When is Less More?
Bank Arrangements for Liquidity vs Central Bank Support

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Motivation

- Financial crises still occur periodically, even in industrial countries (e.g., Ferguson et al., 2023; Reinhart and Rogoff, 2013; Schularick and Taylor, 2012)

  Schularick-Taylor | Reinhart-Rogoff | US Crises post-FDIC

- Silicon Valley Bank and associated failures
- This despite substantial central bank and government intervention
  - Guarantees, lending, restructuring, asset purchases, capital injections...

  Public Intervention | CB Balance Sheet | CB History

Motivation... contd.

- Could intervention be part of the problem?
  - Could the private sector get it right on its own?
  - Why might it go off track?
  - What would it take for the intervention to be done right?
- Becomes more important as governments run out of fiscal capacity

Starting Point – Stein (2012): Model with Fire-Sale Externalities

- Stein (2012): banking sector raises funds from households via ST liabilities (money-like deposits) and LT bonds to invest in long-term projects
  - Money-like deposits: cheaper than bond funding due to a premium attributed to riskless liquid assets, but depositors run in a crisis state
    - Also see Diamond and Dybvig (1983), Diamond and Rajan (2001), Dang, Gorton, Holmstrom and Ordonez (2017)
  - In the crisis state, bank can sell assets but cannot arrange new borrowing
    - The amount of money-like deposits issued constrained by the need to have enough saleable assets (collateral constraint)
  - If deposit funding is cheap and constrained by assets, banks overinvest in real assets to be able to borrow more through deposits, neglecting effects on the fire-sale price

Our paper

- Money issuance can be supported privately, not only by real investment, but also via private contingent capital
  - Private provision of contingent capital restores constrained efficient outcomes in Stein (2012)
    - Also see Krishnamurthy (2003) in the context of amplification effects in KM (1997) or Lorenzoni (2008)
  - Historical evidence of banks having claims on shareholders in bad times (double/unlimited liability)
  - Contingent convertible bonds today

Our paper contd...

- However, fire sales not eliminated even in constrained efficient private outcome.
- Seeing fire sales public authority may be tempted to intervene to supply liquidity
- But constrained efficiency requires public authority to buy at the private fire sale price (the "Bagehot" price)
  - And this implies the public authority "profits from adversity"
- If public intervention underpriced
  - Crowds out private contingent capital
  - Increases money financing (though not relative to constrained efficient)
  - Incentivizes overinvestment in real assets
- Which forms of public intervention do the least damage?

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Our paper contd...

- Thus far, money premium constant as in Stein (2012) – take on illiquidity risk on financing side because money financing "cheap".
- What if strategies generating higher returns for taking illiquidity risk available to the bank on asset side?
- Financing speculation: private returns increase in leverage (and thus liquidity risk), but socially wasteful
  - Can crowd out money financing because speculation offers higher returns to available liquidity than money financing of real investment
  - Now liquidity demand (from financial speculation) as well as overinvestment in real assets both increase in the extent of anticipated underpriced public intervention.
    - Feed on each other
- One reason why crises are not history?

Related Literature

1. Banking Theory
   - Bank Runs: Diamond and Dybvig (1983), Diamond and Rajan (2001), Dang et al. (2017)
   - Fire-sale externality: Krishnamurthy (2003), Lorenzoni (2008), Davila and Korinek (2017), Di Tella (2017), Asriyan (2020)
2. Private Arrangements of Contingent Bank Capital
   - Unlimited and Contingent Liability: Macey and Miller (1992), White (1995, 2014), Grossman and Imai (2013), Turner (2014), Goodhart and Lastra (2020), Kenny and Ogren (2021), etc.
   - Contingent Convertible Bonds: Flannery (2005), Kashyap, Rajan, and Stein (2008), French et al. (2010), Flannery (2014), Vallee (2019), Avdjiev et al. (2020)
3. Monetary Policy and Financial Stability
   - Theory: Bagehot (1873), Holmstrom and Tirole (1998), Stein (2012), Diamond and Rajan (2012), Farhi and Tirole (2012)
   - Empirics and History: Schularick and Taylor (2012), Reinhart and Rogoff (2013), Metrick and Schmelzing (2021), Ferguson et al. (2023)
4. Pre-committed Liquidity
   - Tuckman (2012), King (2016), Nelson (2023), Hanson et al. (2024)
5. The Rise of Financial Speculation
   - Duffie (2020), Barth and Kahn (2021), Vissing-Jorgensen (2021), Kashyap et al. (2025), etc.

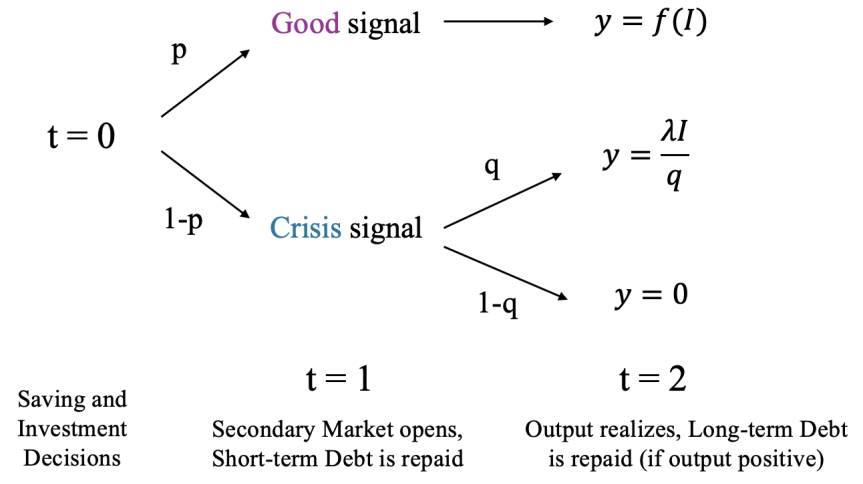
The agents

- Households (representative household)
- Symmetric banks (representative bank)
- Symmetric private investors (representative PI)
- Central bank

Households (in the Background)

- Representative households with unit measure, endowment Y
- Choose between current consumption C_0 and late consumption C_2
- Households can invest in either liquid money-like deposits M or risky, illiquid long term bonds B
- Linear preferences $U = C_0 + \beta \mathbb{E}[C_2] + \gamma M$
  - Expected gross return on bonds: $R^B = \frac{1}{\beta}$
  - Gross return on money: $R^M = \frac{1}{\beta+\gamma}$ where γ is the convenience yield on money
  - Fixed money-bond spread $= R^B - R^M$

Timing and Real Investment



- To make money riskless, depositors withdraw at time 1 in the crisis state

Banks

Assets

- Real investment I:
  - Output $= f(I)$ in good state
  - Expected Output $= \lambda I$ in crisis state

Liabilities

- mI financed by money: pay $M = mIR^M$
  - At $t = 2$ in good state
  - At $t = 1$ in bad state
- $(1 - m)I$ financed by illiquid bonds that pay R^B at $t = 2$

- Crisis state: must meet money demand by depositors $M = mIR^M$
  - Sell real assets at fire-sale price $k \leq 1$ up to $k\lambda I$
  - Arrange for contingent capital $E = \psi I$ at time 0, pay $r^E E$ in good state to receive E in crisis state

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Bank's Problem

$$\max_{m,\psi,I} \underbrace{pf(I) + (1-p)\lambda I - R^B I}_{\text{real investment}} + \underbrace{mI(R^B - R^M)}_{\text{money spread}}$$

$$- \underbrace{pr^E \psi I}_{\text{insurance premium}} + \underbrace{(1-p)\psi I}_{\text{insurance payout}} - \underbrace{(1-p)(\frac{1}{k}-1)[mIR^M - \psi I]}_{\text{loss on fire sale}}$$

s.t.

$$\underbrace{mIR^M}_{\text{Money Liability } (M)} \leq \underbrace{k\lambda I}_{\text{Fire Sale}} + \underbrace{\psi I}_{\text{Private Insurance } (E)} \iff m \leq \frac{k\lambda + \psi}{R^M}$$

FOCs: Bank FOCs

- Money-bond spread (Exogenous) = Fire-sale cost + Shadow cost of money constraint
- Bank's MC of insurance = Savings from fire sale + Shadow cost of money constraint
- MB of bank investment + Shadow cost of money constraint = MC for bank of financing

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Private Investor's Problem

- Private investors (PIs) invest in late-arriving opportunity $g(\cdot)$, in purchasing fire-sold assets, and in providing contingent capital to banks

$$\max_{M,E} p\left[g(W) + \underbrace{r^E E}_{\text{insurance premium}}\right] + (1-p)\left[g(W-M) + \underbrace{\frac{1}{k}(M-E)}_{\text{Fire-sale purchases}}\right]$$

FOCs: PI FOCs

- At time 1 in the crisis state: MB of g investment = MB of fire-sale purchases
- At time 0: MB of contingent capital (premium)
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Private Equilibrium is Efficient

Definition

A private equilibrium is a set of prices and allocations such that

- Taking the prices k, r^E as given, banks and PIs optimize,
- The markets for private insurance and fire sale of real investments clear.

Theorem

The private equilibrium outcome in the baseline model with private contingent liquidity and no friction in its commitment or provision is efficient.

- Consistent with Krishnamurthy (2003) and Asriyan (2020)

Equilibrium Characterization

Full Details I | Full Details II

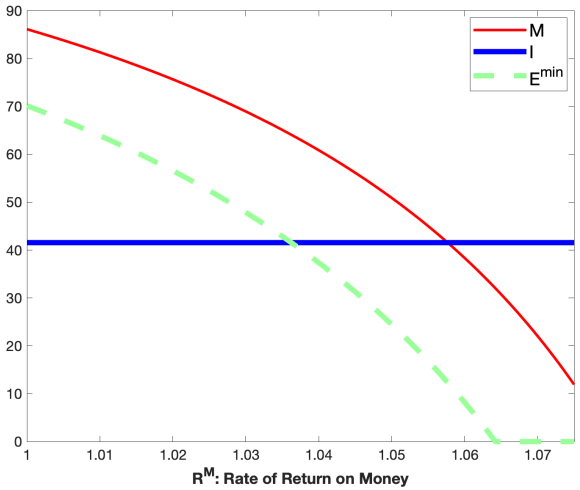
- The money creation constraint never binds:
  - Bank equates MB and MC from buying contingent capital (CC):

    Premium for CC = Bank's fire-sale savings + Shadow cost of constraint
  - PIs equates MB and MC from selling CC:

    Premium for CC = PI's forgone fire-sale gains
  - Banks will want to issue CC until shadow cost of constraint $= 0$
  - Complete markets with CC at time 0 and fire sale at time 1:
    - Price of CC at date 0 ensures money creation constraint does not bind, so no incentive to enhance money issuance by investing more in real asset.

Baseline Model: Numerical Illustration

- Consistent with historical evidence on unlimited / contingent liability



Parameters: $p = 0.95$, $\lambda = 1$, $W = 140$, $R^B = 1.08$, R^M between 1 and 1.075; $f(I) = a\log(I) + I$ with $a = 3.5$, $g(K) = \theta\log(K)$ with $\theta = 140$. These parameters are used throughout the slides.

Historical Success of Private Arrangements for Bank Liquidity

- Example of contingent liability: Unlimited liability, additional liability
- White (1995): "remarkable monetary stability" during the Scottish Free Banking Era from 1716 to 1844:
  - Especially from 1810-1844, **unlimited liability** banks became *"the dominant element in the Scottish banking system"* (Evans and Quigley, 1995)
  - No LOLR, yet greater stability and growth than contemporary England
- 1880s to mid-20th Century: many banks in Europe and North America operated well under **contingent liability** structures:
  - Shareholders were additionally liable for up to a predetermined level of debt after insolvency, often 2-3x their book capital
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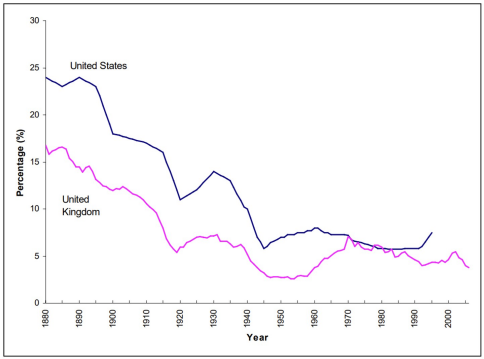
Secular Decline in Banks' Capital Ratios

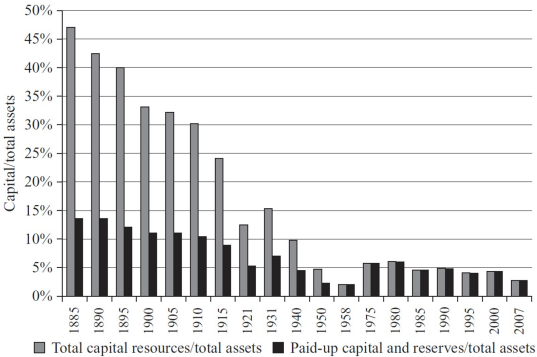
- Contingent / double liability disappeared in the US after FDIC was introduced and in the UK in 1956-58 after a reorganization coordinated by the BoE (Turner, 2014)

Capital ratio for UK and US Banks, 1880-2005



Source: Alessandri and Haldane (2009)

Capital ratio for the UK banking system (including uncalled capital), 1885-2007



Source: Turner (2014)

How does public intervention alter private arrangements and outcomes?

Intervention – Central Bank as a Lender of Last Resort

- Seeing fire sales, might a central bank want to intervene?
  - The setting up of the Federal Reserve: the 1907 Knickerbocker Crisis, JP Morgan and fire sales
- Central Bank provides liquidity $L = \phi I$ to cover a fraction of fire sales during crises and maximize welfare:

$$\max_{\phi} \underbrace{pf(I) + (1-p)\lambda I - R^B I}_{\text{time-0 real investment}} + \underbrace{mI(R^B - R^M)}_{\text{money spread}} + pg(W)$$
$$+ \underbrace{(1-p)\left[g(W - M + L) + M\right]}_{\text{time-1 investment and transfers}} - \underbrace{(1-p)C(L)}_{\text{LOLR Cost}}$$

- At time 1 in the crisis state: $g'(W - M + L) = C'(L)$
  - $C(L)$ captures the central bank's perceived distortionary fiscal / inflation cost or its political sensitivity

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Varieties of central banks

- Planner: can choose I, M, E at time 0 along with $L = \phi I$ altogether
- Bailout:
  - Takes levels of I, M, E as given
  - Chooses L in the crisis state ex post, without repayment (charges $\tau = 0$)
- Pre-committed liquidity/deposit insurance:
  - Takes the private agents' optimizing behavior of I, M, E as given
  - At time 0, fully commits to provide $L = \phi I$ in the crisis state and charges τL in the good state

Problem with a Bailout Central Bank

- More money financing at date 0, anticipating cheap central bank liquidity – socially optimal
- Moral hazard: at time 0, banks perceive that the central bank provides liquidity $L = \phi I$ in the crisis state in proportion to real investment I:

$$\max_{m,\psi,I} \quad \text{Bank's Old Objective} + \underbrace{(1-p)\phi I}_{\text{LOLR payout}} + \underbrace{(1-p)(\frac{1}{k}-1)\phi I}_{\text{savings on fire sales due to LOLR}}$$

- Banks now have additional incentive to scale up real investment at time 0
  - More money-issuance made possible by real investment rather than private contingent capital
  - Could lead to an "endogenously missing market" for private contingent capital

Bank's FOCs with a Bailout Central Bank

Recall: Banks' FOCs in the private equilibrium (constraint not binding):

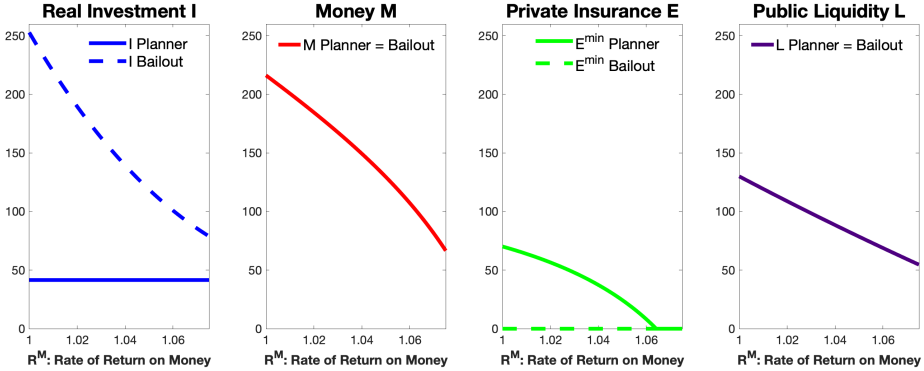
- MB of bank investment = MC of bank financing

With a bailout central bank that sets $L = \phi I$: the FOC w.r.t. investment I changes

- MB of bank investment = MC of bank financing - **Fire-sale savings from LOLR intervention**
- If central bank support is underpriced, i.e., there is an expected fire-sale savings, then the creation of money leads to incentives to overinvest and that crowds out private insurance

Model with a Bailout Central Bank

- M and L at efficient levels, but overinvestment in I due to mispriced L
  - When the money-bond spread is large, a bailout central bank can lead to lower welfare Welfare



Note: Same parameters as the baseline model without central banks, with $C(L) = 0.5cL^2$, $c = 0.02$, and $\beta^{CB} = 1$ (no myopia).

Effects of Central Bank Intervention

- Key intuition: ex-post LOLR intervention that scales with I + banks perceive it to be mispriced at time 0 $\implies$ banks overinvest and under-insure
  - Private money $M-L$ and public intervention L are socially optimal (no distortion on the PIs and CBs), but the balance between the real investment I and contingent capital E supporting private private money creation is distorted
- The "endogenously missing private insurance market" result under a bailout central bank is consistent with
  - The establishment of central banks and expanding liquidity interventions in banking crises

  in conjunction with
  - The disappearance of private contingent capital (in the form of unlimited or contingent liability), and the secular decline in bank capital

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Actuarially Fair Pre-committed Liquidity

- At time 0, CB commits to L in the crisis state taking into account how private agents optimize and charge $(1-p)L$ back in expectation (CB breaks even)
- Continues to crowd out private contingent capital, though to a lesser extent
  - The actuarially fair rate is not enough to restore planner's choice:

$$\text{Bank's Old Objective} \quad + \underbrace{(1-p)\phi I - p\tau\phi I}_{=0} + \underbrace{(1-p)\left(\frac{1}{k}-1\right)\phi I}_{\text{fire-sales savings due to LOLR}}$$

  - If the central bank/deposit insurance charges the right price $\tau = \frac{(1-p)}{p}\frac{1}{k}$ (it makes the fire-sale return on asset purchases), it makes profits in expectation
    - Profiting from adversity!
  - Second-best result: CB commits to less-than-socially-optimal L at time 0 to reduce overinvestment AFPL

Bottom line

Correcting the moral hazard distortion is particularly difficult!

- This is even without accounting for central bank moral hazard – perceives intervention cost to be only $\beta^{CB} C(L)$ where $\beta^{CB} \leq 1$

Model Implications

- To completely offset moral hazard, central bank must charge the fire-sale return (> 1) $\implies$ makes profits
  - Unlikely to be politically feasible $\implies$ underpriced intervention
- In this model: bank franchise value arises only from underpriced public intervention
  - Franchise value depends both on the extent of intervention and the degree of underpricing Bank Franchise Value
- When the money-bond spread $R^B - R^M$ is high:
  - Underpriced interventions are particularly problematic
  - Bank franchise value due to underpriced intervention is high

Other Policy Tools

- Liquidity coverage ratio
  - Forcing banks to hold cash as a fraction of (uninsured) deposit outflow
    $\Longrightarrow$ effectively raises cost of deposits R^M and lowers the money-bond spread
    $\Longrightarrow$ can reduce overinvestment due to moral hazard
  - Holding money as cash instead of investment or immediate consumption lowers welfare
- Private incentives to overinvest prevail even after fixing M, E at efficient levels
  - To restore efficient I: either correct underpricing of interventions, or add additional incentive to lower investment

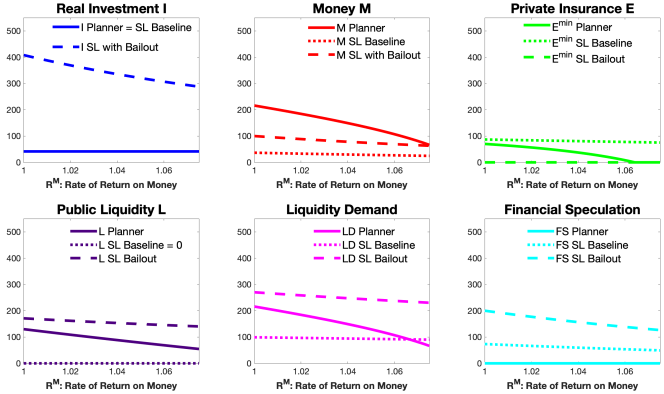
Extension 1: Financial Speculation

Model Setup

- Thus far the return to taking illiquidity/fire sale risk bounded by money premium $R^B - R^M$.
- What if bank returns could be increased by financing socially wasteful speculation? Basis Trade
  - Higher leverage chosen by banks financing speculation: greater returns in the good state, but greater need for liquidity (margin calls) in the crisis state
- Key Results:
  - LOLR continues to crowd out private contingent capital
    - Interaction effect: because fire sale cost and implied subsidy larger, induces additional real investment as well as speculation
    - Fed put consistent with rising financial speculation
  - Institutional liquidity demand through financial speculation crowds out individual money issuance (with a convenience yield)

Model with Bailout Central Bank and Financial Speculation

- Financial speculation + bailout central bank: excessive real investment and underprovision of private insurance continues to prevail
  - Excessive intervention L , but less M relative to planner's choice — why? SL2



Note: Same parameters as the baseline model, and we choose $s = 0.01$, $\bar{m} = 0.5$, $v(I) = 0.002I^2 + 0.001I$. These parameters give reasonable levels of speculation returns (net return of 0.1-0.13) and leverage (I is around 20-26; the size of the margin call, $v(I)$, is around 0.8-1.3).

Extension 2: Limited Commitment

- Motivation: disappearance of contingent liability in the 1930s-50s due to private frictions (transaction costs as shareholder base grew, limited wealth of shareholders during the Great Depression)
- PI cannot commit to provide E at time 1 in the crisis state, so at time 0, they must put E into a liquid technology in advance that can be withdrawn in the bad state and earns $h(E)$ in the good state PI's Problem
  - Can be thought of as solving an unmodeled agency problem
- Key results
  - Without LOLR: over-investment, over-creation of money (as in Stein, 2012), hence too much private insurance relative to planner's choice Intuition LC Private
  - With a Bailout CB: crowding-out of private contingent capital remains Full Results E over I

Conclusion

- Private-sector constrained efficient remedies to problem of banks over-issuing money/overleveraging
- Leaves fire sale prices – possibility of public intervention
- Public intervention is invariably underpriced and distortionary
  - Politically difficult to charge an adequate fee that is higher than actual public costs to restore the right private incentives
  - Leads to crowding out of incentives to deploy private sector remedies
- Can incentivize liquidity dependence in investment allocation (financing speculation) as well as overinvestment
- Finding the right mix of private contracting and public support remains an important topic for future research and for public authorities in the face of limited fiscal space

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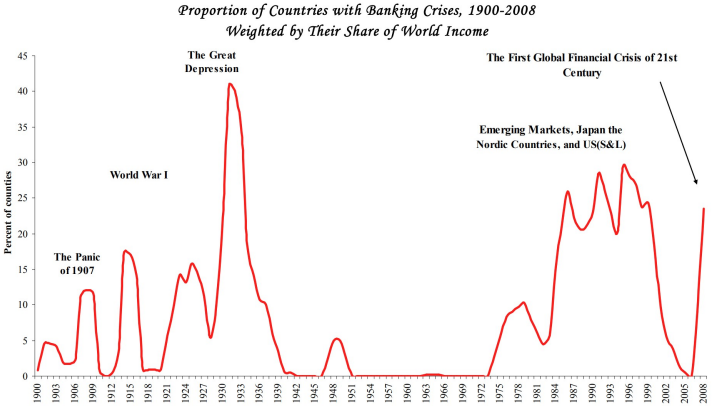
The Recurrence of Banking Crises Persists

Back

- Significant banking crises continue to occur across the world
  - Despite public intervention, made easier in the fiat money era
  - Including in advanced economies with comprehensive regulatory frameworks



Source: Reinhart and Rogoff (2013)

The Recurrence of Banking Crises Persists

Back

- List of Banking Crises from Schularick and Taylor (2012)

Country	ISO	Financial crisis (first year)
Australia	AUS	1893, 1989
Canada	CAN	1873, 1906, 1923, 1983
Denmark	DNK	1877, 1885, 1902, 1907, 1921, 1931, 1987
France	FRA	1882, 1889, 1904, 1930, 2008
Germany	DEU	1880, 1891, 1901, 1931, 2008
Italy	ITA	1887, 1891, 1907, 1931, 1930, 1935, 1990, 2008
Japan	JPN	1882, 1907, 1927, 1992
Netherlands	NLD	1897, 1921, 1939, 2008
Norway	NOR	1899, 1921, 1931, 1988
Spain	ESP	1920, 1924, 1931, 1978, 2008
Sweden	SWE	1876, 1897, 1907, 1922, 1931, 1991, 2008
Switzerland	CHE	1870, 1910, 1931, 2008
United Kingdom	GBR	1890, 1974, 1984, 1991, 2007
United States	USA	1873, 1884, 1893, 1907, 1929, 1984, 2007

Notes: As described in the text, our crisis coding follows previous work, notably Reinhart and Rogoff (2009, RR), and Bordo, Eichengreen, Klingebiel, and Martinez-Peria (2001, BEKM). We corroborated the coding with Laeven and Valencia (2008) as well as Cechetti et al. (2009). There are only three major cases where these sources differ and which we need to discuss briefly:

Source: Schularick and Taylor (2012)

US Crises Post FDIC

Back

List of U.S. banking crises and financial crises involving financial stability concerns since the establishment of central banking and deposit insurance:

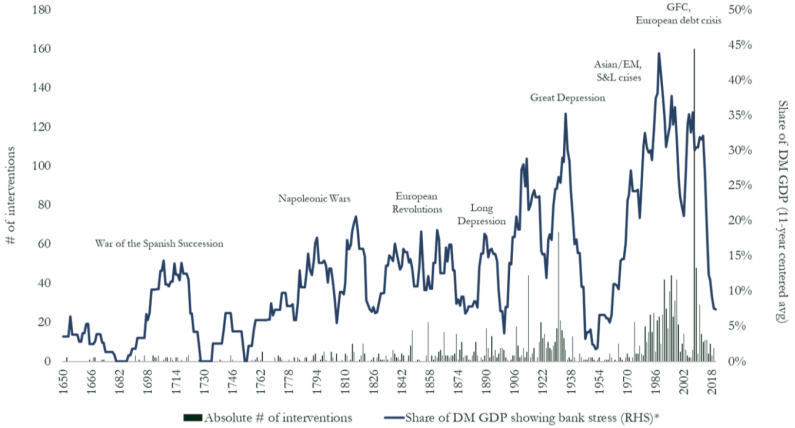
- 1970: Penn Central bankruptcy
- 1980s: Savings and Loans (S&L) crisis
- 1983 – 1984: Bailout of Continental Illinois National Bank and Trust Company
- 1998: Failure of Long-Term Capital Management
- 2007 – 2009: Great Financial Crisis
- 2023: US regional bank crisis

Source: Bouis, Romain, Damien Capelle, Giovanni Dell'Ariccia, Christopher Erceg, Maria Martinez Peria, Mouhamadou Sy, Ken Teoh, and Jerome Vandenbussche, 2025, Navigating trade-offs between price and financial stability in times of high inflation, IMF Staff Discussion Notes 2025

The Growing Reach of Public Interventions

Back

- Over the past century: considerable increase in the size and scope of government / central bank interventions in response to banking crises



Source: Metrick and Schmelzing (2021). The left axis reports the total number of interventions for their database. The right axis (the line) takes a GDP-weighted view for advanced economies, focused on the subset of eight leading developed economies (Italy, the U.K., Netherlands, France, Germany, Spain, the U.S., and Japan).

The Emergence of Central Banking

Back

- Central banks emerged globally in the 19th and 20th centuries, taking on the role of lender of last resort (LOLR)

Country	Modern Central Bank was Established in	First LOLR-type Intervention by Central Bank
United Kingdom	1694	1711
Spain	1782	1829
France	1800	1818
Netherland	1814	1924
Germany	1876	1880
Japan	1882	1890
Italy	1893	1906
United States	1913	1916

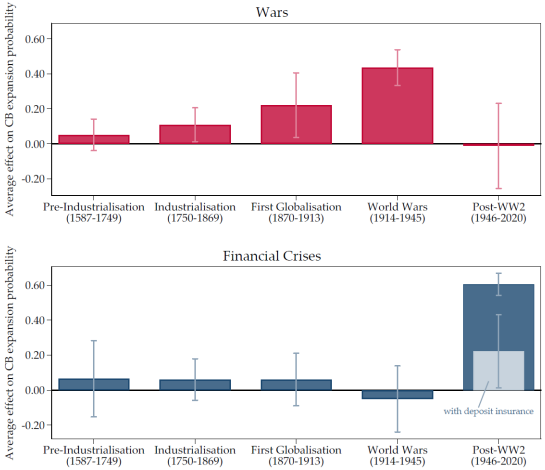
Source: Bordo and Siklos (2018), Metrick and Schmelzing (2021)

Note: The First and Second Bank of United States were in place between 1791-1836 but not included as a modern central bank. The first lender of last resort-type intervention were based on the chronology provided by Metrick and Schmelzing (2021).

Financial Crises as Central Bank Balance Sheet Drivers

Back

- Post-WW2, central bank policy responses have become *"close to systematic"* amid financial crisis (Ferguson, Kornejew, Schmelzing, and Schularick, 2023)



Source: Ferguson et al. (2023). The figure plots average effects on the probability of a central bank balance sheet expansion of +15% or more during the current or the next year.

Bank's FOCs

Back

- w.r.t. bank's fraction of real investment financed by deposits, m:

$$\underbrace{R^B - R^M}_{\text{Money-bond spread}} \underbrace{-(1-p)(\frac{1}{k}-1)R^M}_{\text{Fire-sale cost}} = \underbrace{\frac{\eta}{I}}_{\text{Shadow cost of constraint}}$$

- w.r.t. bank's fraction of real investment covered by private contingent capital ψ:

$$\underbrace{pr^E}_{\text{MC of insurance}} = \underbrace{\frac{\eta}{IR^M}}_{\text{Shadow cost of constraint}} + \underbrace{(1-p)(\frac{1}{k})}_{\text{Fire sale savings}}$$

- w.r.t. bank's real investment I:

$$\underbrace{pf'(I)+(1-p)\lambda}_{\text{Expected MB of investment}} = \underbrace{R^B}_{\text{MC of financing}} - \underbrace{\frac{\eta}{I}\left[m - \frac{\psi}{R^M}\right]}_{\text{Shadow cost of constraint}}$$

Private Investor's FOCs

Back

- At time 1 in the crisis state:

$$\underbrace{g'(W-M)}_{\text{MB of g investment}} = \underbrace{\frac{1}{k}}_{\text{MB of fire-sale purchases}}$$

- At time 0:

$$\underbrace{pr^E}_{\text{MB of insurance (premium)}} = \underbrace{(1-p)\frac{1}{k}}_{\text{Forgone gains from fire-sale / g inv in crisis state}}$$

Equilibrium Characterization I

Back

- Private contingent capital markets FOCs $\implies$ money creation constraint never binds:

$$\underbrace{(1-p)(\frac{1}{k})}_{\text{PI's MC of Insurance}} = \underbrace{pr^E}_{\text{Insurance Premium}} = \frac{\eta}{IR^M} + \underbrace{(1-p)(\frac{1}{k})}_{\text{Bank's Fire Sale Savings}} \implies \eta = 0$$

- Fire sale price k pinned down by bank's FOC w.r.t. m:

$$\underbrace{\frac{R^B - R^M}{R^M}}_{\text{Money spread}} = \underbrace{(1-p)(\frac{1}{k} - 1)}_{\text{Expected Fire Sale Cost}}$$

  - In expectation, the overall financing cost is the same via money vs bonds

Equilibrium Characterization II

Back

- Real investment I is pinned down by the bank's FOC w.r.t I:

$$\underbrace{pf'(I) + (1-p)\lambda}_{\text{Expected MB of investment}} = \underbrace{R^B}_{\text{MC of Financing}}$$

- Total amount of money $M = mIR^M$: from PI's FOC at time 1:

$$\underbrace{g'(W-M)}_{\text{PI's MB of } g \text{ investment}} = \underbrace{\frac{1}{k}}_{\text{PI's MB of fire-sale purchases}}$$

- Take costs arising from insurance friction $\to 0 \implies$ frictionless benchmark

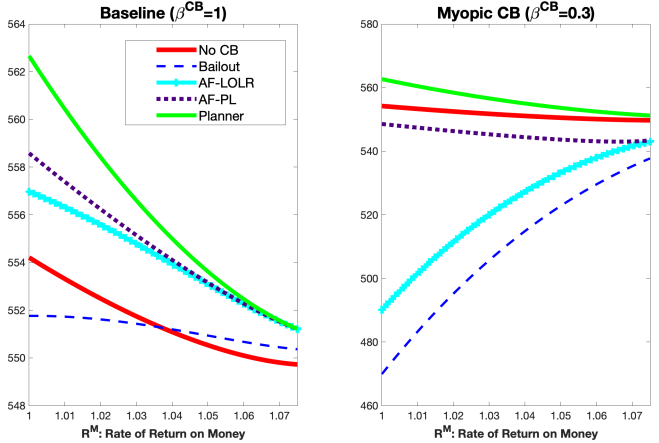
$$\underbrace{E}_{\text{Private contingent capital}} = \underbrace{M}_{\text{Money Liability}} - \underbrace{k\lambda I}_{\text{Fire-sold real investment}}$$

  - More generally, any E s.t. $M - k\lambda I \leq E \leq M$ is an equilibrium outcome (only in the frictionless model).

Baseline Model: Welfare

Back

- Myopic central bank: perceives a lower cost of intervention $\beta^{CB} C(L)$, with $\beta^{CB} < 1$ capturing myopia due to political economy reasons

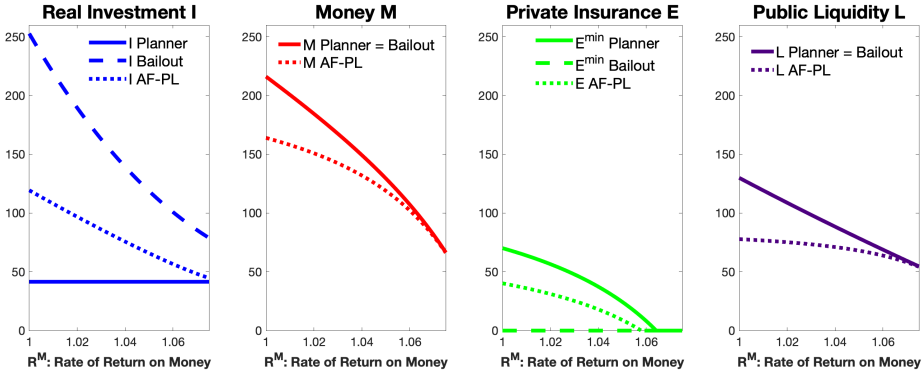


Parameters: $p = 0.95$, $\lambda = 1$, $W = 140$, $R^B = 1.08$, R^M between 1 and 1.075; $f(I) = a\log(I) + I$ with $a = 3.5$, $g(K) = \theta\log(K)$ with $\theta = 140$. These parameters are used throughout the slides, with $C(L) = 0.5cL^2$, $c = 0.02$.

Model with Actuarially Fair Pre-committed Liquidity

Back

- At time 0, less public intervention L and therefore money M to alleviate the distortion on money creation via I vs E, charge L back at $t = 2$
  - Banks save (1 + fire-sale costs) from public liquidity intervention $\implies$ a central bank that breaks even is not enough to restore efficient outcomes



Note: Same parameters as the baseline model without central banks, with $C(L) = 0.5cL^2$, $c = 0.02$.

Bank Franchise Value in the Model

Back

- Bank profit:

$$\max_{\phi} \underbrace{pf(I) + (1-p)\lambda I - R^B I}_{\text{time-0 real investment}} + \underbrace{mI(R^B - R^M)}_{\text{money spread}} + \underbrace{[-pr^E \psi I + (1-p)\psi I]}_{\text{private insurance}}$$
$$+ \underbrace{[-p\tau\phi I + (1-p)\phi I]}_{\text{CB Liquiditry}} - (1-p)\underbrace{(\frac{1}{k} - 1)[mIR^M - \psi I - \phi I]}_{\text{loss from fire sales}}$$

- In private equilibrium: money spread = total fire-sale losses, private insurance premium = fire-sale savings $\implies$ no franchise value
- With underpriced public intervention ($\tau < \frac{1-p}{p}\frac{1}{k}$), bank franchise value is

$$\underbrace{[(1-p)(\frac{1}{k}) - p\tau]}_{\text{degree of underpricing}} \quad \underbrace{L}_{\text{size of intervention}}$$

Modern Motivation: Rising Financial Speculation

Back

- How do the model's insights on the distortive effects of public intervention on money creation inform our understanding of the modern financial system?
  - Not only overinvestment in real technology, but also financial speculation
- The bond basis trade (long Treasuries with leverage, short futures) has raised major financial stability concerns
  - A key factor in the bond market turmoil in March 2020 (Duffie, 2020; Schrimpft et al, 2020; Barth and Kahn, 2021; etc.), followed by Fed's $1T intervention in Treasuries (Vissing-Jorgensen, 2021)
  - Kashyap et al. (2025) advocate for a more targeted policy response by the Fed

According to the Composite Index for the Euro Area, several other recent episodes of financial speculation have also raised financial stability concerns due to fire sales triggered by margin calls. Notable examples include the €100M trading losses from Einar Aas borne by Nasdaq and its clearing house members in September 2018, the collapse of Archegos Capital Management in April 2021, and the liability-driven investment (LDI) crisis involving UK pension funds in September 2022.

Financial Speculation

Back

Assets

- Real investments I
- Speculation: pays $1 + ls$ per dollar invested (leverage l chosen)
  - At time 1 in crisis state: margin calls $v(l)$ per dollar invested
  - Must be financed by at least a fraction $\bar{m}$ in money

Liabilities

- Money M (gross rate R^M)
  - Can be issued to finance either real investment or financial speculation
  - At $t = 1$ in crisis state: must repay depositors
- Illiquid bonds (pay R^B at $t = 2$)

- Consider the case where speculation is more profitable than an R^B storage technology, even after accounting for margin calls
- Total liquidity demand during crises = money liabilities + margin calls
  - Financed by fire sale of real investments and private contingent capital (and possibly public liquidity)

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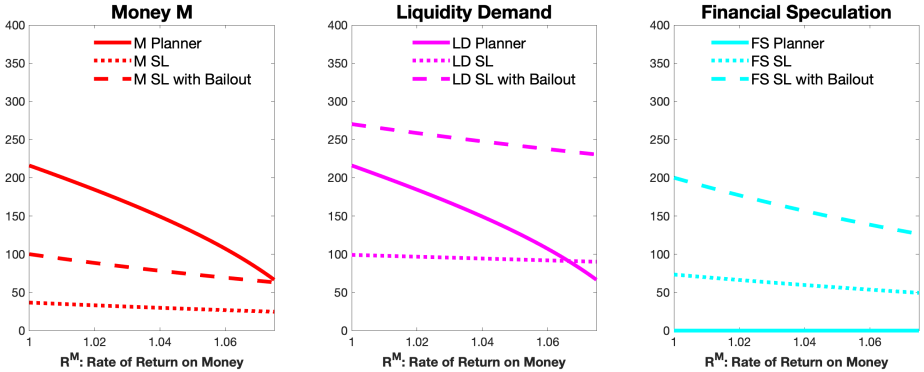
Model with Bailout Central Bank and Financial Speculation

Back

- Institutional liquidity demand through financial speculation (margin calls) crowds out individual deposit demand (with a convenience yield)
  - LOLR also induces more financial speculation than the private outcome
  - Consistent with rising financial speculations post-QE



Note: Same parameters as the baseline model, and we choose $s = 0.01$, $\bar{m} = 0.5$, $v(l) = 0.002l^2 + 0.001l$. These parameters give reasonable levels of speculation returns (net return of 0.1-0.13) and leverage (l is around 20-26; the size of the margin call, $v(l)$, is around 0.8-1.3).

Private Investor's Problem with Limited Commitment

Back

- The PI must set aside E in a liquid storage technology $h(\cdot)$ (e.g. $h(E) = E$) instead of investing E in g in the good state – effectively an enforcement cost

$$\max_{M,E} p\left[g(W-E) + \underbrace{h(E)}_{\text{liquid storage}} + \underbrace{r^E E}_{\text{insurance premium}}\right] + (1-p)\left[g(W-M) + \underbrace{\frac{1}{k}(M-E)}_{\text{Fire-sale purchases}}\right]$$

FOCs:

PI FOCs

- At time 1 in the crisis state: MB of g investment = MB of fire-sale purchases
- At time 0: MB (premium) of contingent capital
  = **Enforcement costs (in good state)** + MB of fire-sale purchases in crises

Private Investor's FOCs under Limited Commitment

Back

- At time 1 in the crisis state:

$$\underbrace{g'(W-M)}_{\text{MB of g investment}} = \underbrace{\frac{1}{k}}_{\text{MB of fire-sale purchases}}$$

- At time 0:

$$\underbrace{pr^E}_{\text{MB of Insurance}} = \underbrace{p(g'(W-E)-h'(E))}_{\text{Enforcement Costs in good state}} + \underbrace{(1-p)\frac{1}{k}}_{\text{MB of fire-sale / g inv in crisis state}}$$

Equilibrium Characterization with Limited Commitment

Back

- The money creation constraint now binds:
  - Bank equates MB and MC from buying contingent capital (CC):

    Premium for CC = Bank's fire-sale savings + Shadow cost of constraint

  - PIs equates MB and MC from selling CC:

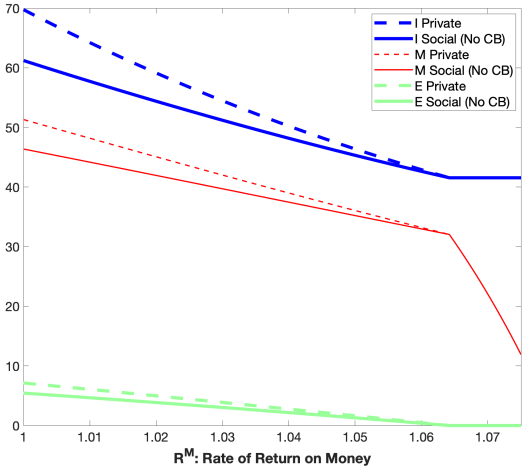
    Premium for CC = PI's forgone fire-sale gains + Private enforcement cost

  - When constraint binds: banks will want to issue CC until shadow cost of constraint = private enforcement cost
  - Private shadow cost of constraint $>$ planner's shadow cost of constraint $\implies$ over-insurance
- With limited enforcement, constraint binds $\implies$ overcreation of money and overinvestment, which resembles Stein (2012)

Model with Limited Commitment and no LOLR

Back

- Without LOLR: over-investment, over-creation of money (as in Stein, 2012), hence too much private insurance without a LOLR

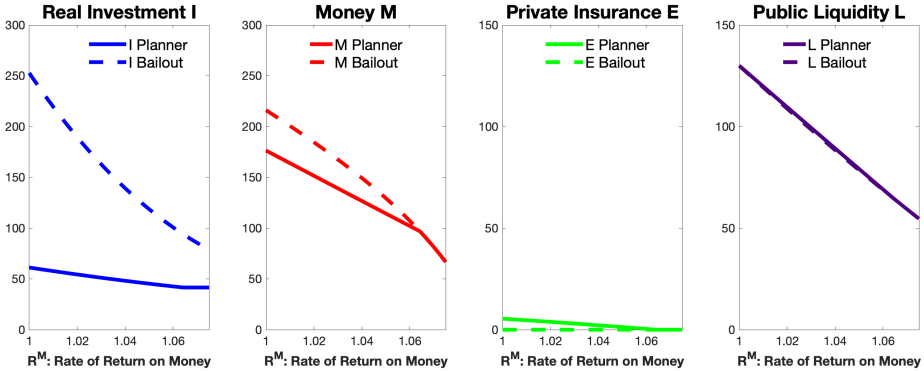


Note: Same parameters as the baseline model without central banks, with $h(E) = E$.

Model with Limited Commitment and Bailout Central Bank

Back

- Private frictions reduce E, but CB continues to crowding out of private contingent capital and make them under-provided

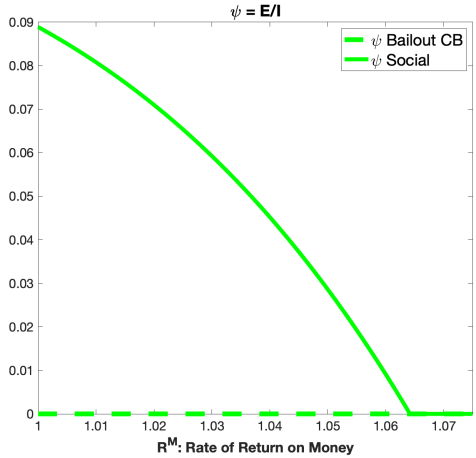


Note: Same parameters as the baseline model without central banks, with $h(E) = E$.

Model with Limited Commitment and Bailout Central Bank

Back

- E may appear to be small, but E/I is reasonably high under planner's choice yet 0 under a bailout central bank



Note: Same parameters as the baseline model without central banks, with $h(E) = E$.