Secured Wholesale Debt, Funding Stability and Moral Hazard

Tijmen R. Daniëls†  Philipp J. Koenig∗

†De Nederlandsche Bank NV, ∗Deutsche Bundesbank

University of Economics – Prague
April 4, 2019

Disclaimer: The views expressed in this presentation are those of the authors. No responsibility for them should be attributed to the De Nederlandsche Bank, Deutsche Bundesbank or to the Eurosystem.
Chart 1
Covered bonds, outstanding in Europe
(EUR billions)

Chart 2
Average daily turnover in secured and unsecured cash lending
(Index: 2002 = 100)
Motivation

Chart 1 Cumulative quarterly turnover in the euro money market (EUR trillion)

Note: The panel comprised 98 credit institutions.

Chart 2 Breakdown, by segment, of cumulative quarterly turnover in the euro money market (percentages of total)

Note: The panel comprised 98 credit institutions.
Motivation

Chart 3 Cumulative quarterly turnover in various money market segments
(index: total segment volume in 2003 = 100)

Note: The panel comprised 98 credit institutions.
Chart 5 Maturity breakdown for various money market segments in 2014
((percentages of total)

Chart 6 Maturity breakdown for various money market segments in 2015
((percentages of total)

Note: The panel comprised 149 credit institutions.
Financial stability aspects of secured bank funding

- Reduce funding risk (+)
- Less access to unsecured funding (–)
- Less monitoring (–)
- Risk shifting to deposit guarantee schemes (–)
- (Less scope for bail in (–))

Main questions:
1. Does secured funding improve funding stability and under what conditions?
2. Can secured funding create moral hazard and under what conditions?
Financial stability aspects of secured bank funding

- Reduce funding risk (+)
- Less access to unsecured funding (−)
- Less monitoring (−)
- Risk shifting to deposit guarantee schemes (−)
- (Less scope for bail in (−))

Main questions:

1. Does secured funding improve funding stability and under what conditions?
2. Can secured funding create moral hazard and under what conditions?
Financial stability aspects of secured bank funding

- Reduce funding risk (+)
- Less access to unsecured funding (−)
- Less monitoring (−)
- Risk shifting to deposit guarantee schemes (−)
- (Less scope for bail in (−))

Main questions:
1. Does secured funding improve funding stability and under what conditions?
2. Can secured funding create moral hazard and under what conditions?
This presentation

What we do

• Stylized model of unsecured and secured bank funding.

• Funding risk modelled as coordination risk.

Main results

• **Catalytic Effect**: Secured debt issuance reduces funding risk → bank refinancing becomes easier

• **Crowding-in vs Crowding-Out**: Issuance of secured funding may lead to more / less unsecured funding (crowding-in / -out) compared to situation with only unsecured debt.

• **Inefficiencies**: Unsecured lending can induce inefficient liquidations, secured lending can induce inefficient investment (moral hazard / risk-shifting).

• **Tiering**: Stronger banks tend to issue unsecured, weaker banks tend to issue secured debt.
What we do

- Stylized model of unsecured and secured bank funding.
- Funding risk modelled as coordination risk.

Main results

- **Catalytic Effect**: Secured debt issuance reduces funding risk → bank refinancing becomes easier

- **Crowding-in vs Crowding-Out**: Issuance of secured funding may lead to more / less unsecured funding (crowding-in / -out) compared to situation with only unsecured debt.

- **Inefficiencies**: Unsecured lending can induce inefficient liquidations, secured lending can induce inefficient investment (moral hazard / risk-shifting).

- **Tiering**: Stronger banks tend to issue unsecured, weaker banks tend to issue secured debt.
This presentation

What we do

• Stylized model of unsecured and secured bank funding.

• Funding risk modelled as coordination risk.

Main results

• Catalytic Effect: Secured debt issuance reduces funding risk → bank refinancing becomes easier

• Crowding-in vs Crowding-Out: Issuance of secured funding may lead to more / less unsecured funding (crowding-in / -out) compared to situation with only unsecured debt.

• Inefficiencies: Unsecured lending can induce inefficient liquidations, secured lending can induce inefficient investment (moral hazard / risk-shifting).

• Tiering: Stronger banks tend to issue unsecured, weaker banks tend to issue secured debt.
This presentation

What we do

- Stylized model of unsecured and secured bank funding.
- Funding risk modelled as coordination risk.

Main results

- **Catalytic Effect**: Secured debt issuance reduces funding risk → bank refinancing becomes easier
- **Crowding-in vs Crowding-Out**: Issuance of secured funding may lead to more / less unsecured funding (crowding-in / -out) compared to situation with only unsecured debt.
- **Inefficiencies**: Unsecured lending can induce inefficient liquidations, secured lending can induce inefficient investment (moral hazard / risk-shifting).
- **Tiering**: Stronger banks tend to issue unsecured, weaker banks tend to issue secured debt.
What we do

- Stylized model of unsecured and secured bank funding.
- Funding risk modelled as coordination risk.

Main results

- **Catalytic Effect**: Secured debt issuance reduces funding risk → bank refinancing becomes easier

- **Crowding-in vs Crowding-Out**: Issuance of secured funding may lead to more / less unsecured funding (crowding-in / -out) compared to situation with only unsecured debt.

- **Inefficiencies**: Unsecured lending can induce inefficient liquidations, secured lending can induce inefficient investment (moral hazard / risk-shifting).

- **Tiering**: Stronger banks tend to issue unsecured, weaker banks tend to issue secured debt.
What we do

- Stylized model of unsecured and secured bank funding.
- Funding risk modelled as coordination risk.

Main results

- **Catalytic Effect**: Secured debt issuance reduces funding risk → bank refinancing becomes easier

- **Crowding-in vs Crowding-Out**: Issuance of secured funding may lead to more / less unsecured funding (crowding-in / -out) compared to situation with only unsecured debt.

- **Inefficiencies**: Unsecured lending can induce inefficient liquidations, secured lending can induce inefficient investment (moral hazard / risk-shifting).

- **Tiering**: Stronger banks tend to issue unsecured, weaker banks tend to issue secured debt.
What we do

- Stylized model of unsecured and secured bank funding.
- Funding risk modelled as coordination risk.

Main results

- **Catalytic Effect**: Secured debt issuance reduces funding risk → bank refinancing becomes easier

- **Crowding-in vs Crowding-Out**: Issuance of secured funding may lead to more / less unsecured funding (crowding-in / -out) compared to situation with only unsecured debt.

- **Inefficiencies**: Unsecured lending can induce inefficient liquidations, secured lending can induce inefficient investment (moral hazard / risk-shifting).

- **Tiering**: Stronger banks tend to issue unsecured, weaker banks tend to issue secured debt.
Outline of Presentation

1. Model Overview
2. Monotone Equilibrium without Collateral
3. ... with Collateral
4. Properties of Equilibrium
Setting

• Two dates, \( t \in \{0, 1\} \).

• Limited liable bank with legacy asset funded by retail deposits and wholesale debt.

• **Maturity mismatch:** Asset matures at \( t = 1 \), wholesale debt refinanced at \( t = 0 \).

• Bank balance sheet at \( t = 0 \):

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>securities: 1</td>
<td>retail deposits: ( 1 - \alpha )</td>
</tr>
<tr>
<td>wholesale debt: ( \alpha )</td>
<td></td>
</tr>
<tr>
<td>total assets: 1</td>
<td>total liabilities: 1</td>
</tr>
</tbody>
</table>
Setting

- Two dates, $t \in \{0, 1\}$.
- Limited liable bank with legacy asset funded by retail deposits and wholesale debt.
- **Maturity mismatch:** Asset matures at $t = 1$, wholesale debt refinanced at $t = 0$.
- Bank balance sheet at $t = 0$:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>securities: 1</td>
<td>retail deposits: $1 - \alpha$</td>
</tr>
<tr>
<td>wholesale debt: $\alpha$</td>
<td></td>
</tr>
<tr>
<td>total assets: 1</td>
<td>total liabilities: 1</td>
</tr>
</tbody>
</table>
Setting

- Two dates, \( t \in \{0, 1\} \).
- Limited liable bank with legacy asset funded by retail deposits and wholesale debt.
- **Maturity mismatch:** Asset matures at \( t = 1 \), wholesale debt refinanced at \( t = 0 \).
- Bank balance sheet at \( t = 0 \):

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>securities: 1</td>
<td>retail deposits: 1 - ( \alpha )</td>
</tr>
<tr>
<td>total assets: 1</td>
<td>wholesale debt: ( \alpha )</td>
</tr>
<tr>
<td></td>
<td>total liabilities: 1</td>
</tr>
</tbody>
</table>
Bank Liabilities

- Retail deposits insured at (normalized) rate of 0, face value $D$ (risk-free rate).

- Retail deposits automatically rolled over until $t = 1$.

- Wholesale debt uninsured, refinanced at $t = 1$ at prevailing market rates.

- Face value of wholesale debt $D_k$, $k \in \{u, s\}$:
  - if **unsecured**: $D_u > D$.
  - if **secured**, $\beta \in [0, 1] =$ degree of collateralization (share of $D_s$ secured by collateral):
    $$D_s = D_s(\beta) \in [D, D_u]$$
    - Assumptions: $D_s'(\beta) < 0$, $D_s(0) = D_u$, $D_s(1) = D$. 


Wholesale Market and Bank Failure

- Wholesale market consists of measure $m$ of identical small risk-neutral financiers.

- Wholesale market sufficiently large: $m > \alpha$.

- Bank fails at $t = 0$ if and only if

  $$\lambda m < \alpha$$

  where $\lambda \in [0, 1]$ denotes share of financiers willing to invest with the bank.
Bank Asset

- Bank asset indivisible: if bank fails at $t = 0$, asset liquidated for $L \leq 1$.

- If bank refinance and continues until $t = 1$, asset yields stochastic return

\[
\tilde{X} = \begin{cases} 
X_g & \text{with probability } \theta \\
X_b & \text{else}
\end{cases}
\]

- Solvency probability $\theta$ drawn from continuous p.d.f. with support $[0, 1]$ at $t = 0$.

- Assumptions: $X_g > D_u > LD > X_b$

- Keeping the asset until $t = 1$ is efficient if and only if

\[
\theta > \theta^{\text{eff}} \equiv \frac{LD - X_b}{X_g - X_b}
\]
Bank Asset

• Bank asset indivisible: if bank fails at $t = 0$, asset liquidated for $L \leq 1$.

• If bank refines and continues until $t = 1$, asset yields stochastic return

$$\tilde{X} = \begin{cases} X_g & \text{with probability } \theta \\ X_b & \text{else} \end{cases}$$

• Solvency probability $\theta$ drawn from continuous p.d.f. with support $[0, 1]$ at $t = 0$.

• Assumptions: $X_g > D_u > LD > X_b$

• Keeping the asset until $t = 1$ is efficient if and only if

$$\theta > \theta^{\text{eff}} \equiv \frac{LD - X_b}{X_g - X_b}$$
Bank Moral Hazard

- At start of $t = 0$, only bank observes $\theta$, and can decide to liquidate or continue.

- If bank continues, assumptions imply default in state $b$ and no default in state $g$.

- Due to limited liability, bank strictly prefers to continue for all $\theta > 0$.

- Reduced form for risk-shifting and moral hazard *vis-à-vis* deposit insurance.
Debt and Deposit Seniority

- Retail deposits are senior over unsecured wholesale debt.

- Secured wholesale financier has exclusive recourse to collateral $\beta D_s$.

- Encumbering assets to secure wholesale debt circumvents seniority of deposits.
  $\rightarrow$ Issuance of secured debt exerts externality on deposit insurer.

- We emphasize this by assuming: $\alpha < \min \left\{ \frac{X_b}{\max_{\{\beta\}} \{\beta D_s(\beta)\}}, 1 - \frac{X_b}{D} \right\}$
Financiers’ Investment Problem

• Suppose bank issues only unsecured debt at market rates $D_u > D$.

• Typical financier $i$ faces the following strategic situation:

<table>
<thead>
<tr>
<th>Financier $i$</th>
<th>Other financiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>do not lend</td>
<td>do not lend</td>
</tr>
<tr>
<td>$D$</td>
<td>$D$</td>
</tr>
<tr>
<td>lend unsecured</td>
<td>0</td>
</tr>
<tr>
<td>$\theta D_u$</td>
<td></td>
</tr>
</tbody>
</table>

• $\theta$ common knowledge among financiers: **multiple equilibria** for $\theta > \frac{D}{D_u}$.

• Eliminating multiplicity via global game: Financiers observe private signal

\[ \theta_i = \theta + \sigma \epsilon_i \]

where $\sigma \geq 0$ and $\epsilon_i$ i.i.d. with mean zero and bounded support.

• Focus on monotone symmetric strategies: financier $i$ lends iff $\theta_i \geq \theta^*$. 
Financiers’ Investment Problem

- Suppose bank issues only unsecured debt at market rates $D_u > D$.

- Typical financier $i$ faces the following strategic situation:

<table>
<thead>
<tr>
<th>Financier $i$</th>
<th>Other financiers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>do not lend</td>
<td>lend unsecured</td>
</tr>
<tr>
<td>do not lend</td>
<td>$D$</td>
<td>$D$</td>
</tr>
<tr>
<td>lend unsecured</td>
<td>0</td>
<td>$\theta D_u$</td>
</tr>
</tbody>
</table>

- $\theta$ common knowledge among financiers: multiple equilibria for $\theta > \frac{D}{D_u}$.

- Eliminating multiplicity via global game: Financiers observe private signal

\[ \theta_i = \theta + \sigma \epsilon_i \]

where $\sigma \geq 0$ and $\epsilon_i$ i.i.d. with mean zero and bounded support.

- Focus on monotone symmetric strategies: financier $i$ lends iff $\theta_i \geq \theta^*$. 
Financiers’ Investment Problem

- Suppose bank issues only unsecured debt at market rates $D_u > D$.

- Typical financier $i$ faces the following strategic situation:

<table>
<thead>
<tr>
<th>Financier $i$</th>
<th>Other financiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>do not lend</td>
<td>do not lend: $D$</td>
</tr>
<tr>
<td></td>
<td>lend unsecured: $D$</td>
</tr>
<tr>
<td>lend unsecured</td>
<td>do not lend: 0</td>
</tr>
<tr>
<td></td>
<td>lend unsecured: $\theta D_u$</td>
</tr>
</tbody>
</table>

- $\theta$ common knowledge among financiers: **multiple equilibria** for $\theta > \frac{D}{D_u}$.

- Eliminating multiplicity via global game: Financiers observe private signal

$$\theta_i = \theta + \sigma \epsilon_i$$

where $\sigma \geq 0$ and $\epsilon_i$ i.i.d. with mean zero and bounded support.

- Focus on monotone symmetric strategies: financier $i$ lends iff $\theta_i \geq \theta^*$. 
Financiers’ Investment Problem

- Suppose bank issues only unsecured debt at market rates $D_u > D$.

- Typical financier $i$ faces the following strategic situation:

\[
\begin{array}{c|cc}
\text{Financier } i & \text{do not lend} & \text{lend unsecured} \\
\text{Other financiers} & D & D \\
\hline
\text{do not lend} & D & D \\
\text{lend unsecured} & 0 & \theta D_u \\
\end{array}
\]

- $\theta$ common knowledge among financiers: multiple equilibria for $\theta > \frac{D}{D_u}$.

- Eliminating multiplicity via global game: Financiers observe private signal

\[\theta_i = \theta + \sigma \epsilon_i\]

where $\sigma \geq 0$ and $\epsilon_i$ i.i.d. with mean zero and bounded support.

- Focus on monotone symmetric strategies: financier $i$ lends iff $\theta_i \geq \theta^*$.
Monotone Equilibrium

- Given joint threshold $\theta^*$, bank fails iff $\theta < \hat{\theta}(\theta^*)$ since, by LLN,

$$\lambda < \frac{\alpha}{m} \iff P(\theta_i > \theta^* | \hat{\theta}) < \frac{\alpha}{m}$$

- Focus on global game solution for $\sigma \to 0$. In this case:

$$P(\theta_i > \theta^* | \hat{\theta}) = P(\theta \leq \hat{\theta} | \theta^*) = \frac{\alpha}{m}$$

- Financiers' threshold $\theta^*$ determined from indifference condition:

$$\left(1 - P(\theta \leq \hat{\theta} | \theta^*_u)\right) \times \theta^*_u \times D_u = D$$

$$\iff \left(1 - \frac{\alpha}{m}\right) \times \theta^*_u \times D_s = D$$

$$\iff \theta^*_u = \frac{D}{D_s} \times \frac{1}{1 - \frac{\alpha}{m}}$$
Monotone Equilibrium

• Given joint threshold $\theta^*$, bank fails iff $\theta < \hat{\theta}(\theta^*)$ since, by LLN,

$$\lambda < \frac{\alpha}{m} \iff P(\theta_i > \theta^* | \hat{\theta}) < \frac{\alpha}{m}$$

• Focus on global game solution for $\sigma \to 0$. In this case:

$$P(\theta_i > \theta^* | \hat{\theta}) = P(\theta \leq \hat{\theta} | \theta^*) = \frac{\alpha}{m}$$

• Financiers’ threshold $\theta^*$ determined from indifference condition:

$$(1 - P(\theta \leq \hat{\theta} | \theta_u^*)) \times \theta_u^* \times D_u = D$$

$$\iff \left(1 - \frac{\alpha}{m}\right) \times \theta_u^* \times D_s = D$$

$$\iff \theta_u^* = \frac{D}{D_s} \times \frac{1}{1 - \frac{\alpha}{m}}$$
Monotone Equilibrium

- Given joint threshold $\theta^*$, bank fails iff $\theta < \hat{\theta}(\theta^*)$ since, by LLN,

$$\lambda < \frac{\alpha}{m} \iff \mathbb{P}(\theta_i > \theta^* | \hat{\theta}) < \frac{\alpha}{m}$$

- Focus on global game solution for $\sigma \to 0$. In this case:

$$\mathbb{P}(\theta_i > \theta^* | \hat{\theta}) = \mathbb{P}(\theta \leq \hat{\theta} | \theta^*) = \frac{\alpha}{m}$$

- Financiers’ threshold $\theta^*$ determined from indifference condition:

$$\left(1 - \mathbb{P}(\theta \leq \hat{\theta} | \theta_u^*)\right) \times \theta_u^* \times D_u = D$$

$$\iff \left(1 - \frac{\alpha}{m}\right) \times \theta_u^* \times D_s = D$$

$$\iff \theta_u^* = \frac{D}{D_s} \times \frac{1}{1 - \frac{\alpha}{m}}$$
Monotone Equilibrium

- Given joint threshold $\theta^*$, bank fails iff $\theta < \hat{\theta}(\theta^*)$ since, by LLN,

$$\lambda < \frac{\alpha}{m} \iff \mathbb{P}(\theta_i > \theta^* | \hat{\theta}) < \frac{\alpha}{m}$$

- Focus on global game solution for $\sigma \to 0$. In this case:

$$\mathbb{P}(\theta_i > \theta^* | \hat{\theta}) = \mathbb{P}(\theta \leq \hat{\theta} | \theta^*) = \frac{\alpha}{m}$$

- Financiers’ threshold $\theta^*$ determined from indifference condition:

$$\left(1 - \mathbb{P}(\theta \leq \hat{\theta} | \theta^*_u)\right) \times \theta^*_u \times D_u = D$$

$$\iff \left(1 - \frac{\alpha}{m}\right) \times \theta^*_u \times D_s = D$$

$$\iff \theta^*_u = \frac{D}{D_s} \times \frac{1}{1 - \frac{\alpha}{m}}$$
Monotone Equilibrium

• Given joint threshold $\theta^*$, bank fails iff $\theta < \hat{\theta}(\theta^*)$ since, by LLN,

$$\lambda < \frac{\alpha}{m} \iff P(\theta_i > \theta^* | \hat{\theta}) < \frac{\alpha}{m}$$

• Focus on global game solution for $\sigma \to 0$. In this case:

$$P(\theta_i > \theta^* | \hat{\theta}) = P(\theta \leq \hat{\theta} | \theta^*) = \frac{\alpha}{m}$$

• Financiers’ threshold $\theta^*$ determined from indifference condition:

$$\left(1 - P(\theta \leq \hat{\theta} | \theta_u^*)\right) \times \theta_u^* \times D_u = D$$

$$\iff \left(1 - \frac{\alpha}{m}\right) \times \theta_u^* \times D_s = D$$

$$\iff \theta_u^* = \frac{D}{D_s \times \frac{1}{1 - \frac{\alpha}{m}}}$$
Model Overview

Monotone Equilibrium without Collateral

Properties of Equilibrium

\[ \theta^* \]

unsecured funding

no funding
Refinancing game with secured and unsecured debt

- Bank issues secured and unsecured claims at face values $D_s(\beta)$ and $D_u$.
- In case of default, secured financier has recourse to asset up to $\beta D_s(\beta)$.
- Secured funding externality: Secured debt issuance dilutes retail depositors.
- Retail depositors still senior to unsecured creditors.

<table>
<thead>
<tr>
<th>Creditor $i$</th>
<th>do not lend</th>
<th>lend secured</th>
<th>lend unsecured</th>
</tr>
</thead>
<tbody>
<tr>
<td>do not lend</td>
<td>$D$</td>
<td>$D$</td>
<td>$D$</td>
</tr>
<tr>
<td>lend secured</td>
<td>$\beta D_s$</td>
<td>$\theta_i D_s + (1 - \theta_i) \beta D_s$</td>
<td>$\theta_i D_s + (1 - \theta_i) \beta D_s$</td>
</tr>
<tr>
<td>lend unsecured</td>
<td>0</td>
<td>$\theta_i D_u$</td>
<td>$\theta_i D_u$</td>
</tr>
</tbody>
</table>
Refinancing game with secured and unsecured debt

- Bank issues secured and unsecured claims at face values $D_s(\beta)$ and $D_u$.

- In case of default, secured financier has recourse to asset up to $\beta D_s(\beta)$.

- Secured funding externality: Secured debt issuance dilutes retail depositors.

- Retail depositors still senior to unsecured creditors.

<table>
<thead>
<tr>
<th>Creditor $i$</th>
<th>do not lend</th>
<th>lend secured</th>
<th>lend unsecured</th>
</tr>
</thead>
<tbody>
<tr>
<td>do not lend</td>
<td>$D$</td>
<td>$D$</td>
<td>$D$</td>
</tr>
<tr>
<td>lend secured</td>
<td>$\beta D_s$</td>
<td>$\theta_i D_s + (1 - \theta_i) \beta D_s$</td>
<td>$\theta_i D_s + (1 - \theta_i) \beta D_s$</td>
</tr>
<tr>
<td>lend unsecured</td>
<td>0</td>
<td>$\theta_i D_u$</td>
<td>$\theta_i D_u$</td>
</tr>
</tbody>
</table>
Monotone equilibrium of three-action game:

- Note: actions are ordered

\[
\text{do not lend} \prec \text{lend secured} \prec \text{lend unsecured}
\]

- Basteck et al. (2013):
  Equilibrium of 3-action game by patching monotone equilibria of 2-action games.

- Switch from no to secured lending at $\theta_s^*(\beta)$.

- Switch from secured to unsecured lending at $\theta_{s,u}^*$. 
Montone Equilibrium

Monotone equilibrium of three-action game:

• Note: actions are ordered
  
  do not lend $\prec$ lend secured $\prec$ lend unsecured

• Basteck et al. (2013):
  
  Equilibrium of 3-action game by patching monotone equilibria of 2-action games.

  • Switch from no to secured lending at $\theta^*_s(\beta)$.

  • Switch from secured to unsecured lending at $\theta^*_{s,u}$.
Monotone equilibrium of three-action game:

- Note: actions are ordered
  
  \[ \text{do not lend} \prec \text{lend secured} \prec \text{lend unsecured} \]

- Basteck et al. (2013):
  Equilibrium of 3-action game by patching monotone equilibria of 2-action games.

- Switch from no to secured lending at \( \theta_s^*(\beta) \).

- Switch from secured to unsecured lending at \( \theta_{s,u}^* \).
Monotone equilibrium of three-action game:

- Note: actions are ordered
  
  do not lend $\prec$ lend secured $\prec$ lend unsecured

- Basteck et al. (2013):
  Equilibrium of 3-action game by patching monotone equilibria of 2-action games.

- Switch from no to secured lending at $\theta^*_s(\beta)$.

- Switch from secured to unsecured lending at $\theta^*_{s,u}$. 
Thresholds for binary action games

- Financier $i$ prefers secured over no lending if
  \[
  \theta_i \geq \theta_s^*(\beta) \equiv \frac{D - \beta D_s(\beta)}{(1 - \beta) D_s(\beta)} \times \frac{1}{1 - \frac{\alpha}{m}}
  \]

- For $\sigma \to 0$, financier $i$ prefers unsecured over secured lending if
  \[
  \theta_i \geq \theta_{s,u}^*(\beta) \equiv \frac{\beta D_s(\beta)}{D_u - (1 - \beta) D_s(\beta)}
  \]

- Tacitly assumed: *Catalytic effect of secured debt*, i.e. $\theta_s(\beta) < \theta_s^*(0) \equiv \theta_u^*$
  - Financiers do not switch directly from no to unsecured lending.
  - Secured debt reduces loss-given-default $\to$ raises incentives to lend ($\#$)
  - Secured debt has lower face value $\to$ lowers incentives to lend ($\#\#$).
  - *Catalytic effect* requires ($\#$) to dominate ($\#\#$).
Thresholds for binary action games

• Financier $i$ prefers secured over no lending if

$$\theta_i \geq \theta_s^*(\beta) \equiv \frac{D - \beta D_s(\beta)}{(1 - \beta) D_s(\beta)} \times \frac{1}{1 - \frac{\alpha}{m}}$$

• For $\sigma \to 0$, financier $i$ prefers unsecured over secured lending if

$$\theta_i \geq \theta_{s,u}^*(\beta) \equiv \frac{\beta D_s(\beta)}{D_u - (1 - \beta) D_s(\beta)}$$

• Tacitly assumed: *Catalytic effect of secured debt*, i.e. $\theta_s(\beta) < \theta_u^*(0) \equiv \theta_u^*$
  • Financiers do not switch directly from no to unsecured lending.
  • Secured debt reduces loss-given-default $\to$ raises incentives to lend (#)
  • Secured debt has lower face value $\to$ lowers incentives to lend (##).
  • *Catalytic effect* requires (#) to dominate (##).
Thresholds for binary action games

- Financier $i$ prefers secured over no lending if
  \[
  \theta_i \geq \theta_s^*(\beta) \equiv \frac{D - \beta D_s(\beta)}{(1 - \beta)D_s(\beta)} \times \frac{1}{1 - \frac{\alpha}{m}}
  \]

- For $\sigma \to 0$, financier $i$ prefers unsecured over secured lending if
  \[
  \theta_i \geq \theta_{s,u}^*(\beta) \equiv \frac{\beta D_s(\beta)}{D_u - (1 - \beta)D_s(\beta)}
  \]

- Tacitly assumed: \textit{Catalytic effect of secured debt}, i.e. $\theta_s(\beta) < \theta_{s,u}^*(0) \equiv \theta_u^*.$
  - Financiers do not switch directly from no to unsecured lending.
    - Secured debt reduces loss-given-default $\rightarrow$ raises incentives to lend ($\#$)
    - Secured debt has lower face value $\rightarrow$ lowers incentives to lend ($\#\#$).
    - \textit{Catalytic effect} requires ($\#$) to dominate ($\#\#$).
Thresholds for binary action games

- Financier $i$ prefers secured over no lending if

$$\theta_i \geq \theta_s^*(\beta) \equiv \frac{D - \beta D_s(\beta)}{(1 - \beta) D_s(\beta)} \times \frac{1}{1 - \frac{\alpha}{m}}$$

- For $\sigma \to 0$, financier $i$ prefers unsecured over secured lending if

$$\theta_i \geq \theta_{s,u}^*(\beta) \equiv \frac{\beta D_s(\beta)}{D_u - (1 - \beta) D_s(\beta)}$$

- Tacitly assumed: Catalytic effect of secured debt, i.e. $\theta_s(\beta) < \theta_s^*(0) \equiv \theta_u^*$
  - Financiers do not switch directly from no to unsecured lending.
  - Secured debt reduces loss-given-default $\rightarrow$ raises incentives to lend (#)
    - Secured debt has lower face value $\rightarrow$ lowers incentives to lend (##).
    - Catalytic effect requires (#) to dominate (##).
Thresholds for binary action games

- Financier $i$ prefers secured over no lending if

$$
\theta_i \geq \theta_i^*(\beta) \equiv \frac{D - \beta D_s(\beta)}{(1 - \beta)D_s(\beta)} \times \frac{1}{1 - \frac{\alpha}{m}}
$$

- For $\sigma \to 0$, financier $i$ prefers unsecured over secured lending if

$$
\theta_i \geq \theta_{i,u}^*(\beta) \equiv \frac{\beta D_s(\beta)}{D_u - (1 - \beta)D_s(\beta)}
$$

- Tacitly assumed: *Catalytic effect of secured debt*, i.e. $\theta_s(\beta) < \theta_{s,u}^*(0) \equiv \theta_u^*$
  - Financiers do not switch directly from no to unsecured lending.
  - Secured debt reduces loss-given-default $\rightarrow$ raises incentives to lend ($\#$)
  - Secured debt has lower face value $\rightarrow$ lowers incentives to lend ($\#\#$).
  - *Catalytic effect* requires ($\#$) to dominate ($\#\#$).
Thresholds for binary action games

- Financier $i$ prefers secured over no lending if
  \[
  \theta_i \geq \theta_s^*(\beta) \equiv \frac{D - \beta D_s(\beta)}{(1 - \beta)D_s(\beta)} \times \frac{1}{1 - \frac{\alpha}{m}}
  \]

- For $\sigma \to 0$, financier $i$ prefers unsecured over secured lending if
  \[
  \theta_i \geq \theta_{s,u}^*(\beta) \equiv \frac{\beta D_s(\beta)}{D_u - (1 - \beta)D_s(\beta)}
  \]

- Tacitly assumed: *Catalytic effect of secured debt*, i.e. $\theta_s(\beta) < \theta_s^*(0) \equiv \theta_u^*$
  - Financiers do not switch directly from no to unsecured lending.
  - Secured debt reduces loss-given-default $\rightarrow$ raises incentives to lend (#)
  - Secured debt has lower face value $\rightarrow$ lowers incentives to lend (##).
  - *Catalytic effect* requires (#) to dominate (##).
Catalytic Effect and the Price of Safety

Lemma (Catalytic Effect)

Fix $\hat{\beta} \in (0, 1)$. Secured debt with collateralization $\hat{\beta}$ exerts a catalytic effect iff

\[
\frac{D_u - D}{D} > \frac{D_u - D_s(\hat{\beta})}{\hat{\beta}D_s(\hat{\beta})}
\]

($\star$)

- Left-hand side:
  Interest foregone due to default on unsecured debt relative to risk-free claim.

- Right-hand side:
  Return foregone on secured debt per unit of safety $\rightarrow$ Price of safety

- Catalytic effect requires:
  Paying price of safety cheaper than not earning unsecured rate due to default.
Catalytic Effect and the Price of Safety

Lemma (Catalytic Effect)

Fix $\hat{\beta} \in (0, 1)$. Secured debt with collateralization $\hat{\beta}$ exerts a catalytic effect iff

$$\frac{D_u - D}{D} > \frac{D_u - D_s(\hat{\beta})}{\hat{\beta}D_s(\hat{\beta})}$$

$(\star)$

- **Left-hand side:**
  Interest foregone due to default on unsecured debt relative to risk-free claim.

- **Right-hand side:**
  Return foregone on secured debt per unit of safety $\rightarrow$ Price of safety

- **Catalytic effect requires:**
  Paying price of safety cheaper than not earning unsecured rate due to default.
Monotone Equilibrium of 3-action Game

Proposition (Equilibrium with Secured and Unsecured Debt)

1. Suppose condition \((\star)\) holds at \(\hat{\beta}\).

   There exists a unique monotone equilibrium for \(\sigma \to 0\) where financiers:
   - do not lend if \(\theta_i < \theta_s^*(\hat{\beta})\);
   - lend secured if \(\theta_i \geq \theta_s^*(\hat{\beta})\) and \(\theta_i < \theta_{s,u}^*(\hat{\beta})\);
   - lend unsecured if \(\theta_i \geq \theta_{s,u}^*(\hat{\beta})\).

   The bank fails for \(\theta < \theta_s^*(\hat{\beta})\).

2. If condition \((\star)\) fails at \(\hat{\beta}\), financiers invest into unsecured debt if

   \[\theta_i \geq \theta_u^* = \theta_s^*(0)\]

   and never invest into secured debt. The bank fails for \(\theta < \theta_u^*\).
Model Overview

Monotone Equilibrium without Collateral

... with Collateral

Properties of Equilibrium

\[ \theta \]

\[ \theta^* \]

\[ s, u \]

unsecured funding

secured funding

no funding

\[ \theta \]

\[ \theta^*_s \]

\[ \theta^*_s, u \]

1
Crowding-In Unsecured Debt

• **Catalytic effect:** Secured debt allows refinancing for larger range of $\theta$: $\theta^*_s(\beta) < \theta^*_u$

• **Crowding-in:** Secured debt allows more unsecured funding: $\theta^*_{s,u}(\beta) < \theta^*_u$

Corollary (Crowding-In Unsecured Debt)

*Suppose condition (*) holds. Secured debt crowds in unsecured funding iff*

\[
\frac{(1 - \frac{\alpha}{m})D_u - D}{D} < \frac{D_u - D_s(\hat{\beta})}{\hat{\beta}D_s(\hat{\beta})} \tag{**}
\]

*Otherwise unsecured debt is crowded-out.*

• Left-hand side: Loss of holding unsecured debt due to default *conditional* on successful refinancing.

• Right-hand side: Price of safety (again).

• If strategic uncertainty ($\alpha/m$) large, funding stability improves primarily by crowding-in unsecured debt.
Crowding-In Unsecured Debt

- **Catalytic effect**: Secured debt allows refinancing for larger range of \( \theta \): \( \theta^*_s(\beta) < \theta^*_u \)

- **Crowding-in**: Secured debt allows more unsecured funding: \( \theta^*_s,u(\beta) < \theta^*_u \)

**Corollary (Crowding-In Unsecured Debt)**

*Suppose condition (*) holds. Secured debt crowds in unsecured funding iff*

\[
\frac{(1 - \frac{\alpha}{m})D_u - D}{D} < \frac{D_u - D_s(\hat{\beta})}{\hat{\beta}D_s(\hat{\beta})}
\]

("")

*Otherwise unsecured debt is crowded-out.*

- Left-hand side: Loss of holding unsecured debt due to default *conditional* on successful refinancing.

- Right-hand side: Price of safety (again).

- If strategic uncertainty \( \alpha/m \) large, funding stability improves primarily by crowding-in unsecured debt.
Crowding-In Unsecured Debt

- unsecured funding
- secured funding
- no funding

Model Overview

Crowding-In Unsecured Debt

- Monotone Equilibrium without Collateral
- Properties of Equilibrium
- ... with Collateral
Crowding-Out Unsecured Debt

- unsecured funding
- secured funding
- no funding

\[ \theta, \theta_s^*, \theta_u^*, \theta_s^*, \theta_{s,u} \]
Inefficient Liquidations with Unsecured Debt

• Limited liability can induce moral hazard, i.e. bank attempts refinancing for \( \theta < \theta^{\text{eff}} \).

• With only unsecured debt, moral hazard prevented, but at expense of inefficient liquidations.

Proposition (Inefficient Liquidations)

Unsecured funding inefficiently prevents moral hazard since

\[
\theta_u^* > \theta^{\text{eff}}
\]

• This follows because for \( \theta_i > \theta_u^* \):

\[
LD < D < \theta_i D_u \left(1 - \frac{\alpha}{m}\right) < \theta_i D_u < \theta_i X_g < \theta_i X_g + (1 - \theta_i)X_b
\]
Inefficient Liquidations with Unsecured Debt

- Limited liability can induce moral hazard, i.e. bank attempts refinancing for \( \theta < \theta^{\text{eff}} \).

- With only unsecured debt, moral hazard prevented, but at expense of inefficient liquidations.

**Proposition (Inefficient Liquidations)**

*Unsecured funding inefficiently prevents moral hazard since*

\[
\theta^*_u > \theta^{\text{eff}}
\]

- This follows because for \( \theta_i > \theta^*_u \):

\[
LD < D < \theta_i D_u \left(1 - \frac{\alpha}{m}\right) < \theta_i D_u < \theta_i X_g < \theta_i X_g + (1 - \theta_i)X_b
\]
Bank Moral Hazard and Secured Funding

• Secured funding may enable moral hazard, i.e. allow bank to refinance for $\theta < \theta^{\text{eff}}$.

Proposition (Bank Moral Hazard)

There exists $\beta^{mh}$ such that secured debt with collateralization $\beta^{mh}$ induces moral hazard, $\theta^*(\beta^{\text{eff}}) < \theta^{\text{eff}}$, if:

$$- \frac{D_s'(1)}{D} > 1 - \left(1 - \frac{\alpha}{m}\right) \theta^{\text{eff}}$$

• Higher strategic uncertainty (higher $\alpha/m$) attenuates moral hazard.

• Illiquid (low $L$) or high return assets (high $X_g$ or $X_b$) also attenuate moral hazard.

• Reason: Such assets have a low efficiency point s.t. inefficient liquidation problem more severe than moral hazard.
Bank Moral Hazard and Secured Funding

- Secured funding may enable moral hazard, i.e. allow bank to refinance for $\theta < \theta^{\text{eff}}$.

Proposition (Bank Moral Hazard)

There exists $\beta^{mh}$ such that secured debt with collateralization $\beta^{mh}$ induces moral hazard, $\theta^*(\beta^{eff}) < \theta^{eff}$, if:

$$-\frac{D'(1)}{D} > 1 - \left(1 - \frac{\alpha}{m}\right)\theta^{eff}$$  \hspace{1cm} (\ast \ast \ast)

- Higher strategic uncertainty (higher $\alpha/m$) attenuates moral hazard.

- Illiquid (low $L$) or high return assets (high $X_g$ or $X_b$) also attenuate moral hazard.

- Reason: Such assets have a low efficiency point s.t. inefficient liquidation problem more severe than moral hazard.
Empirical Implications

- **Model predicts cross-sectional tiering:**
  - Banks with strong balance sheets, high $\theta$, predominantly issue unsecured debt.
  - High reliance on secured debt sign of weak balance sheets.

- In low interest rate environments, banks more susceptible to moral hazard through secured debt issuance.

- Banks holding illiquid assets are less susceptible to moral hazard; conversely banks with very liquid assets (e.g. market-based banking), more susceptible to moral hazard.
Model Overview

Properties of Equilibrium

Empirical Implications

- Model predicts cross-sectional tiering:
  - Banks with strong balance sheets, high $\theta$, predominantly issue unsecured debt.
  - High reliance on secured debt sign of weak balance sheets.

- In low interest rate environments, banks more susceptible to moral hazard through secured debt issuance.
  - Banks holding illiquid assets are less susceptible to moral hazard; conversely banks with very liquid assets (e.g. market-based banking), more susceptible to moral hazard.
Empirical Implications

• Model predicts cross-sectional tiering:
  • Banks with strong balance sheets, high $\theta$, predominantly issue unsecured debt.
  • High reliance on secured debt sign of weak balance sheets.

• In low interest rate environments, banks more susceptible to moral hazard through secured debt issuance.

• Banks holding illiquid assets are less susceptible to moral hazard; conversely banks with very liquid assets (e.g. market-based banking), more susceptible to moral hazard.
Relation to Literature

• Global game theory: Frankel et al. (2003), Basteck et al. (2013), Basteck Daniels (2013)


• Global games with secured debt: Ahnert et al. (2018), Matta Perrotti (2015)
Revisiting financial stability aspects

- Reducing coordination risk (+)
- Less monitoring (-)
- Less access to unsecured funding (+/-)
- Risk shifting to deposit guarantee schemes (-)