t \pi_{t+1} = -(E_{t+1} - E_t) \sum \beta^j s_{t+j}/b_t$

- "Neo-Fisherian:" No $\pi$ decline. Pricing frictions did not fix.
Impulse-response, simple price stickiness model

$c_t = E_t c_{t+1} - (i_t - E_t \pi_{t+1})$

$\pi_t = c_t$

$\pi_{t+1} - E_t \pi_{t+1} = -(E_{t+1} - E_t) \sum \beta_j s_{t+j}/b_t$

Mix $i$ rise with fiscal shock. Conventional NK. Data / VAR? Future?
Impulse-response, simple price stickiness model

\[ c_t = E_t c_{t+1} - (i_t - E_t \pi_{t+1}) \]
\[ \pi_t = c_t \]
\[ \pi_{t+1} - E_t \pi_{t+1} = -(E_{t+1} - E_t) \sum \beta_j s_{t+j} / b_t \]

- Pre-announced interest rate rise. Why pair these shocks?
- \[ \rightarrow \] look for “monetary policy” alone (no s).
A Real New-Keynesian model

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

Central banks are half right! Attempts to produce a negative response...
Money

- Add monetary frictions as well as pricing frictions
- Hope: old policy raised \( i \) by lowering \( M \). That lowers \( \pi \) temporarily.
- Would explain past, but not IOR. (Monetarist past, Fisherian future)
- Model:

\[
\max E \sum_{t=0}^{\infty} \beta^t u(c_t, m_t), \ u_{cm} \neq 0 \ldots
\]

\[
c_t = E_t c_{t+1} + (\sigma - \xi) \left( \frac{m}{c} \right) E_t \left[ (i_{t+1} - i_{m_{t+1}}) - (i_t - i_{m_t}) \right] - \sigma \left( i_t - E_t \pi_{t+1} \right).
\]

\( \xi \) = interest elasticity of money demand.

- Expected rise in interest costs lowers consumption today relative to tomorrow, like a higher real rate. → Inflation too!
- Higher level of interest cost has no effect on AD. → Standard unexpected permanent \( i \) shock has no effect!
Impulse-response functions with money

Expected rate rise lowers inflation! But it needs huge \( m/c \).
A simple, modern, economic model, consistent with experience, that produces a temporary decline in inflation? (Without joint fiscal policy.)

Paper: Many failed attempts.

- Add more frictions?
- Borrowing or collateral constraints, hand-to-mouth consumers, irrational expectations or other irrational behavior, habits, labor/leisure, production, capital, variable capital utilization, adjustment costs, lending channel, informational, market, payments, monetary, financial frictions?
- Lose simple, modern, or economic. Admits standard monetary policy sign must have complex / noneconomic ingredients; There is no simple, modern, economic baseline. (Goal: Simple model for sign. DSGE soup for exact match.)
- VAR evidence is not strong, “price puzzle.”
- Maybe raising interest rates without s really does just raise inflation?
New-Keynesian analysis of the zero bound (Werning 2012)

\[
\frac{dx_t}{dt} = \sigma (i_t - r_t - \pi_t)
\]
\[
\frac{d\pi_t}{dt} = \rho \pi_t - \kappa x_t
\]

\[\leftrightarrow\]

\[x_t = E_t x_{t+1} - \sigma [i_t - r_t - E_t \pi_{t+1}]\]
\[
\pi_t = e^{-\rho} E_t \pi_{t+1} + \kappa x_t
\]

- \(r_t = \) natural rate = −5\% to \(t = T = 5\), then \(r_t = +5\%\).
- \(i_t = 0\) to \(t = T = 5\), then \(i_t = r_t = 5\%\) (Or Taylor rule)
- \(\pi_T = 0\).
The standard NK analysis of the zero bound

- High real rate, c must grow. C jumps down. Big depression, deflation (counterfactual).
- Less friction $\rightarrow$ worse! Limit $\neq$ limit point ($\pi = 5\%$, $x = 0$)!
- Backwards unstable $\rightarrow$ forward guidance, magical multipliers.
New-Keynesian model: a closer look

\[
\begin{align*}
\frac{dx_t}{dt} &= \sigma (i_t - r_t - \pi_t) \\
\frac{d\pi_t}{dt} &= \rho \pi_t - \kappa x_t \\
\frac{d}{dt} \begin{bmatrix} x_t \\ \pi_t \end{bmatrix} &= \begin{bmatrix} 0 & -\sigma \\ -\kappa & \rho \end{bmatrix} \begin{bmatrix} x_t \\ \pi_t \end{bmatrix} + \sigma \begin{bmatrix} i_t - r_t \\ 0 \end{bmatrix}
\end{align*}
\]

- Two eigenvalues, \( \lambda^m < 0, \lambda^p > 0 \); two free constants.
- No forward explosions. Set \( e^{\lambda^p t} \) term to zero.
- One-dimensional family of solutions. Index by \( \pi_T \).
- All equilibria have the same interest rate path \( \{i_t\} \).
"Indeterminacy" = multiple stable solutions
Stable forward = unstable backward. Sensitive to small $\Delta E_t \pi_T$.
$(E_0 - E_{-1}) \pi_0 = (E_0 - E_{-1}) \sum \beta^t s_t$ is large for conventional solution.
The no-inflation-jump equilibrium

- \( \pi_0 = 0 \) → no big \( \pi_t < 0 \), small \( x_t \) effects. \( \pi_t > 0 \) solves \( r < 0, i = 0 \).
- Nice frictionless limit!
- \( (E_0 - E_{-1}) \pi_0 = -(E_0 - E_{-1}) \sum \beta^t s_t / b = 0 \). “Monetary policy.”
- “Backward stable.” Faraway promises have little current effects.
NK model summary

- Conventional NK model & equilibrium choice predicts huge deflation, depression.

- Also paradoxical policies and magical multipliers:
  1. Promises in the far future have huge effects. Weird frictionless limit.
  2. Less stickiness makes matters worse.
  3. Enormous multipliers. (Fiscal → future π → more c now. Not \( C = \bar{C} + \alpha Y \).)
  4. All from forward-stable = backward-explosive. (Thus, robust.)

- But there are many equilibria. “Backward stable” equilibria with
  1. limited \( \pi_0, x_0, (E_0 - E_{-1}) \sum \beta^t s_t = 0 \) jumps,
  2. expectations of events \( t \to \infty \) have bounded effects at 0,

solve all these problems. But then:

- Zero bound is not a big deal. Look elsewhere for slow growth.

- Gets rid of the policy magic. Alas, if you like magic.

- Bottom line: conventional NK/DSGE structure is fine. Pick different equilibria. Here: No big jumps at \( t = 0 \). Before: No big fiscal policy coincident with monetary policy.

- But this gives quite different answers!
Old-Keynesian (& Monetarist) Models

NK Model:

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

OK Model:

\[ x_t = -\sigma (i_t - \pi_t) + u_{xt} \]
\[ \pi_t = \pi_{t-1} + \kappa x_t + u_{\pi t}. \]

OK: myopic or backward-looking behavior:

▶ IS: No \( E_t x_{t+1}; i_t - \pi_t \) not \( i_t - E_t \pi_{t+1} \).
▶ PC: \( \pi_{t-1} \) not \( E_t \pi_{t+1} \)

Solution:

\[ \pi_t = \frac{1}{1 - \sigma \kappa} \pi_{t-1} - \frac{\sigma \kappa}{1 - \sigma \kappa} i_t + \frac{1}{1 - \sigma \kappa} (\kappa u^x_t + u^\pi_t). \]

▶ Unstable, determinate
Old-Keynesian (& Monetarist) Models

Response of inflation to an interest rate rise, old-Keynesian model.

- Peg is unstable. Predicts deflation spiral at $i = 0$.
- “Right” sign of $i$ policy in short and long run.
- Lost “modern” and “economic.”
Old-Keynesian (Monetarist) Models with Taylor rule

\[ x_t = -\sigma(i_t - \pi_t) + u^x_t \]
\[ \pi_t = \pi_{t-1} + \kappa x_t + u^\pi_t \]
\[ i_t = \phi_{\pi}\pi_t + u^i_t. \]

\[ \pi_t = \frac{1}{1 + \kappa\sigma(\phi_{\pi} - 1)\pi_{t-1} + \frac{1}{1 + \kappa\sigma(\phi_{\pi} - 1)}(\kappa u^x_t + u^\pi_t - \sigma\kappa u^i_t)} \]

▶ Taylor rule \( \phi_{\pi} > 1 \) induces stability in an otherwise unstable but already determinate model.

▶ NK: Taylor rule \( \phi_{\pi} > 1 \) induces instability, hence local determinacy, in an otherwise stable but indeterminate model.
Response to a permanent tightening $u_t^i$ in the Taylor rule $i_t = \phi \pi_t + u_t^i$.

- Fisher in long run. Opposite sign in the short run.
- Clearest conventional view.
- Answer? No. Failed in data. And if so, monetary policy has no economic roots.
Caution

\[ i_t = r + E_t \pi_{t+1} \]

\[ \pi_{t+1} - E_t \pi_{t+1} = -(E_t - E_{t-1}) \sum_{j=0}^{\infty} \frac{1}{R^j} s_{t+j}/b_t \]

▶ Does raising interest rates really raise inflation? Before you jump...

1. Maybe we will find enough frictions to produce a temporary negative?
2. Model has short term debt. Long debt drags out the dynamics.
   \( (\Delta t \approx \text{duration} \approx 2 \text{ years US.}) \)
3. Beware the fiscal foundations! Will they really believe \( s \) has not changed? Like disinflations (Sargent), which always combine fiscal and monetary.

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

▶ Fiscal foundations warning: Debt is an earthquake fault. High value (low \( P \)) comes from low \( R \) not from big \( s \)! Higher real rates (permanent, so not central banks) could be quite inflationary.

▶ Be careful what you wish for!
Extra Slides
Low rate promise – standard equilibrium

- Interest rate stays at zero for time $\tau$ after the trap ends

- Far-away promises have huge effects. Bigger for less price stickiness.
Low rate promise – backwards-stable equilibrium

- Faraway promises have little current effects → frictionless.
Taylor rule and the standard solution

- Not: “if $\pi_T > 0$, Fed tightens too much, lowers inflation too fast”
- Yes: “if $\pi_T > 0$ people expect the Fed to explode the economy.” Or those equilibria are not ruled out.
A Taylor rule could select the glidepath too

- Equilibrium selection policy to choose $\pi_t^*$ (glidepath) is just as possible.