How Central Banks Should Use Their Balance Sheets to Control Flight-to-Safety

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- Large shifts in *asset demand* during financial crises (historically, regulated banking sector)

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  (BIS and Financial Stability Board: e.g., money market funds, hedge funds)
  - Held $63 trillion in 2020, representing 79% of global GDP (S&P Global)

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  - Held $63 trillion in 2020, representing 79% of global GDP (S&P Global)
- Wholesale Banking Panics: several flight-to-safety events in the last decades
  - September 2008: $400B withdrawal (2% of U.S. GDP); March 2020: $100B withdrawal

This Paper

Implications of wholesale banking panics for *central bank balance sheet policies*

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- Expansions through open market operations involve purchasing Treasury bills
  - Lower T-bill returns $\longrightarrow$ reduce investors' flight-to-safety incentive
  - **General asset return reduction** through endogenous shifts in asset demand
    - Mitigate flight-to-safety $\longrightarrow$ increase demand for bank liabilities, bidding down returns

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Endogenous shifts in asset demand can lead to unintended policy implications!

- **Decreased asset returns** hinder transactions, e.g., repo transactions involving T-bills

Model

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3. Infinite measure of bankers self-select to operate retail or wholesale banks:

$$c_1^B - h_1^B + c_3^B - h_3^B$$

work in $t = 1$ to raise (sweat) equity and in $t = 3$ to pay debts; consume profits

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- Government: fiscal authority and central bank

Trading Frictions Give Rise to Demand for Assets

- Exchanges are essential because goods are **perishable**
  - Depositors trade *bilaterally* with producers in period 2 (take-it-or-leave-it offer)
- **Limited commitment** $\longrightarrow$ no unsecured IOU $\longrightarrow$ exchanges are supported by assets
  - Depositors and banks trade goods and assets in a *Walrasian market* in period 1

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Underlying Assets (scarce in aggregate)

- Government bonds ($\hat{b}$): everyone can hold them
- Central bank reserves ($\bar{m}$): restricted to retail banks only ▸ details
  - Central bank purchase $\hat{b} - \bar{b}$ government bonds (assets) with $\bar{m}$ reserves (liabilities)
  - The rest of the bonds circulate in the private sector

Banking & Risk of Wholesale Banking Failure

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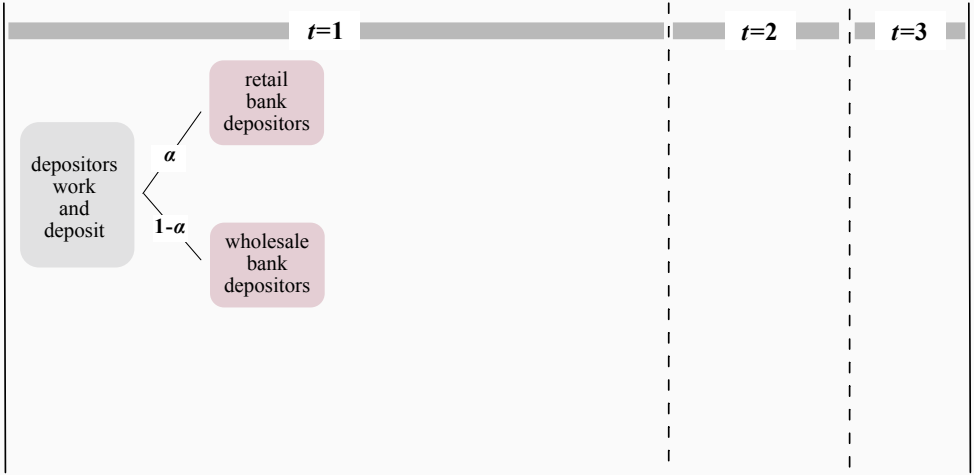
Risk of Banking Failure Sparks Wholesale Banking Panics (Gertler and Kiyotaki, 2015)

- Depositors decide whether to withdraw in period 1 under imperfect information
  - Withdraw with exogenous prob. ρ to meet liquidity needs
  - Withdraw with **endogenous** prob. η due to safety concerns (panicking depositors)
    - Panicking depositors flee to bonds, capturing the severity of panics

Timing


t=1
t=2
t=3
depositors work and deposit
α
1-α
retail bank depositors
wholesale bank depositors

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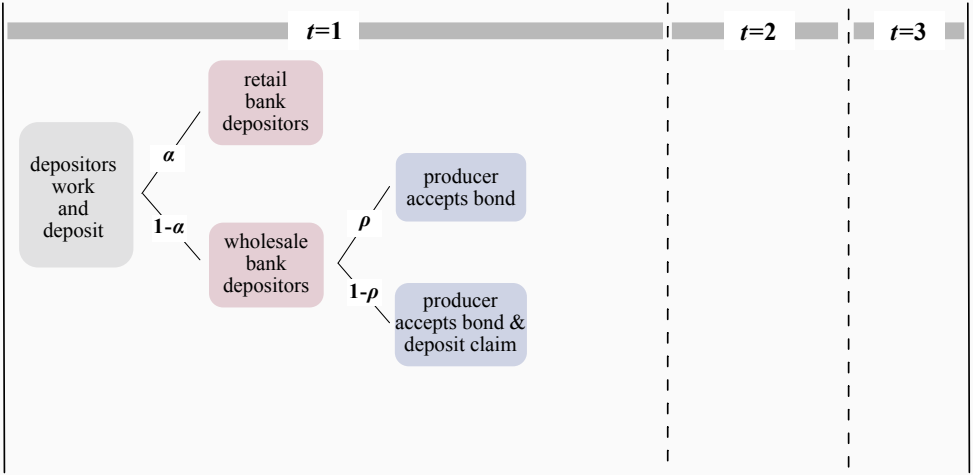
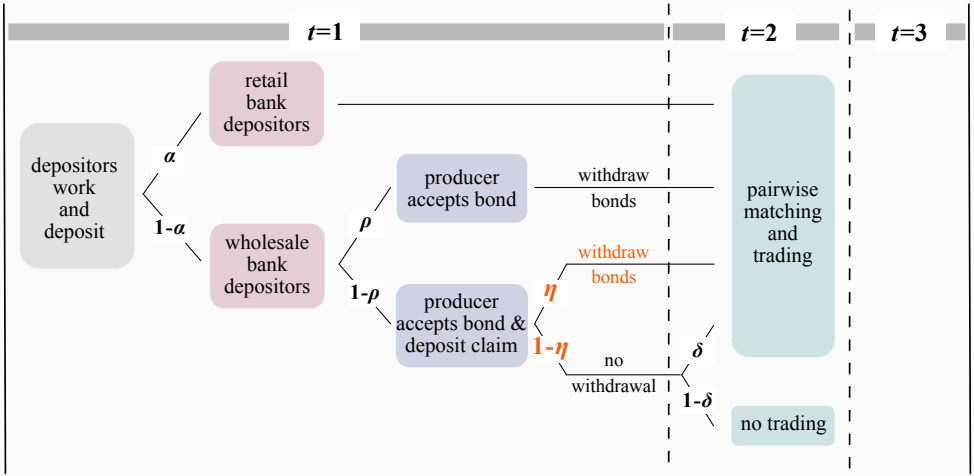

t=1
t=2
t=3
depositors work and deposit
α
1-α
retail bank depositors
wholesale bank depositors
ρ
1-ρ
producer accepts bond
producer accepts bond & deposit claim

Timing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depositors work and deposit
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retail bank depositors
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1-ρ
producer accepts bond
producer accepts bond & deposit claim
withdraw bonds
withdraw bonds
η
1-η
no withdrawal
δ
1-δ
pairwise matching and trading
no trading

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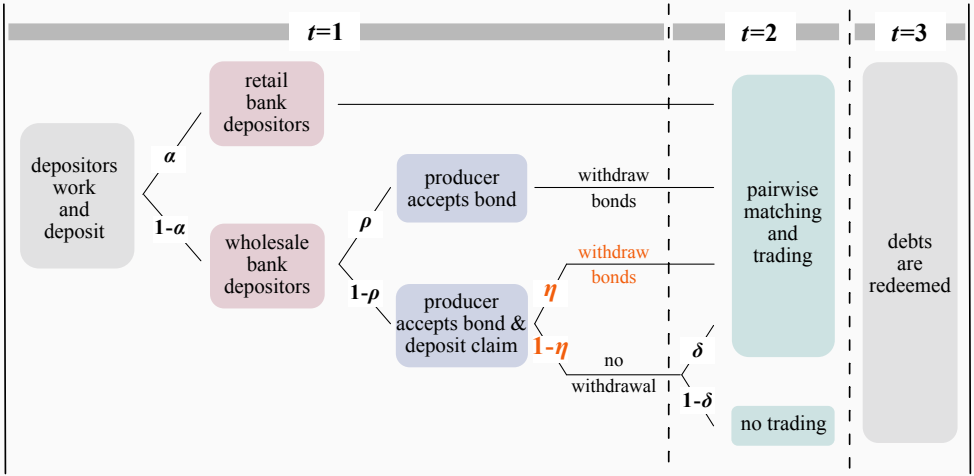
t=1
t=2
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depositors work and deposit
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1-α
retail bank depositors
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producer accepts bond
producer accepts bond & deposit claim
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withdraw bonds
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pairwise matching and trading
no trading
debts are redeemed

Retail Bank

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

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Subject to a leverage constraint (collateral constraint holds automatically)

- A fraction θ of their return on assets should cover their payments on liabilities
- Finance $1-\theta$ of their assets with bank capital (sweat equity) $\longrightarrow$ balance sheet cost

Asset	Liability & Equity
$r^m m$	d^r
$r^b b^r$	$r^\ell \ell^r$
	e ‣ equity

Wholesale Bank

1. Deposit contract: k^w, quantity of bonds if withdrawal (b'), and d^w
   - ρ depositors must trade with bonds (liquidity needs in settling wholesale payments)
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Subject to a collateral constraint (no leverage requirement $\longrightarrow$ no bank capital)

Asset	Liability	
$r^b b^w$	$r^b[\rho + (1-\rho)\eta]b'$	$\longrightarrow$ *withdraw*
$r^\ell \ell^w$	$(1-\rho)(1-\eta)d^w$	$\longrightarrow$ *not withdraw*

- Endogenous withdrawal probability η adjusts the composition bank liabilities

Will wholesale bank depositors withdraw their funds?

Wholesale bank depositors' ex ante expected utility

$$\underbrace{-k^w}_{\text{deposits}} + \underbrace{[\rho + (1-\rho)\eta]u(r^b b') + (1-\rho)(1-\eta)[\delta u(d^w) + (1-\delta)u(0)]}_{\text{expected return on deposit contract}}$$

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(i) No banking panic: $\eta = 0$, if $u\left(r^b b'\right) \leq \delta u(d^w) + (1-\delta)u(0)$;

(ii) Partial banking panic: $0 < \eta < 1$, if $u\left(r^b b'\right) = \delta u(d^w) + (1-\delta)u(0)$;

(iii) Full banking panic: $\eta = 1$, if $u\left(r^b b'\right) \geq \delta u(d^w) + (1-\delta)u(0)$.

Perfectly Competitive Wholesale Banking

▸ retail bank's problem

- Maximize depositors' expected utility (infinite mass of potential entrants & free entry)

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Subject to

- Nonnegative profit:

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

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

Equilibrium

No Bank Holds Government Bonds as Collateral

scarcity of collateral

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Asset	Liability & Equity
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Lemma 1 *Retail banks never hold government bonds*

▸ intuition

- Wholesale banks value bonds more as they are not subject to leverage requirements

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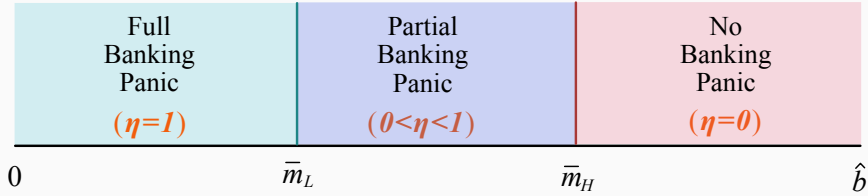
Lemma 2 *Wholesale banks only purchase government bonds for depositors' withdrawal requests*

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

Central Bank Balance Sheet and Wholesale Banking Panics



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(constant η in full/partial panic)

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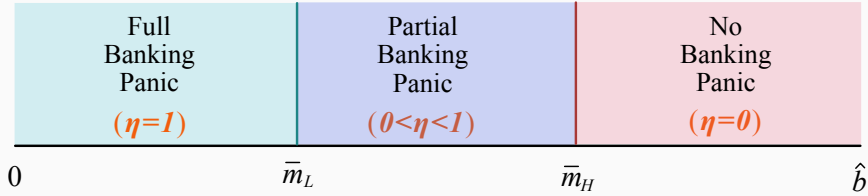

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Main Result

An expansion of the central bank's balance sheet **mitigates wholesale banking panics** but **lowers asset returns and impedes transactions**.

▸ no/full panic

Equilibrium Conditions under Partial Banking Panic $u(c_2^b) = \delta u(c_2^w)$

No-arbitrage Interbank Market (equate marginal returns from trading with retail/wholesale deposits)

$$u'\left(c_2^r\right) = 1 - \delta + \delta u'\left(c_2^w\right)$$

Collateral Market Clearing

▸ details

$$\underbrace{\theta \bar{m}}_{\text{effective collateral supply (i.e., reserves)}} = \underbrace{\alpha c_2^r \left[1 - \theta + \theta u'\left(c_2^r\right)\right]}_{\text{retail banks' demand for collateral}} + \underbrace{(1-\alpha)(1-\rho)(1-\eta) c_2^w \left[1 - \theta\delta + \theta\delta u'\left(c_2^w\right)\right]}_{\text{wholesale banks' demand for collateral}}$$

Bond Market Clearing

$$\underbrace{\hat{b} - \bar{m}}_{\text{bonds circulating in private sector, } \bar{b}} = \underbrace{(1-\alpha)[\rho + (1-\rho)\eta] c_2^b u'(c_2^b)}_{\text{wholesale bank depositors' demand for bonds}}$$

Mitigation of Wholesale Banking Panics

A central bank balance sheet expansion has three effects (open market operations)

1. Government bond supply $\downarrow \longrightarrow$ interest rate on government bonds $\downarrow$ (price $\uparrow$)
2. Reserve supply $\uparrow \longrightarrow$ relax banks' constraints $\longrightarrow \uparrow$ pressure on deposit returns
   - Directly relax retail banks' leverage constraint
   - Indirectly relax wholesale banks' collateral constraint through the interbank market

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$\rightarrow$ 3. Deposits become more attractive relative to bonds $\longrightarrow$ withdrawal probability $\eta \downarrow$

Reduction in Asset Returns & Trading Surplus

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Reduction in Asset Returns & Trading Surplus: Government Bonds

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An expansion in the size of the central bank's balance sheet ($\bar{m} \uparrow$ and $\bar{b} \downarrow$)

- Harms depositors trading with **government bonds**
  - Lower interest rate on government bonds ($\frac{\partial r^b}{\partial \bar{m}} < 0$)
  - Lower trading volume for transactions settled with government bonds ($\frac{\partial c_2^b}{\partial \bar{m}} < 0$)

Reduction in Asset Returns & Trading Surplus: Wholesale Deposits

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- Harms depositors trading with **wholesale deposits**
  - Lower trading volume for transactions settled with wholesale deposits ($\frac{\partial c_2^w}{\partial \bar{m}} < 0$)
  - Intensify banks' competition for collateral ($\frac{\partial r^\ell}{\partial \bar{m}} < 0$ and $\frac{\partial r^m}{\partial \bar{m}} < 0$)

Reduction in Asset Returns & Trading Surplus: Retail Deposits

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An expansion in the size of the central bank's balance sheet ($\bar{m} \uparrow$ and $\bar{b} \downarrow$)

- Harms depositors trading with bonds & wholesale deposits: lower r^b, c_2^b; c_2^w, r^ℓ, r^m
- Harms depositors trading with **retail deposits**
  - Retail banks substitute their funding source to cheaper interbank borrowing
  - Reduce the supply of retail deposits (no shift in demand for retail deposits)
    - Lower trading volume for transactions settled with retail deposits ($\frac{\partial c_2^r}{\partial \bar{m}} < 0$)

Expanding the Reach of Central Bank Liabilities to Wholesale Banks

Giving Wholesale Banks Direct Aceess to Central Bank Liabilities

- Introduce central bank liabilities (o) that both retail and wholesale banks can hold
  - Example: Fed's overnight reverse repurchase agreements (ON-RRPs)

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  - Size of its balance sheet $s = \bar{m} + \bar{o}$ (same results as before)
  - Composition of reserves ($\bar{m}$) and ON-RRPs ($\bar{o}$)

▸ central bank balance sheet

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▸ central bank balance sheet

Main Result

A swap of reserves ($\bar{m}$) for ON-RRPs ($\bar{o}$) **mitigates banking panics** and **increases asset returns and promotes transactions**

Mitigation of Wholesale Banking Panics

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

▸ collateral market clearing

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

- A swap increases effective collateral supply by avoiding retail banks' regulatory costs
- Wholesale banks provide more attractive deposits to compete for depositors:

$\longrightarrow$ Mitigating wholesale banking panics (withdrawal probability $\eta \downarrow$)

Moderate Shifts in Asset Demand

- A swap of reserves for ON-RRPs does not take out government bonds

$$\underbrace{\hat{b} - s}_{\text{bonds circulating in private sector, } \bar{b}} = \underbrace{(1-\alpha)[\rho + (1-\rho)\eta]c_2^b u'(c_2^b)}_{\text{wholesale bank depositors' demand for bonds}}$$

  - No direct pressure that makes bonds less attractive $\longrightarrow$ moderate change in η
  - **Opposite effects** on asset returns and transactions

By contrast, central bank balance sheet expansions impede transactions because

Large change in withdrawals η $\longleftrightarrow$ Large shifts in demand for assets

- Two direct effects: increased collateral supply + decreased government bond supply

Increase in Asset Returns & Trading Surplus

Retail Bank

Asset	Liability
$r^m m$	d^r
	$r^\ell \ell^r$
	e

Wholesale Bank

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

Increase in Asset Returns & Trading Surplus: Government Bonds

Retail Bank

Asset	Liability
$r^m m$	d^r
	$r^\ell \ell^r$
	e

Wholesale Bank

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

A swap of reserves for ON-RRPs ($\bar{m} \downarrow$ and $\bar{o} \uparrow$)

- Benefits depositors trading with **government bonds** (no shift in bond supply)
  - Higher interest rate on government bonds ($\frac{\partial r^b}{\partial \bar{m}} > 0$)
  - Higher trading volume for transactions settled with government bonds ($\frac{\partial c_2^b}{\partial \bar{m}} > 0$)

Increase in Asset Returns & Trading Surplus: Wholesale Deposits

Retail Bank

Asset	Liability
$r^m m \downarrow$	d^r
	$r^\ell \ell^r \downarrow$
	e

Wholesale Bank

Asset	Liability
$r^b b^w$	$r^b[\rho + (1-\rho)\eta]b'$
$r^\ell \ell^w \downarrow$	$(1-\rho)(1-\eta \downarrow)d^w \uparrow$
$r^o o \uparrow$	

A swap of reserves for ON-RRPs ($\bar{m} \downarrow$ and $\bar{o} \uparrow$)

- Benefits depositors trading with government bonds: higher r^b, c_2^b
- Benefits depositors trading with **wholesale deposits**
  - Higher trading volume for transactions settled with wholesale deposits ($\frac{\partial c_2^w}{\partial \bar{o}} > 0$)
  - Reduce banks' competition for collateral ($\frac{\partial r^\ell}{\partial \bar{o}} > 0$ and $\frac{\partial r^m}{\partial \bar{o}} > 0$)

Increase in Asset Returns & Trading Surplus: Retail Deposits

Retail Bank

Asset	Liability
$r^m m \downarrow$	$d^r \uparrow$
	$r^\ell \ell^r \downarrow$
	e

Wholesale Bank

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

A swap of reserves for ON-RRPs ($\bar{m} \downarrow$ and $\bar{o} \uparrow$)

- Benefits depositors trading with bonds & wholesale deposits: higher r^b, c_2^b; c_2^w, r^ℓ, r^m
- Benefits depositors trading with **retail deposits**
  - Retail banks substitute their funding source to cheaper deposits
  - Increased supply of retail banks' deposit claims (no shift in demand for these claims)
    - Higher trading volume for transactions settled with these claims ($\frac{\partial c_2^r}{\partial \bar{o}} > 0$)

Conclusions

- Two-sector banking model with flight-to-safety driven by wholesale banking panics
- Endogenous shifts in asset demand in response to central bank crisis interventions
- Expanding the balance sheet mitigates banking panics but impedes transactions
  - Differ from scenarios when there is no shift in asset demands (no/full banking panic)

Swapping reserves for ON-RRPs mitigates panics and facilitates transactions

- *Moderate shifts in asset demands*: Swap of central bank liabilities does not take out government bonds, putting no direct pressure that makes bonds less attractive

Appendix

Related Literature

1. Monetary model with financial instability: Williamson (2019) + Gertler and Kiyotaki (2015)
   - Diamond-Dybvig type:
     Robatto(2017,2014), Andolfatto, Berentsen, Martin (2020), Gu, Monnet, Nosal, and Wright (2023)
   - **Wholesale bank run** in the absence of sequential service constraints:
     Gertler, Kiyotaki, and Prestipino (2016), Andolfatto and Nosal (2020), Huang and Keister (2024)
2. Central bank balance sheet and the role of central bank liabilities in financial stability
   - Reserves and ON-RRPs: Carlson, Duygan-Bump, Natalucci, Greenwood, Hanson, and Stein (2016), Nelson, Ochoa, Stein, and Van den Heuvel (2016), Bush, Kirk, Martin, Weed, and Zobel (2019)
3. Policy implications for *short-term funding markets*
   - Gorton and Metrick (2012), Martin, Skeie, and Thadden (2014), Arrata, Nguyen, Rahmouni-Rousseau, and Vari (2020)

Endogenous shifts in asset demand can lead to unintended policy implications!

Fiscal Authority & Central Bank

back

- **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 $\bar{m}$:

central bank balance sheet

$$\bar{m} = \hat{b} - \bar{b}$$

- 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: determine the total government bonds supply $\hat{b} = \bar{m} + \bar{b}$ (exogenous, fixed)

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

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 $\bar{m}$

After introducing ON-RRPs

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

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

back back ON-RRPs

Perfectly Competitive Retail Banking

- Maximize depositors' utility (infinite mass of potential entrants & free entry):

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

Subject to

- Nonnegative profit:

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

- Leverage constraint:

$$\theta \overbrace{(r^m m + r^b b^r)}^{\text{returns on assets}} \geq \underbrace{d^r + r^\ell \ell^r}_{\text{payments on liabilities}}$$

- Nonnegative constraints: $k^r, d^r, m, b^r \geq 0$

back

Sweat Equity

Retail banks finance part of their assets by supplying their own capital

- Nonnegative profit constraint holds in equality due to free entry, implying

$$\underbrace{m + b^r - k^r - \ell^r}_{\text{equity raised at } t=1} = \underbrace{r^m m + r^b - d^r - r^\ell \ell^r}_{\text{equity return at } t=3} \equiv e$$

  - Leverage requirement further implies a positive equity holdings ($e > 0$), recall

$$\overbrace{\theta\left(r^m m + r^b b^r\right)}^{\text{returns on assets}} \geq \underbrace{d^r + r^\ell \ell^r}_{\text{payments on liabilities}}$$

- "Sweat equity" requires banks to work $\longrightarrow$ costly internal funding source

back

Retail Banks Never Invest in Government Bonds: Intuition

Retail Bank

Asset	Liability & Equity
$r^m m$	d^r
~~b^r~~	$r^\ell \ell^r$
	e

Wholesale Bank

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

- Retail banks invest in a positive stock of government bonds only if $r^b > r^\ell$
  - Strict inequality comes from their costs of holding assets due to leverage requirements
- 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 Banking Panic ($\eta = 0$) & Full Banking Panic ($\eta = 1$)

	∂c_2^r	∂c_2^w	∂c_2^b	∂r^m	∂r^ℓ	∂r^b
$\partial \bar{m}$	$+$	$+$	$-$	$+$	$+$	$-$

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

- government bond supply $\downarrow$: reduce transactions settled with government bonds
- effective collateral supply $\uparrow$: increase transactions settled with deposit claims

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

- Different effects compared to the baseline case back
- Central bank cannot improve welfare (in Pareto sense) by adjusting its balance sheet size

Scarcity of Total Government Bond Supply

Assumption 1

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

back

Characterization of Equilibrium

Express conditions on consumption allocation (c_2^r, c_2^b, c_2^w) and withdrawal probability η

$$c_2^r = d^r, \quad c_2^b = r^b b', \quad c_2^w = d^w$$

Depositors' consumption level reflects the overall total trading surplus/welfare
(competitive producers and bankers earn zero profit)

- No-arbitrage interbank market
- Collateral market clearing
- Bond market clearing
- One of depositors' incentive conditions to determine η
  (no banking panic $\eta = 0$, partial banking panic $0 < \eta < 1$, and full banking panic $\eta = 1$)

Equilibrium Conditions

No-arbitrage Interbank Market:

$$\underbrace{u'\left(c_2^r\right)}_{\text{marginal return on retail bank's deposit claims}} = \underbrace{1-\delta+\delta u'\left(c_2^w\right)}_{\text{marginal return on wholesale bank's deposit claims}}$$

- Equate depositors' marginal returns from trading with retail and wholesale deposits
  - intuition
- Marginal returns determine interest rates (consumption-based asset pricing)
  - e.g., $\frac{1}{r^\ell} = u'(c_2^r)$, marginal utility of trading retail deposits

Equilibrium Conditions

No-arbitrage Interbank Market:

$$u'\left(c_2^r\right) = 1 - \delta + \delta u'\left(c_2^w\right)$$

Collateral Market Clearing:

▸ ON-RRP

$$\underbrace{\theta \bar{m}}_{\text{effective collateral supply (i.e., reserves)}} = \underbrace{\alpha c_2^r \left[1 - \theta + \theta u'\left(c_2^r\right)\right]}_{\text{retail banks' demand for collateral}}$$

$$+ \underbrace{(1-\alpha)(1-\rho)(1-\eta) c_2^w \left[1 - \theta\delta + \theta\delta u'\left(c_2^w\right)\right]}_{\text{wholesale banks' demand for collateral}}$$

- Expanding central bank balance sheet ($\bar{m}$) increases the effective collateral supply
- The severity of wholesale banking panics η determines the demand for collateral
  - By mitigating banking panics, policy shifts this demand **upward**

Equilibrium Conditions

No-arbitrage Interbank Market:

$$u'\left(c_2^r\right) = 1 - \delta + \delta u'\left(c_2^w\right)$$

Collateral Market Clearing:

$$\begin{aligned}\theta\bar{m} =& \alpha c_2^r\left[1 - \theta + \theta u'\left(c_2^r\right)\right] \\ &+ (1-\alpha)(1-\rho)(1-\eta)\, c_2^w\left[1 - \theta\delta + \theta\delta u'\left(c_2^w\right)\right]\end{aligned}$$

Bond Market Clearing:

$$\underbrace{\hat{b} - \bar{m}}_{\text{bonds circulating in private sector, } \bar{b}} = \underbrace{(1-\alpha)[\rho + (1-\rho)\eta]c_2^b u'(c_2^b)}_{\text{wholesale bank depositors' demand for bonds}}$$

- Expanding central banks balance sheet reduce the supply of government bonds
- The severity of banking panics η determines the aggregate demand for bonds
  - By mitigating banking panics, policy shifts this demand **downward**

back

No-arbitrage Condition: Inituition

Retail Bank

Asset	Liability & Equity
$r^m m$	d^r
	$r^\ell \ell^r$
	e

Wholesale Bank

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

- 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