Monetary Policy as Bank Liquidity Regulation

Jeremy C. Stein
Harvard University and NBER
October 2009

Some Questions

- How does monetary policy work?
  - Usual story: household preference for medium of exchange.
    - But do bank deposits (which Fed can control) really provide different transactions services than e.g. MMF deposits (which it can't)?
    - Can Fed move long-term real rates enough to matter for investment?
  - Alternative story: bank lending channel. Easing of monetary policy = relaxation of bank funding constraints.
- Why do financial firms use so much short-term debt?
  - Diamond-Dybvig (83): consumption insurance.
  - Gorton-Pennacchi (90): reduce adverse selection.
  - Diamond-Rajan (01): commitment device.
- Central bank role in controlling system-wide leverage?
  - "Macro-prudential" regulation: e.g. time-varying capital requirements.
  - Interest-rate policy that leans against financial-firm leverage.
    - E.g., Adrian-Shin (09).
  - What about the shadow banking system?
    - Gorton (09); Gorton-Metrick (09): repo finance of asset-backed securities as a form of rogue money creation.

The Basic Idea in Four Steps

1. Private money creation in an unregulated financial sector.

- Banks finance themselves with debt claims.
- If debt is completely riskless, it is "money": provides transactions services; households accept a lower yield.
- Only way for banks to make debt riskless is to make it short-term—this gives effective seniority.
- But short-term debt can lead to banking crises with fire sales, which have real effects that banks don't fully internalize.
- Bottom line: some private money creation is good. But unregulated banks do too much.
    - Can think not only of commercial banks in a "free banking" regime, but also of shadow banking system today.

The Basic Idea in Four Steps

2. A Crude Policy: Cap on Money Creation

- Constrain banks from issuing as much riskless short-term debt as they would like.
- This can improve welfare.
- At the margin, loosening the cap raises investment.

3. A Better Policy: Cap and Trade

- Regulator issues permits that allow banks to create money. Permits trade among banks.
- Price of permits reveals useful information to regulator—if price is high, may want to loosen cap.

Note: so far this is an entirely real economy.

The Basic Idea in Four Steps

4. Monetary Policy as a Mechanism for Implementing Cap and Trade Regulation

- Introduce a government sector that issues two types of nominal liabilities: T-bills and reserves.
- Price level pinned down by total nominal government liabilities (fiscal theory of price level).
- Banks are required to hold reserves in order to create money. T-bills don't count towards reserve requirements.
- So *composition* of government liabilities is a real variable: more reserves = more permits for banks to issue short-term debt.
- And price of permits = opportunity cost of holding reserves = nominal interest rate.

Implications

- Suggests how monetary policy can work:
  - Even if central bank does not have monopoly control of transactions media.
    - Can introduce, e.g., MMFs that also create money but that aren't subject to reserve requirements—model still works the same.
  - Without moving real rates by much.
    - Even if real rates on money and bonds are *fixed*, easing of MP allows banks to finance more with cheap money—a pure quantity effect.
- Makes clear that central bank is inevitably in business of discretionary, high-frequency regulation of bank capital structure.
  - So harder to argue that e.g. macro-prudential capital regulation is not an appropriate central bank function.
  - Kashyap-Stein (09): should implement time-varying bank capital regulation via system of cap-and-trade. Seems less odd if think of monetary policy as already doing this with liquidity regulation.
- Underscores general temptation for private money creation to migrate outside of regulated banking sector.

Real Model with Private Money Creation

- **Households:** Initial endowments at time 0. Choose between immediate consumption and investment in riskless "money" or risky "bonds".
- **Banks:** Raise money from households at time 0 by issuing money and bonds. Invest in portfolios of real projects that pay off at time 2.
  - To be riskless, money must be short-term (maturing at time 1) debt.
  - In bad state of the world, banks may have to sell off projects at time 1 to service this short-term debt.
- **Patient Investors (PIs):** Receive endowment of W at time 1: a war chest that can be used for opportunistic investments.
  - Can buy existing assets at fire-sale discount from banks at time 1.
  - Or invest in new, late-arrival projects.
  - But cannot raise further funds at time 1.
  - As fire-sale discount increases, investing in new projects becomes less attractive (as in Shleifer-Vishny 09); this is real cost of fire sales.

Households

- Have linear preferences over early (time 0) and late (time 1 or time 2) consumption. Also derive utility from monetary services: any privately-created claim on late consumption, so long as it is *completely riskless*.
- Utility of a representative household is given by:

$$U = C_0 + \beta E(C_1 + C_2) + \gamma M$$

  - convention: saying a household has M units of money at time 0 means it holds claims that are *guaranteed* to deliver M units of time-2 consumption.

- Gross real return on risky "bonds" that pay off at time 2: $R^B = 1/\beta$.

- Gross real return on riskless "money": $R^M = 1/(\beta+\gamma)$.
  - Like in standard model, monetary services imply a convenience yield.
  - But unlike in standard model, money-bond spread is *invariant to quantity of M*—thanks to linear preferences. For starkness, not realism.

Banks

- Continuum of banks with total mass one. Each bank can invest a variable amount I at time 0.
- **Bank asset-side technology:**
  - In good state (ex ante prob p), output at time 2 = $f(I) > I$.
  - In rare "crisis" state (ex ante prob $(1 - p)$) *expected* output at time 2 of each bank = $\lambda I \leq I$, but there is non-zero chance that output = 0.
  - State is revealed at time 1.
  - In crisis, bank can sell a fraction Δ of assets at time 1 to a PI. Sale yields $\Delta k \lambda I$, where $k \leq 1$ is discount determined endogenously.
- **Comments on assumptions:**
  - Model aggregates banks and their borrowers for simplicity. Equivalent to assuming no contracting frictions; borrowers can pledge all output to banks.
  - So in what sense is this about banks and not operating firms? If individual firms have idiosyncratic prob of total failure (output = 0) by time 1, diversification allows a bank to issue riskless money which firms cannot do.

Bank Financing Options

- Can raise I either with short-term or long-term debt. Only short-term debt can be riskless, given chance of zero output at time 2.
- Banks want to issue short-term debt to create money, which is cheaper source of funding.
- But this leads to fire sales in crisis; costs of fire sales not fully internalized by banks when choosing debt structure.
- Suppose bank raises fraction m of investment with short-term debt.
  - If riskless, promised repayment is $M = mIR^M$.
  - To meet promise in crisis with asset sales, require: $\Delta k\lambda I = mIR^M$.
- So upper bound on private money creation is $m^{\max} = \frac{k\lambda}{R^M}$
- Note asset sales are unavoidable given overhang of long-term debt.

Patient Investors

- PIs have total resources of W at time 1. Can invest an amount $K \leq W$ in new late-arrival projects.
- Total output from investment in new projects is $g(K)$.
- **In good state:** PIs invest all funds in new projects: $K = W$.
- **In crisis state:** PIs absorb fire-sale assets from banks, invest rest in new projects.
  - Value of asset sales = M (banks need to sell enough to pay off short-term debt).
  - So $K = (W - M)$.
- PIs must be indifferent between buying assets from banks and investing in new projects, which implies:

$$\frac{1}{k} = g'(W - M)$$

  - As M rises, so do crisis-state liquidations. This makes PI capital scarcer relative to investment opportunities, and drives down asset resale value k.

Bank's Optimization Problem

- Bank's expected profit Π is given by:

$$\Pi = \{pf(I) + (1-p)\lambda I - IR^B\} + mI(R^B - R^M) - (1-p)zmIR^M =$$

$$\{pf(I) + (1-p)\lambda I - IR^B\} + \frac{M}{R^M}(R^B - R^M) - (1-p)zM$$

where $z = (1 - k)/k$ is net rate of return on fire-sold assets.

- Each bank takes z as fixed when formulating its decisions; optimizes by picking m and M (or equivalently, m and I).
- Bank will go to a corner solution, setting $m^* = m^{max}$ if:

  $(R^B - R^M) > (1 - p)zR^M$, i.e, if fire-sale losses not too big relative to spread between bonds and money.

Privately-Optimal Money Creation

- First order condition with respect to M:

$$\frac{d\Pi}{dM} = \{pf'(I) + (1-p)\lambda - R^B\}\left[\frac{dI}{dM}\right]_{Bank} + \frac{(R^B - R^M)}{R^M} - (1-p)z = 0$$

- Define I^B as optimal investment in all-bond-financed world:

$$pf'(I^B) + (1-p)\lambda - R^B = 0$$

- There are two regions:
  - Low-M Region (for $(R^B - R^M)$ small): $m^* < m^{max}$ and $I^* = I^B$.
  - High-M Region (for $(R^B - R^M)$ large): $m^* = m^{max}$ and $I^* > I^B$.

- In High-M Region $I^* = M^*/k\lambda$.
  - So bank sees $\left[\frac{dI}{dM}\right]_{Bank} = \frac{1}{k\lambda}$ (Recall that bank takes k as fixed.)

Social Planner's Problem

- Social planner's utility given by:

$$U = \{pf(I) + (1-p)\lambda I - IR^B\} + \frac{M}{R^M}(R^B - R^M) + E\{g(K) - K\}$$

- Planner's optimal choice of M:

$$\frac{dU}{dM} = \{pf'(I) + (1-p)\lambda - R^B\}\left[\frac{dI}{dM}\right]_{Planner} + \frac{(R^B - R^M)}{R^M} + E\{(g'(K)-1)\frac{dK}{dM}\} =$$

$$\{pf'(I) + (1-p)\lambda - R^B\}\left[\frac{dI}{dM}\right]_{Planner} + \frac{(R^B - R^M)}{R^M} - (1-p)z = 0.$$

- Looks very similar to FOC for bank. Key difference: in high-M region, when $m^* = m^{max}$,

$$\left[\frac{dI}{dM}\right]_{Planner} > \left[\frac{dI}{dM}\right]_{Bank}$$

  - This is because planner takes into account dependence of *k* on *M*.

What Happens if Planner Can Put a Cap on Money Creation?

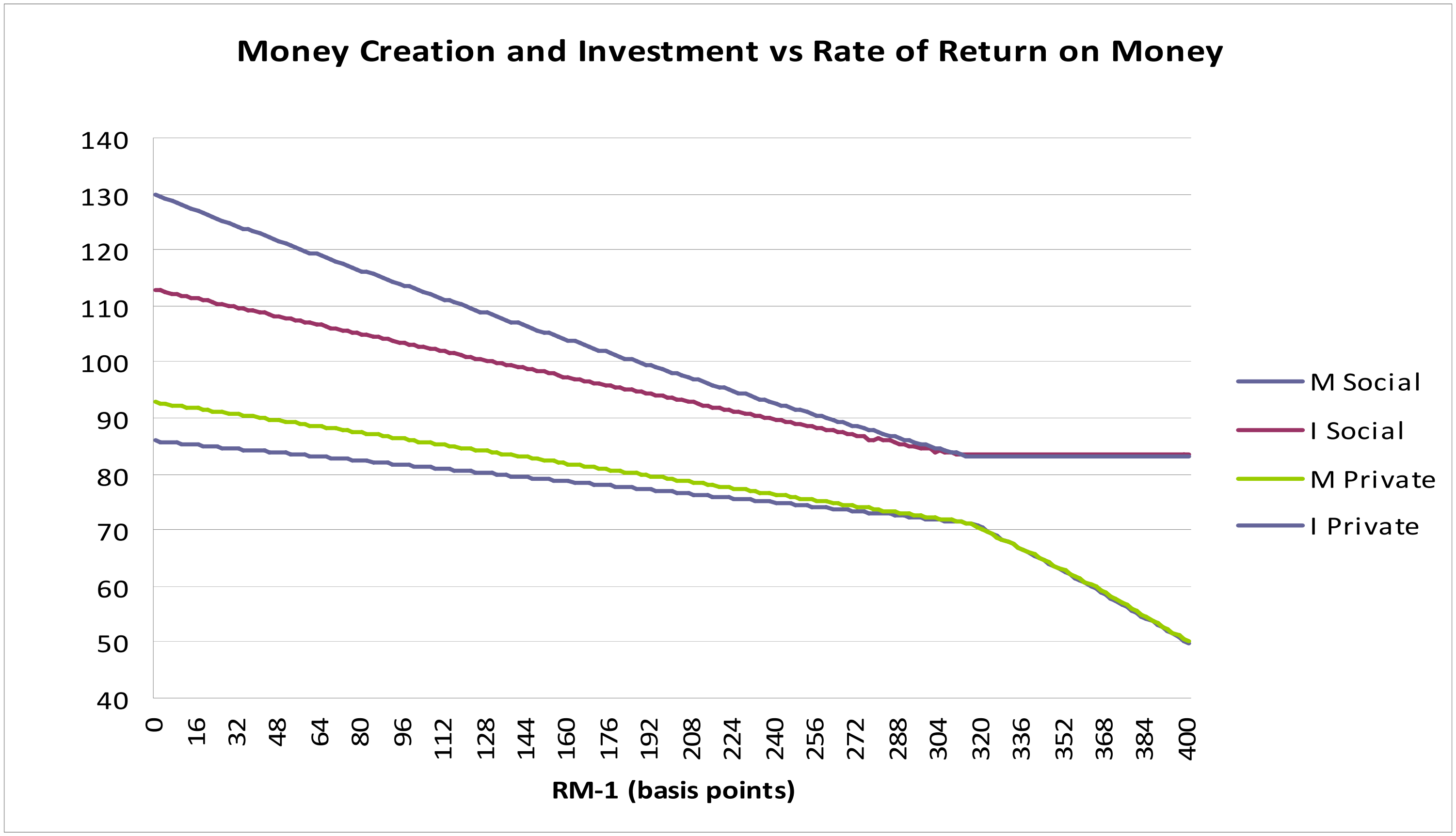
- Suppose we let planner pick socially optimal level of money creation M^{**}.
  - In low-M region, planner's solution coincides with private optimum: $M^{**}=M^{*}$.
  - In high-M region, planner wants to restrain money creation: $M^{**}< M^{*}$, and hence $I^{**}<I^{*}$ (since $m = m^{max}$).
- Intuition: bank does not internalize negative impact of its own money creation on ability of other banks to create money.
  - As bank A creates more M, equilibrium value of k falls and bank B can create less M for a given level of I.
  - Reminiscent of "industry debt capacity" argument in Shleifer-Vishny (92).
  - Externality is only relevant when banks are at a corner, creating as much money as they can given crisis-state liquidation values.

Numerical Example

- Pick functional forms and parameter values:
  - $f(I) = \psi \log(I) + I$
  - $g(K) = \theta \log(K)$
  - $R^B = 1.04$; $R^M = 1.02$; $\psi = 3.5$; $\theta = 150$; $\lambda = 1$; $W = 200$; $p = 0.95$.
- Private optimum: banks choose $M^{*}= 79.1$.
  - At private optimum, $I^{*}= 98.1$;
  - And rate of return z on fire-sale assets = 24.1% ($k = 0.806$).
- Social optimum: planner chooses $M^{**}= 76.8$.
  - At social optimum, $I^{**}= 93.5$;
  - And rate of return z on fire-sale assets = 21.8% ($k = 0.821$).
- This is a high-M equilibrium.
  - Planner actively constrains money creation.
  - In neighborhood of social optimum, dI/dM is positive: changes in the cap matter for investment.

How Outcomes Vary with (R^B – R^M)

- $R^B = 1.04$; $\psi = 3.5$; $\theta = 150$; $\lambda = 1$; $W = 200$; $p = 0.95$.
- R^M varies from 1.0 to 1.04



Flexible Regulation: The Advantage of Cap and Trade

- To implement socially optimal M^{**}, planner needs to know all the relevant parameters of the model.
  - What if, e.g. investment-productivity parameter ψ is known by banks but not by the planner?
  - Planner can grant permits for money creation to banks, and allow them to be traded.
  - Price of permits is given by:

$$\frac{d\Pi}{dM} = \{pf'(I) + (1-p)\lambda - R^B\}\left[\frac{dI}{dM}\right]_{Bank} + \frac{(R^B - R^M)}{R^M} - (1-p)z$$

  - If planner knows all other parameters, permit price reveals investment productivity, allows planner to select correct value of M^{**}.

Numerical Example, Cont'd

- Suppose, as above, we begin in a world where $\psi = 3.5$.
  - Planner knows this, and sets cap accordingly: $M^{**} = 76.8$.
  - At this value, planner expects permits to trade for a price of 0.003356.
- But then there is a productivity shock, such that $\psi = 4.0$.
  - Because of higher marginal productivity of investment, permits now trade for a price of 0.008731.
  - This higher permit price allows planner to learn the new value of ψ.
  - Can then adjust the cap to new optimal value of $M^{**} = 81.3$.
  - At new optimum, permits trade for a price of 0.002616.
- Note that optimal regulation involves the planner actively stabilizing the price of permits.
  - When price of permits rises, regulator infers that productive opportunities have increased, and loosens the cap.

Introducing a Monetary Dimension

- Basic idea: monetary policy as a particular mechanism for implementing the cap and trade approach to regulation.
  - Bank reserves play the role of permits to create money.
  - And the nominal interest rate plays the role of the permit price.
- The subtlety: so far have been working in an entirely real setting.
  - Need to introduce nominal government liabilities, and pin down the price level.
  - Will do so using fiscal theory of the price level.

The Government's Balance Sheet

- Government raises fixed *real* tax revenues of T at time 2.
- Government has stock of outstanding *nominal* liabilities at time 0, composed of Treasury bonds and reserves: $l_0 = b_0 + r_0$.

- Need to pin down time-0 price level P_0 and riskless nominal interest rate i.
  - Time-2 price level then given by: $P_2 = \frac{P_0(1+i)}{R^M}$

- P_0 determined by fiscal theory: PV of future tax revenues must equal value of government liabilities:

$$\frac{l_0}{P_0} = \frac{T}{R^M}$$

  - As in e.g. Cochrane (98).
  - Am assuming that government rebates any seignorage revenue in a lump sum so real tax revenues always stay fixed at T.

How Open-Market Operations Determine Nominal Interest Rates and Real Activity

- With fractional reserve requirement of ρ, cap on (net) real money creation given by:

$$M = \frac{(1-\rho)r_0}{\rho P_0} = \frac{(1-\rho)r_0 T}{\rho l_0 R^M}$$

  - So *composition* of government liabilities—bonds vs. reserves—is a real variable: only reserves enable money creation.
  - Central bank open-market operations correspond to changes in supply of permits for creating private money.
- Without loss of generality, assume $P_0 = 1$.
- If a bank wishes to expand net M by one unit, and hence real time-2 profits by $d\Pi/dM$, must finance holdings of $\rho/(1-\rho)$ reserves at time 0.
- This entails a net dollar repayment of $\rho i/(1-\rho)$ at time 2, or $\rho i/(1-\rho)P_2$ in real terms.
- Can use this to show: $$\frac{i}{(1+i)} = \frac{(1-\rho)}{\rho R^M}\frac{d\Pi}{dM}$$
  - Nominal interest rate plays role of price of permits in this setting.

Numerical Example, Cont'd

- Return to case where $R^B = 1.04$; $R^M = 1.02$; $\psi = 3.5$.
  - At social optimum of $M^{**} = 76.8$, permit price = $d\Pi/dM = 0.003356$.
  - With fractional reserve requirement of $\rho = .10$, this corresponds to nominal riskless rate $i = 3.05\%$.
  - Since i exceeds real riskless rate of 2.0%, implied inflation is 1.05%.
- Keep all else the same, but set $R^M = 1.01$. At new social optimum of $M^{**} = 81.4$, get $i = 6.35\%$.
  - Greater spread between money and bonds makes money creation more attractive, increases shadow value of reserves.
- What if productivity parameter rises to $\psi = 4.0$, and central bank does not adjust M?
  - With $R^M = 1.02$, saw that permit price goes up to 0.008731
  - This translates into nominal rate i spiking up from 3.05% to 8.34%.

Extensions and Implications

- Deposit insurance.
- Lender or market-maker of last resort.
- Diminishing marginal utility of money.
  - Alternative (complementary) policy approach: reduce incentives for private money creation by creating more public money.
  - Finance more of federal debt with short-term T-bills?
- Cap-and-trade regulation of bank capital (Kashyap-Stein (09)).
  - Use tradeable capital relief certificates to inform time-varying capital requirements; combat procyclicality problems.
- The shadow banking system, repo finance and unregulated money creation (Gorton-Metrick (09)).
  - How best to regulate?