Wholesale Banking Panics and Monetary Policy

Fengfan Xiang

University of Western Ontario

May 15, 2024

Financial Instability & Wholesale Banking Panics

- Concern with financial instability has been around for a long time, and there have been various regulatory and policy responses to it
  (Handbook chapters: Gertler and Kiyotaki, 2011; Gertler, Kiyotaki and Prestipino, 2016)

  1. Regulation and supervision of financial institutions — Basel III
  2. Fiscal policy — loans, subsidies, transfers
  3. Monetary policy — central bank's balance sheet policies *(Greenwood, Hanson and Stein, 2016; Woodford, 2016)*

- I focus on the instability in the form of wholesale banking panics *(Bernanke, 2010, 2018)*
  - Prime funds: money market funds that invest in high-quality and short-term securities
    - $400B withdrawal in September 2008 (2% of U.S. GDP)
    - $100B withdrawal in March 2020

Wholesale Banks

Financial intermediaries operate outside of the regulated banking system (BIS)

- Example: institutional money market funds, hedge funds

Unlike regulated retail banks, wholesale banks:

- Highly leveraged
- No safeguard such as deposit insurance & no access to central bank reserves
- Serve for large institutional investors rather than individual businesses and consumers

This paper: How can monetary policy impact

- the severity of wholesale banking panics?
- the efficient use of financial assets and economic welfare?

Two-sector Banking Model

- Retail banks: leverage constraint, reserves, no risk
- Wholesale banks: no leverage constraint, no reserves, risk of banking failure
- Retail and wholesale banks hold collateral (e.g., central bank reserves) to intermediate

Exogenous random failure of wholesale banks can generate a panic

- Wholesale bank depositors execute large-scale withdrawals (flee to safe government bonds)
  - Make withdrawal decision before they know which banks will fail
- Due to this endogenous withdrawal response, policies could have different implications
  - Affecting the effective supply of assets, which depends on the amount of economic agents use them

Main Results

Expanding central bank balance sheet mitigates wholesale banking panics (fewer withdrawals)

- Crowding-out effect: scarcity of bonds $\Longrightarrow$ increases price $\Longrightarrow$ lowers return on bonds
- Collateral supply channel: an increase in collateral supply $\Longrightarrow$ more attractive bank deposits

A large central bank balance sheet, despite mitigates banking panics, is inefficient

- Crowding-out effect: bond holders earn a lower return
- As withdrawal falls, collateral per depositor decreases $\Longrightarrow$ depositors get a lower return

Alternative policy: overnight reverse repurchase agreement

- Improves efficiency: collateral supply channel + NO crowding-out effect

Environment

Exchange Economy with Banking

- Three periods $t = 1, 2, 3$ — no time discount between periods
  - Centralized exchange in period 1
  - Random matching and bilateral exchange in period 2
  - Centralized meeting with payoffs on debts in period 3

- Three sets of private agents: consume (c) goods and supply labor (h)
  1. Measure one of depositors: $-h_1 + u(c_2) - h_3$, where $-c\frac{u''(c)}{u'(c)} < 1$
  2. Measure one of risk-neutral producers: $-h_2 + c_3$
  3. Infinite measure of risk-neutral banks self-select to be retail or wholesale bank: $c_1 - h_1 + c_3 - h_3$
     - Linear production technology: all agents can covert labor to goods one-for-one

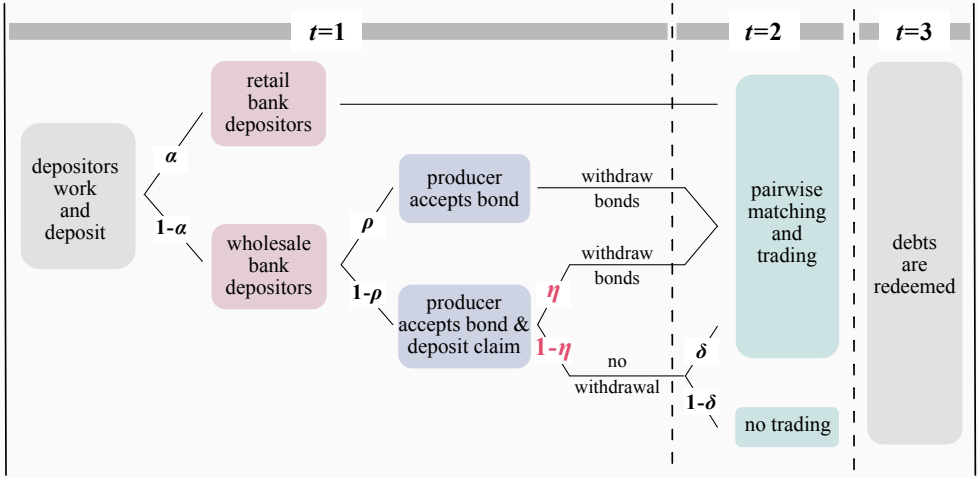
Trading Friction & Banking Technology

- Limited commitment $\Longrightarrow$ no unsecured credit $\Longrightarrow$ period 2 exchanges supported by assets
- Banks have access to collateral technology to secure their tradeable deposit claims

Underlying assets

- Central bank reserves: restricted to retail banks only (segmented market)
  - Later: overnight reverse repurchase agreement (retail & wholesale banks)
- Government bonds: everyone, including depositors, can hold them (provide greater liquidity)

Timing



▸ retail and wholesale deposits ▸ wholesale banking panic

Fiscal Authority & Central Bank

- No government debt outstanding at the beginning of period 1
  - Fiscal authority issues government bonds ($\hat{b}$) and transfer revenue (τ_1) to depositors: $\hat{b} = \tau_1$
  - Central bank purchases $\hat{b} - \bar{b}$ with reserves $\bar{m}$: $\bar{m} = \hat{b} - \bar{b}$
- Government liabilities are redeemed in period 3
  - Fiscal authority taxes depositors τ_3, pays off debt, transfers τ^{cb} to central bank: $r^b \hat{b} + \tau^{cb} = \tau_3$
  - Central bank pays off its debt: $r^m \bar{m} = r^b(\hat{b} - \bar{b}) + \tau^{cb}$

Fiscal policy: fix the total government bonds supply $\hat{b} = \bar{m} + \bar{b}$

Monetary policy: determine the size of the central bank's balance sheet, described by $\bar{m}$

▸ central bank balance sheet ▸ consolidated government

Banking

Retail Bank

Maximize profits, choosing

1. Deposit contract: required deposits (k^r), tradeable deposit claims (d^r)
2. Financial portfolio: reserves (m), government bonds (b^r), interbank borrowing (ℓ^r)

Balance sheet

Asset	Liability & Equity
m	d^r
b^r	ℓ^r
	e ▸ sweat equity

- Competitive retail banks maximize depositors' utility, subject to ▸ retail bank's problem
  - Nonnegative profit constraint
  - Leverage constraint ($0 < \theta < 1$): $\theta(r^m m + r^b b^r) \geq d^r + r^\ell \ell^r$
  - Nonnegative constraints

Wholesale Bank

Maximize profits, choosing

1. Deposit contract: k^w, quantity of bonds if withdrawal (b'), and d^w
2. Financial portfolio: government bonds (b^w), interbank lending (ℓ^w)

Balance sheet

Asset	Liability
b^w	$[\rho + (1-\rho)\eta]b'$
ℓ^w	$(1-\rho)(1-\eta)d^w$

- Adjusted by endogenous withdrawal response η
  - η is a choice of depositors – the probability of withdrawal (mixed strategy)
- No leverage requirement $\implies$ no bank capital

Wholesale Bank's Problem

Perfectly competitive banking (infinite mass of potential entrants & free entry)

- Maximize their depositors' expected utility, considering potential banking panic η

$$\underbrace{-k^w}_{\text{deposits}} + \underbrace{[\rho + (1-\rho)\eta]u(r^b b') + (1-\rho)(1-\eta)\delta u(d^w)}_{\text{expected return on deposit contract}}$$

- Subject to
  - Nonnegative profits:

$$\underbrace{k^w - (1-\rho)(1-\eta)\delta d^w}_{\text{profits from deposit contract}} \underbrace{-b^w - \ell^w + r^b\left[b^w - [\rho + (1-\rho)\eta]b'\right] + r^\ell \ell^w}_{\text{profits from portfolio decision}} \geq 0$$

  - Collateral constraint:

$$\underbrace{r^b\left[b^w - [\rho + (1-\rho)\eta]b'\right] + r^\ell \ell^w}_{\text{returns on assets}} \geq \underbrace{(1-\rho)(1-\eta)d^w}_{\text{payments on liabilities}}$$

  - Nonnegative constraints: $k^w, b', d^w, b^w, b^w - [\rho + (1-\rho)\eta]b' \geq 0$

- Probability $1-\delta$, banks experience a collapse in collateral technology $\implies$ insolvency

Will wholesale bank depositors withdraw their funds?

Withdrawal: get b' units of government bonds with gross interest rate of r^b

No withdrawal: get a tradeable claim to d^r units of consumption good with probability δ

- No banking panic ($\eta = 0$) if $u(r^b b') \leq \delta u\left(d^w\right)$
- Partial banking panic ($0 < \eta < 1$) if $u(r^b b') = \delta u\left(d^w\right)$
- Full Banking panic ($\eta = 1$) if $u(r^b b') \geq \delta u\left(d^w\right)$

▸ definition of equilbrium

Equilibrium

No Bank Holds Government Bonds as Collateral

Assumption 1

Assume the total supply of government bonds is scarce such that $\theta\hat{b} < \alpha c^\star$, where $u'(c^\star) = 1$.

- Retail bank's leverage and wholesale bank's collateral constraints bind
  - Otherwise, depositors consume a satiated level $c^\star$ and monetary policy becomes neutral
  - Low return on safe assets, particularly, government bonds

Lemma 1

Retail banks never invest in government bonds.

- Wholesale banks value bonds more because they are not subject to leverage requirement

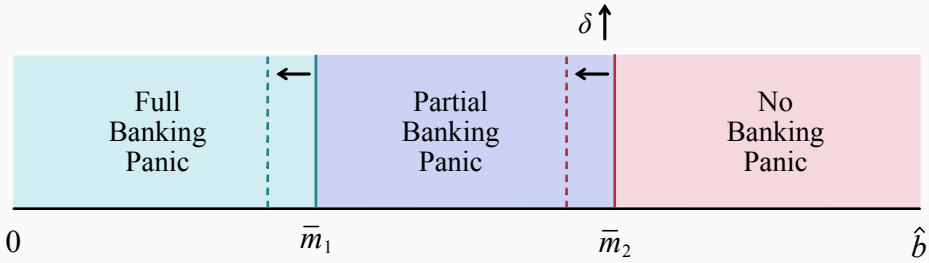
▸ intuition

Lemma 2

Wholesale banks only purchase government bonds for their depositors' withdrawal requests.

- Wholesale bank depositors directly use government bonds in exchange to avoid risk

How Monetary Policy Determines the Type of Equilibrium



- Two thresholds $\bar{m}_1$ and $\bar{m}_2$ characterize three types of equilibrium
- Expanding the size of the central bank's balance sheet mitigates banking panic
- These thresholds increase with the risk of wholesale banking failure $1 - \delta$

Aggregate Collateral Constraint

▸ ON-RRP

$$\underbrace{\theta \bar{m}}_{\text{effective collateral supply (i.e., reserves)}} = \underbrace{\alpha c_s^r \left[1 - \theta + \theta u'\left(c_s^r\right)\right]}_{\text{retail banks' demand for collateral}}$$

$$+ \underbrace{(1-\alpha)(1-\rho)(1-\eta) c_s^w \left[1 - \theta\delta + \theta\delta u'\left(c_s^w\right)\right]}_{\text{wholesale banks' demand for collateral}}$$

- Marginal utilities of trading assets determine interest rates (consumption-based asset pricing)
  - e.g. $\frac{1}{r^{\bar{m}}} = 1 - \theta + \theta u'(c_s^r)$, marginal utility of trading with deposit claims, which backed by reserves
- Expanding central bank balance sheet ($\bar{m}$) increases the effective collateral supply
  - Reserves back retail (directly) and wholesale (indirectly, through interbank market) banks' liabilities
- Demand for collateral adjusted by endogenous withdrawal response η.

Bond Market Clearing Condition

$$\underbrace{\hat{b} - \bar{m}}_{\text{bonds circulating in private sector, } \bar{b}} = \underbrace{(1-\alpha)[\rho + (1-\rho)\eta]c_s^b u'(c_s^b)}_{\text{wholesale bank depositors' demand for bonds to settle transactions}}$$

- Expanding size of central bank's balance sheet crowds out government debt
  - As they become scarce, return on government bonds decreases
- Demand for government bonds adjusted by endogenous withdrawal response η.

▸ No-arbitrage Condition

Partial Panic Equilibrium ($0 < \eta < 1$): Effects of Monetary Policy

Condition supports a partial panic equilibrium with $0 < \eta < 1$: $u(c_s^b) = \delta u(c_s^w)$

- Panicky depositors are indifferent between withdrawing and holding on

Expanding the size of the central bank's balance sheet has three effects

- Increases effective collateral supply $\implies$ lower η (withdrawal probability)
- Crowds out government bonds $\implies$ lower η

$\implies$ Large-scale withdrawal response: wholesale bank depositors switch to deposit claims

Partial Panic Equilibrium: Comparative Statics

	∂c_s^r	∂c_s^w	∂c_s^b	$\partial \eta$	∂r^m	∂r^ℓ	∂r^b
$\partial \bar{m}$	$-$	$-$	$-$	$-$	$-$	$-$	$-$

- Crowding-out effect: reduce the trading volume for depositors trade with bond (lower c_s^b)
- Withdrawal response > collateral supply channel:
  reduce the trading volume for depositors who trade with deposit claims (lower c_s^r & c_s^w)
  - Too many depositors switch to deposit claims
  - Collateral per depositor decreases despite an increase in the aggregate collateral supply
  - Example: $\frac{1 \text{ reserves}}{1 \text{ depositors}} \to \frac{2 \text{ reserves}}{3 \text{ depositors}}$

No Banking Panic ($\eta = 0$) & Full Banking Panic ($\eta = 1$)

	∂c_s^r	∂c_s^w	∂c_s^b	∂r^m	∂r^ℓ	∂r^b
$\partial \bar{m}$	$+$	$+$	$-$	$+$	$+$	$-$

No change in withdrawal response given η constant (endogenously determined)

- Different effects compared to the case studied before
- Similar results can be obtained in a model with NO endogenous withdrawal response

Expanding the size of the central bank's balance sheet has two effects

- Crowding-out effect: reduce transactions settled with government bonds
- Effective collateral supply: increase transactions settled with deposit claims

Giving Wholesale Banks Access to Central Bank Liabilities

Overnight Reverse Repo Facility

Expanding the central bank's balance sheet can be **harmful**

- Too many withdrawals because of the crowding-out and collateral supply effects

Add a new central bank liability: overnight reverse repo (ON-RRP) facility (o)

- Both retail and wholesale banks can hold this interest-bearing central bank liability
- Monetary policy has two dimensions ▸ central bank balance sheet
  - Size of its balance sheet $s = \bar{m} + \bar{o}$
  - Composition of its liabilities (relative supply of reserves and ON-RRPs)

Increasing the supply of ON-RRPs mitigates wholesale banking panic and **improves welfare**

- Increase the effective collateral supply by avoiding retail bank's regulatory costs
- No crowding-out effect $\Longrightarrow$ not that many withdrawals

Substitute Reserves with ON-RRPs

▸ balance sheet

Effective collateral supply (determined by $\bar{o}$ for any s):

$$\theta \times \underbrace{\bar{m}}_{\text{reserve supply}} + \underbrace{\bar{o}}_{\text{ON-RRP supply}} = \theta \times \underbrace{s}_{\text{size of central bank balance sheet}} + (1-\theta)\,\bar{o}$$

- An increase in $\bar{o}$ increases effective collateral supply

▸ aggregate collateral constraint

  - By avoiding "balance sheet costs" from the retail bank's leverage constraint

No crowding-out effect:

$$\underbrace{\hat{b} - s}_{\text{bonds circulating in private sector}} = \underbrace{(1-\alpha)[\rho + (1-\rho)\eta]c_s^b u'(c_s^b)}_{\text{wholesale bank depositors' demand for bonds to settle transactions}}$$

- Only depend on the size of the central bank's balance sheet (s)

ON-RRP: Comparative Statics

	∂c_s^r	∂c_s^w	∂c_s^b	$\partial \eta$	∂r^m	∂r^ℓ	∂r^b
$\partial \bar{o}$	$+$	$+$	$+$	$-$	$+$	$+$	$+$

- Collateral supply channel > withdrawal response (in the absence of crowding-out effect): increase transactions settled with deposit claims
  - Not that many depositors switch to deposit claims
  - Collateral per depositor increases
- Withdrawal response: increase transactions settled with government bonds
  - Each depositor obtains more bonds for transaction with fewer withdrawals ($\eta \downarrow$)

Conclusions

- Expanding the central bank balance sheet mitigates wholesale banking panics
  - However, it can be harmful in the presence of the endogenous withdrawal response

- Giving wholesale banks direct access to central bank liabilities improves welfare
  - Increases effective collateral supply by avoiding regulatory costs $\Longrightarrow$ mitigates banking panics
  - Does not crowd out government bonds $\Longrightarrow$ improves the efficient asset allocation

Appendix

Retail & Wholesale Deposits

Retail bank depositors (fraction α, exogenous)

- Retail bank's deposit claims are safe and always a valid means of payment

Wholesale bank depositors (fraction $1 - \alpha$)
(Large institutional investors use government bonds in transactions)

- Wholesale bank's deposit claims are less liquid
  - Wholesale depositors can use bank claims for transactions with probability $1 - \rho$
  - Must withdraw and use government bonds for transactions with probability ρ
- Wholesale bank's deposit claims are less safe

back

Wholesale Banking Panic

- An exogenous fraction $1 - \delta$ of wholesale banks will become insolvent in period 2
  - Insolvent banks default on their liabilities *(Gertler and Kiyotaki, 2015; Williamson, 2022)*
  - Producers will not accept deposit claims issued by an insolvent bank
- Depositors make their withdrawal decision with imperfect information in period 1
  - Don't know which banks will fail
  - Panicky depositors can trade with bank claims but choose to withdraw bonds
- Panicky depositors choose to withdraw bonds with an endogenous probability η

Wholesale banking panic: a fraction $\eta > 0$ of panicky depositors withdraw bonds

back

Central Bank's Balance Sheet

Baseline case

Asset	Liability
$\hat{b} - \bar{b}$	$\bar{m}$

- Central bank purchases $\hat{b} - \bar{b}$ to back its reserves $\bar{m}$

Add ON-RRPs

Asset	Liability & Equity
$\hat{b} - \bar{b}$	$\bar{m}$
	$\bar{o}$

- Central bank purchases $\hat{b} - \bar{b}$ to back reserves $\bar{m}$ and ON-RRPs $\bar{o}$

back back ON-RRPs

Consolidated Government Budget Constraints

- Period 1: $\underbrace{\bar{m}}_{\text{reserve supply}} + \underbrace{\bar{b}}_{\text{government bond supply}} = \underbrace{\tau_1}_{\text{lump-sum transfer to depositors}}$
- Period 3: $\underbrace{r^m \bar{m} + r^b \bar{b}}_{\text{repayment for debt from period 1}} = \underbrace{\tau_3}_{\text{lump-sum tax to depositors}}$

Fiscal policy: fix the supply of the consolidated government liabilities $\hat{b} = \bar{m} + \bar{b}$

- $\bar{m}$ and $\bar{b}$ are reserves and bonds circulating in the private sector

Monetary policy: determine determines the size of the central bank's balance sheet ($\bar{m}$)

- hold $\hat{b} - \bar{b}$ to back its liabilities

back

"Sweat Equity"

Retail banks finance part of their assets by supplying their own capital (e)

- A result of the leverage requirement: liability-to-asset ratio cannot exceed $\theta < 1$
  - capital = $(1-\theta)$asset when the leverage constraint binds, i.e., $\frac{\text{liability}}{\text{asset}} = \theta$
- "Sweat equity": costly (as a source of internal funding, requires banks to work)

back

Retail Bank's Problem

Perfectly competitive banking (infinite mass of potential entrants & free entry)

- Retail banks maximize depositors' utility:

$$-k^r + u(d^r)$$

- Subject to
  - Nonnegative profit:

$$\underbrace{k^r - d^r}_{\text{profits from deposit contract}} \qquad \underbrace{-m - b^r + \ell^r + r^m m + r^b b^r - r^\ell \ell^r}_{\text{profits from portfolio decision}} \geq 0$$

  - Leverage constraint: $\theta \underbrace{(r^m m + r^b b^r)}_{\text{returns on assets}} \geq \underbrace{d^r + r^\ell \ell^r}_{\text{payments on liabilities}}$
  - Nonnegative constraints: $k^r, d^r, m, b^r \geq 0$

back

Equilibrium

- Solve banks' problems
  - Satisfying conditions for banking panic to determine η

- Market clearing conditions
  - Reserve market: $\alpha m = \bar{m}$
  - Government bond market: $\alpha b^r + (1-\alpha)\, b^w = \bar{b}$
  - Interbank market: $\alpha \ell^r = (1-\alpha)\, \ell^w$

back

Retail Banks Never Invest in Government Bonds: Intuition

Retail Bank

Asset	Liability & Equity
m	d^r
~~b^r~~	ℓ^r
	e

Wholesale Bank

Asset	Liability
b^w	$[\rho + (1-\rho)\eta]b'$
ℓ^w	$(1-\rho)(1-\eta)d^w$

- Retail banks invest in a positive stock of government bonds only if $r^b > r^\ell$
  - The strict inequality comes from their costs of holding assets because of the leverage requirement
- Wholesale banks ask a higher return on loans than bonds, i.e., $r^\ell \geq r^b$
  - Government bonds provide a greater liquidity, which are always available to them
- Contradiction $\Longrightarrow$ retail banks never invest in bonds

back

No-arbitrage Condition

No-arbitrage condition:

$$\underbrace{u'\left(c_s^r\right)}_{\text{return on retail bank's deposit claims}} = \underbrace{1-\delta+\delta u'\left(c_s^w\right)}_{\text{return on wholesale bank's deposit claims}}$$

- Equating returns from exchanging with retail and wholesale banks' deposit claims ‣ intuition

‣ back

No-arbitrage Condition: Inituition

Retail Bank

Asset	Liability & Equity
m	d^r
	ℓ^r
	e

Wholesale Bank

Asset	Liability
b^w	$[\rho + (1-\rho)\eta]b'$
ℓ^w	$(1-\rho)(1-\eta)d^w$

- On the liability side of the retail bank

  return rate on retail deposits $=$ return rate on interbank borrowing

- Wholesale banks use claims on interbank lending back deposit claims

  return rate on interbank lending $=$ return rate on wholesale deposits adjusted by risk

back

Private Banks' Balance Sheets with ON-RRP

Retail Bank

Asset	Liability
m	d^r
	ℓ^r
	e

Wholesale Bank

Asset	Liability
b^w	$[\rho + (1-\rho)\eta]b'$
ℓ^w	$(1-\rho)(1-\eta)d^w$
o	

back