More Perils of Taylor Rules
Work in Progress

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Motivation

- Sargent and Wallace (*JPE*, 1975): indeterminacy under interest rate pegs

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- Conventional wisdom: solve with active Taylor rules
- The ability of hitting the interest rate target is taken for granted

▸ More Discussion of Interest Rate Rules

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- An interest-rate peg sets the relative price of bonds and money
- In (non-strategic) monetary models, Fisher equation ensures low interest rates $\Longrightarrow$ low inflation

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- An interest-rate peg sets the relative price of bonds and money
- In (non-strategic) monetary models, Fisher equation ensures low interest rates $\Longrightarrow$ low inflation
- When open-market operations are subject to bounds, the peg is subject to runs
- Taking such bounds into account reveals a strategic complementarity in the game induced by an interest rate rule

An Extreme Example

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- Fraction of T-Bills held by the Reichsbank in Nov 1923: 99.1%

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- Fed just announced that we will hold rates at 0-0.25% until mid-2013
- What if inflation increases? How long is this feasible?
- Can there be a run? What does it look like?

Outline of Talk

- Set up simple Cash-In-Advance economy
- Analyze environment using standard general equilibrium tools: low inflation
- Revisit in a game setting, including bounds (and measurability restrictions): multiple equilibria
- Discuss some extensions that get closer to reality

The Cast of Actors

- A continuum of households
- A government/central bank described as an automaton (rules)

Timing

1. Households enter period t holding w_{t-1} units of nominal assets (bonds and money).
2. Government pays off bonds with cash, and levies lump sum taxes T_t (in terms of cash).
3. Central bank is a "bond vending machine": sets (one-period) bond price Q_t. Get one bond out per Q_t dollars put in.
4. Households now have $m_t \equiv w_{t-1} - T_t - Q_t b_t$ dollars on hand.
5. Households split into workers and shoppers.
6. Worker produces y_t.
7. Shopper purchases c_t.
8. Shoppers face cash-in-advance constraint, $c_t P_t \leq m_t$.
9. Workers then produce g_t for government (which needs $\overline{G}$), paid in cash or bonds.

Preferences

$$\sum_{t=0}^{\infty} u(c_t) - (y_t + g_t)$$

Assumptions: RRA > 1 around intended equilibrium

General Equilibrium: Household Problem

- Taking $\{Q_t, P_t, T_t\}_{t=0}^{\infty}$, w_{-1} as given, households solve

$$\max_{c_t, m_t, b_t, y_t, g_t} \sum_{t=0}^{\infty} \beta^t [u(c_t) - (y_t + g_t)]$$

s.t.

$$Q_t b_t + m_t + T_t \leq w_{t-1}$$

$$w_t = m_t + P_t(y_t + g_t - c_t) + b_t$$

$$P_t c_t \leq m_t$$

and no-Ponzi condition.

General Equilibrium: Necessary Conditions from Household Optimization

$$u'(c_t) = 1/Q_t$$

$$\frac{P_{t+1}}{P_t} = \frac{\beta}{Q_{t+1}}$$

(Assume $Q_t < 1$)

$$P_t c_t = m_t$$

General Equilibrium: Government Policy

- A government policy is a sequence $\{Q_t, T_t\}_{t=0}^{\infty}$, as a function of the price sequence $\{P_t\}_{t=0}^{\infty}$ that satisfies
- Nonnegative bonds in the intended equilibrium:

$$T_t \leq B_{t-1} + P_{t-1}G_{t-1} + M_{t-1}(1 - \beta/Q_t)$$

- "Ricardian" policy (sufficient condition): there exist $\bar{b}$ and $\alpha \in (0, 1)$ such that and

$$|B_{t-1}/P_{t-1}| \geq \bar{b} \Longrightarrow T_t \geq \alpha B_{t-1}$$

- Assumptions rule out commodity money (FTPL).

Equilibrium Price Sequences

- Pretty remarkable. Still lots of equilibria (since P_0 not pinned down), but all of them have the same inflation rate for every date:

$$\frac{P_{t+1}}{P_t} = \frac{\beta}{Q_{t+1}}$$

- Same consumption and welfare too
- Thus, if the government wants price stability ($P_{t+1} = P_t$ for all t), all it has to is be willing to borrow or lend at $(1 - \frac{1}{\beta})$

Sunspots

- Yes, there can be sunspots if $Q_t \equiv \beta$
- Necessary condition becomes

$$E[\frac{P_t}{P_{t+1}}|\mathcal{I}_t] = 1$$

- Expected (inverse) inflation, welfare fixed

Back to the Reichsbank

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- Need a better model of trade (especially between central bank and households)

Environment as a Game

- Households enter period with w_{t-1} money and/or bonds
- Gov't pays off bonds in cash and imposes lump sum taxes (in cash)
- Households unable to pay taxes are "flogged"
- Households access bond vending machine subject to bounds
- Bound has to depend on information up to this point (P_t is out)
- Interest rate $1/Q_t$ also must depend on info up to here
- Exact bound not so important. Assume $B_t \geq 0$.

Game (continued)

- Households split into a worker and a shopper, travel to separate islands
- Workers and shoppers are anonymous on the island
- Bonds cannot be transported to the island
- In each island, a Shubik market is present.

The Shubik Stage of the Game

- Shoppers bid m_t (up to their holdings); aggregate bid: M_t
- Workers bid $y_t \geq \epsilon$; aggregate: Y_t
- Price is determined as $P_t = M_t/Y_t$
- Shopper receives $m_t Y_t/M_t = m_t/P_t$ unit of goods
- Worker receives $y_t M_t/Y_t = y_t P_t$ units of money

Back to the Center Island

- Government auctions $P_t \bar{G}$ units of money on another Shubik market
- Households bid to produce for the government

The Intended Equilibrium

- Households act as price takers, solve the same problem as before
- Assuming that $B_t > 0$ in the desired equilibrium, it remains an equilibrium

The Reichsbank Equilibrium

- Suppose you believe that all other households will not hold bonds in period t
- Fed monetizes government debt
- High money growth, high inflation, nobody lends at low nominal rate
- Government policy becomes a (high) money growth rule, get GE equilibrium of a high money growth rule

The Reichsbank Equilibrium in Math

- HH Euler equation now says

$$\frac{P_{t+1}}{P_t} \geq \frac{\beta}{Q_{t+1}}$$

- Equality is necessary only if $b_t > 0$
- New equilibrium:
  - $B_t = 0$,
  - $M_t = M_{t-1} + B_{t-1} + P_{t-1} G_{t-1} - T_t$
  - $M_t / P_t = C_t$
  - $$u'(C_t) = \frac{P_t}{\beta P_{t-1}}$$

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- So far, two equilibria: intended equilibrium and hyperinflation
- Many frictions can lead to runs with lower inflation:
  - Long-term bonds
  - Limited participation
  - Rational inattention
  - Cost of accessing the market (going to the bond vending machine)

Illustration: Limited Participation

- Same environment as before, except:
- Households divided into T groups
- Each group can only produce every T periods

New household necessary conditions

- $u'(c_t^j) = \beta \lambda_t^j$
- $1 = \lambda_{j+kT}^j P_{j+kT}$
- $Q_t \lambda_t^j \geq \beta \lambda_{t+1}^j, \quad = \quad \text{if } B_t^j > 0$

The Intended Equilibrium

- Borrowing constraint not binding
- $u'(C_t^j) = 1/\bar{Q}$
- $P_{t+1}/P_t = \beta/\bar{Q}$
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- $P_{t+1}/P_t = \beta/\bar{Q}$
- $P_t C_t^j = M_t^j$
- Requires right initial distribution of wealth, right initial price level
- (Otherwise, more in general) periodic allocation and $P_{t+T}/P_t = \beta/\bar{Q}^T$

Run in period t only (Intuition)

- Only period-t producers borrowing constrained
- Other households cut back on bond purchases, but less
- CB is not completely cornering the market, but selling pressure emerges and money increases
- Inflation more limited

Conclusion

- Interest rate rules are subject to runs just as exchange rate pegs
- Runs more severe if interest target is on a deep market
- How do we really achieve price stability?

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- Runs more severe if interest target is on a deep market
- How do we really achieve price stability?
- Commodity money - fiscal policy? (back to Sargent)

Interpretation of Interest Rate Rules

Two interpretations of interest rate rules:

- "Prescribed guide for monetary policy conduct" (Svensson and Woodford, 2005)
  - Implementation is left to the wizards at the trading desk in NY
- Here: central bank strategy to achieve unique implementation of a desirable equilibrium.
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- Here: central bank strategy to achieve unique implementation of a desirable equilibrium.
  - We are muggles trying to make sense of the wizardry
  - Of course, as muggles we fail

Go Back