Opacity: Insurance and Fragility

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Opacity

- A cause of recent financial and economic crisis
  - Widespread calls for transparency in the banking system
    (e.g. Dodd-Frank Act, Regulation AB II)
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  - Widespread calls for *transparency* in the banking system (e.g. Dodd-Frank Act, Regulation AB II)

- The banking system has been historically and *purposefully opaque*
  - This opacity enables banks to issue *information insensitive* liabilities:
    - when the backing asset is difficult to assess,
    - the value of bank liabilities do not vary over some period of time

  *by Gorton (2013 NBER), Holmström (2015 BIS), Dang et al. (2017 AER)*
Opacity

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- The banking system has been historically and purposefully opaque
  - This opacity enables banks to issue information insensitive liabilities:
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- Debates on transparency vs. opacity
This paper

- **Q. Should the banking system be transparent or opaque?**
  - many dimensions to consider

- This paper addresses the question
  - from the view of **financial stability**
  - **opacity** ⇒ **how long asset qualities are unknown**
  - prime example: Asset Backed Commercial Paper conduits

- **Show:** uncertainty created by opacity:
  - provides **insurance** against risky assets (Hirshleifer, 1971 AER)
  - raises **incentive to run on the bank**

- **Describe:** when the degree of opacity should be regulated
What drives a run?

There are some works on this topic

- focus: more information may trigger a bank run
- show: transparency worsens financial stability
  (Bouvard et al. (2015 JF), Faria-e Castro et al. (2017 ReStud)...etc)

My contribution:

- focus: opacity itself makes depositors more likely to panic
- show: opacity worsens financial stability
- study trade-off between enhanced risk-sharing and higher fragility
- explain when opacity should be regulated

Literature Review
The mechanism

*Depositors deposit their endowment*

*Intermediaries make investment*
- *risky* and *long-term* projects

```
Intermediation
as in Diamond and Dybvig (1983JPE)
```

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risk-averse Depositors
```

```
deposits
```
The mechanism

**Depositors deposit their endowment**

**Intermediaries make investment**
- **risky** and **long-term** projects

**Depositors may withdraw before projects mature**

**Projects can be sold before maturity**
- to investors
- by being securitized
  (e.g. Asset Backed Securities)

- risk-neutral Investors
  purchase risky asset
  **Intermediation**
  as in Diamond and Dybvig (1983JPE)
  repayments

- risk-averse Depositors
Once asset qualities are known...

- Price will depend on realized qualities
- Depositors face risk

Risk-neutral Investors

Purchase risky asset

Intermediation
as in Diamond and Dybvig (1983JPE)

Repayments

Risk-averse Depositors
While asset qualities are unknown...

- Price depends on expected qualities
- Investors face risk

The mechanism

risk-neutral Investors

purchase
risky asset

Intermediation
as in Diamond and Dybvig (1983JPE)

repayments

risk-averse Depositors
The mechanism

*While asset qualities are unknown...*
- Price depends on expected qualities
- Investors face risk

**Opacity transfers risk:**
- Insurance for depositors

...but only in the short-term:
- Influences withdrawal decisions

![Diagram](attachment:image.png)
Overview

1. Model: the Environment
2. Equilibria
3. Optimal opacity
4. Unobservable choice of opacity
Depositors

My model is based on Diamond and Dybvig (1983 JPE)

- $t = \{0, 1, 2\}$
- Continuum of mass 1 **depositors**
  - endowed 1 unit of goods in $t = 0$ and consume in $t = 1, 2$
  - liquidity shock: $\pi$ depositors need to consume in $t = 1$ (*impatience*)
A risky project

1 invested in $t = 0$ yields $\begin{bmatrix} R_b \\ R_g \end{bmatrix}$ with prob $\begin{bmatrix} n_g \\ n_b \end{bmatrix}$ in $t = 2$

indexed by $j \in \{b, g\}$, where $n_g + n_b = 1$

realized in period 1
Technology and Market

Augmented to have Allen and Gale (1998 JF) technology and market

- **A risky project**
  - 1 invested in \( t = 0 \) yields \( \begin{cases} R_b \\ R_g \end{cases} \) with prob \( \begin{cases} n_g \\ n_b \end{cases} \) in \( t = 2 \)
  - indexed by \( j \in \{b, g\} \), where \( n_g + n_b = 1 \)
  - realized in period 1

- **A competitive asset market**
  - A large number of risk-neutral **investors**
    - large endowment in period 1
    - discount consumption in period 2 by \( \rho < 1 \)
  - given expected return \( \mathbb{E}R \), investors drive asset price to \( p = \rho \mathbb{E}R \)
Intermediation

- **Bank**: collects deposits in $t = 0$
  - allows depositors to choose when to withdraw
  - $t = 1$: payments made sequentially on first-come-first-serve basis
  - the order of withdrawals is random and unknown
  - $t = 2$: remaining payments made by dividing matured projects evenly
  - operated to maximize expected utility of depositors

*Sequential service*
**Intermediation**

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- **Opacity** of asset $\theta \in [0, \pi]$
  - asset return revealed after $\theta$ withdrawals have been made
    - before $\theta$; nobody knows $R_j$
    - after $\theta$; everybody know $R_j$
  - $='$time required to investigate $R_j'$
Runs and Sunspot

- *Runs* occur when patient depositors withdraw in $t = 1$
- Withdrawals may be conditioned on *sunspot* $s \in S = [0, 1]$
  - allows for the possibility that a bank run may occur in equilibrium (Cooper and Ross, 1998 JME, Peck and Shell, 2003 JPE)
  - bank does not observe $s \Rightarrow$ is *initially* uncertain if a run is underway in period 1

⋆ bank's reaction restores confidence in the bank

⋆ No commitment:

- ⋆ Diamond-Dybvig: commitment prevents a self-fulfilling run
- ⋆ Here: prohibited to use this time-inconsistent policy
- ⋆ bank allocates remaining consumption efficiently
Runs and Sunspot

- **Runs** occur when patient depositors withdraw in $t = 1$
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  - bank does not observe $s \Rightarrow$ is initially uncertain if a run is underway in period 1
- At $\pi$ withdrawals, the bank reacts
  - at this point, the run stops (Ennis and Keister, 2009 AER).
    - bank’s reaction restores confidence in the bank
  - **No commitment:**
    - Diamond-Dybvig: commitment prevents a self-fulfilling run
    - Here: prohibited to use this time-inconsistent policy
    - bank allocates remaining consumption efficiently
Timeline

- Depositors observe $\omega_i$ and $s$
- Withdrawal begins
- Bank sells asset and repays sequentially
- Fraction $\pi$ served
- Sunspot state inferred by bank
- Additional $t = 1$ withdrawal made (if any)

$t=0$
- Deposits made
- $\theta$ chosen

Withdrawal game:
- Depositors choose withdrawal strategies;
- Bank chooses repayment strategies

$t=1$

$t=2$
- $\theta$-th repayment served
- Fundamental state observed
- All remaining withdrawals
Given $\theta$, the bank and depositors play a simultaneous-move game:

- Depositor $i$ maximizes her expected utility
- The bank maximizes the expected utility of depositors

Intuition: A bank run occurs with probability $q$.
Withdrawal game

- Given $\theta$, the bank and depositors play a simultaneous-move game:
  - Depositor $i$ maximizes her expected utility
  - The bank maximizes the expected utility of depositors

- **My interest:** the following *cutoff strategy profile* of depositors

$$\hat{y}_i(\omega_i, s; q) = \begin{cases} 
\omega_i \\
0 
\end{cases} \text{ if } s \begin{cases} 
\geq \\
< 
\end{cases} q \text{ for some } q \in [0, 1], \forall i.$$ 

- Introducing the likelihood of runs (Peck and Shell, 2003 JPE)
- Intuition: a bank run occurs with probability $q$
Withdrawal game

- Given $\theta$, the bank and depositors play a simultaneous-move game:
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- **My interest:** the following cutoff strategy profile of depositors

$$\hat{y}_i(\omega_i, s; q) = \begin{cases} 
\omega_i & \text{if } s \geq q \\
0 & \text{if } s < q
\end{cases}$$

  - for some $q \in [0, 1], \forall i$.
  - introducing the likelihood of runs (Peck and Shell, 2003 JPE)
  - Intuition: a bank run occurs with probability $q$

- **Repayment** depends on $\hat{y}_i$ and her position in the line
  - before $\theta$, funded by selling assets at a pooling price $p_u = \mathbb{E}p_j$
  - after $\theta$ in period 1, funded by selling assets at $p_j$
  - in period 2, funded by realized return of matured assets $R_j$
Overview

1. Model: the Environment
2. Equilibria
3. Optimal opacity
4. Unobservable choice of opacity
Equilibrium bank runs

- Is there an equilibrium in which depositors follow this cutoff strategy?
  - answer depends on \( q \)
- When a run is more likely (\( q \uparrow \)):
  - banks are more conservative: give less to early withdrawers
  - giving less incentive for patient depositors to run

Define \( \bar{q} \) = max value of \( q \) such that \( \hat{y}(q) \) is an equilibrium strategy
- that is, maximum equilibrium probability of a bank run

I use \( \bar{q} \) as the measure of financial fragility \( Q \).

How does the level of opacity (\( \theta \)) affect financial fragility (\( \bar{q} \))?
- need to compare expected payoffs of patient depositors.
Equilibrium bank runs

- Is there an equilibrium in which depositors follow this cutoff strategy?
  - answer depends on $q$
- When a run is more likely ($q$ ↑):
  - banks are more conservative: give less to early withdrawers
    $\Rightarrow$ giving less incentive for patient depositors to run

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  - that is, maximum equilibrium probability of a bank run

- I use \( \bar{q} \) as the measure of financial fragility

**Q.** How does the level of opacity (\( \theta \)) affect financial fragility (\( \bar{q} \))?

\( \Rightarrow \) need to compare expected payoffs of patient depositors.
Result: expected payoffs in period 1 are monotonically decreasing in $q$
Result: expected payoffs in period 2 are monotonically increasing in $q$
Result: \( \mathbb{E} u(c_{2j}^R) \leq \mathbb{E} u(c_{1k}) \) when \( q \leq \bar{q} \)

\( \Rightarrow \) the cutoff strategy profile is a part of equilibrium
Impact of opacity

- Recall: expected payoffs depend on $\theta$

  Q. How does an increase in $\theta$ affect equilibria?
Impact of opacity

- Recall: expected payoffs depend on $\theta$

**Q.** How does an increase in $\theta$ affect equilibria?
An increase in $\theta$

- raises chance of receiving insurance in $t = 1$: $\mathbb{E}u(c_{1k}) \uparrow\uparrow$
- has indirect effects through $(c_{1k}, c^R_{2j})$: $\mathbb{E}u(c^R_{2j}) \uparrow$

![Graph showing consumption vs. $q$ with lines for $\mathbb{E}u(c^R_{2j})$, $\mathbb{E}u(c_{1k})$, and $\bar{q}$]
Proposition

- $\bar{q}$ is increasing in $\theta$
  $\Rightarrow$ Opacity increases fragility
Opacity increases fragility

- This result is novel in the literature
  - Literature: information causes bank runs
  - Here: no information causes self-fulfilling bank runs

- Opacity
  - provides insurance by transferring risks
  - increases financial fragility

⇒ Q. What is the optimal degree of opacity?
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Pessimistic views

- Recall $U(c^*, y^*; \theta)$ depends on $\theta$.
  - multiple equilibria associated with each choice of $\theta$
Pessimistic views

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  - multiple equilibria associated with each choice of $\theta$

- Focus on the worst-case scenario:
  \[
  \max_{\theta} \min_{q \in Q(\theta)} U(c^*, \hat{y}(q); \theta)
  \]
  - Intuition: minimizing losses in the worst case over $q \in Q(\theta)$.
  - the worst case $\Rightarrow \bar{q}(\theta)$ (\because $U(c^*, \hat{y}(q); \theta)$ is decreasing in $q$)
Pessimistic views

- Recall $U(c^*, y^*; \theta)$ depends on $\theta$.
  - multiple equilibria associated with each choice of $\theta$

- Focus on the worst-case scenario:
  $$\max_{\theta} \min_{q \in Q(\theta)} U(c^*, \hat{y}(q); \theta)$$
  - Intuition: minimizing losses in the worst case over $q \in Q(\theta)$.
  - the worst case $\Rightarrow \bar{q}(\theta)$ ($\therefore U(c^*, \hat{y}(q); \theta)$ is decreasing in $q$)

- Anticipating the worst equilibrium outcomes, the bank solves
  $$\max_{\theta \in [0, \pi]} U(c^*, \hat{y}(\bar{q}(\theta)); \theta)$$
  - trade-off: Hirshleifer effect versus Fragility effect
Optimal opacity

**Result:** For some parameter values, $\theta^* < \pi$. 

Numerical example
Optimal opacity

**Result:** For some parameter values, $\theta^* < \pi$.

The optimal opacity becomes *smaller* when:

- the discount rate of investors $\rho$ increases.
Optimal opacity

**Result:** For some parameter values, $\theta^* < \pi$.

The optimal opacity becomes smaller when:

- the discount rate of investors $\rho$ increases.
- assets are riskier
  - $R_g$ increases; $R_b$ decreases.
  - the fundamental state is more uncertain (when $n$ is closer to $\frac{1}{2}$).
Overview

1. **Model: the Environment**

2. **Equilibria**

3. **Determining optimal opacity**

4. **Unobservable choice of opacity**
   - I have assumed that $\theta$ is observable.
   - ⇒ Q. How does the bank behave if $\theta$ is not observable?
Unobservable choice of opacity

- **In the previous analysis:**
  depositors could directly observe their bank’s choice of $\theta$

- **Now:** Suppose instead this information is difficult to observe
  
  ▶ Intuition: depositors may find it difficult to know which of assets takes a longer time to investigate

- In the model,
  
  ▶ depositors can still make inferences and understand bank’s incentives
  ▶ expectations will be correct in equilibrium
  ▶ ... but bank cannot credibly reveal its choice
Regulating opacity

**Result:** The bank’s dominant strategy is the highest possible opacity.
- a larger opacity can still provide insurance to more depositors
- depositors cannot observe the level of opacity
Regulating opacity

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**Welfare comparison**
- the bank may become more opaque $\theta^{**} = \pi \geq \theta^{*}$
  $\Rightarrow$ equilibrium outcomes may be worse for depositors
Regulating opacity

- **Result:** The bank’s dominant strategy is the highest possible opacity.
  - a larger opacity can still provide insurance to more depositors
  - depositors cannot observe the level of opacity

- Welfare comparison
  - the bank may become more opaque $\theta^{**} = \pi \geq \theta^*$
    $\Rightarrow$ equilibrium outcomes may be worse for depositors

- **Regulating opacity**
  - imposing an observable upper bound on $\theta$ so that $\theta \in [0, \theta^*]$
  - the conditional dominant strategy of bank is now $\theta^*$
  - the outcome is the same as when $\theta$ is observable
  - Example: limiting asset classes of investment
Conclusion

I have presented a model of financial intermediation where:

- opacity determines time required to investigate asset quality
- repayment and withdrawal behavior are chosen given the opacity
- bank chooses the opacity anticipating equilibrium outcomes

I show that opacity increases fragility

In choosing opacity, a bank faces trade-off between:

- providing insurance by keeping asset return unknown
- increasing fragility by raising incentives to run
  ⇒ optimal level of opacity is often interior

Bank becomes maximally opaque if its choice is unobservable

- In this case, regulating opacity may improve welfare
Thank you
Effect of opacity on risk-sharing
Hirshleifer (1971 AER), Kaplan (2006 ET), Dang et al. (2017 AER)

Effect of opacity on financial stability
- mixed effects: Bouvard et al. (2015 JF), Ahnert and Nelson (2016 WP)

Effect of opacity on bank’s risk-taking
Hyytinen and Takalo (2002 RoF), Moreno and Takalo (2016 JMCB), Jungherr (2016 WP)
• Bank anticipates the possibility of runs
  Peck and Shell (2003 JPE), Cooper and Ross (1998 JME)

• Bank trades assets in financial markets

• Bank is prohibited from using time-inconsistent policy (i.e. suspension)
  Ennis and Keister (2009 AER), Ennis and Keister (2010 JME)
Sequential services

- Agents are isolated from each other.
- Repayments are made immediately as each agent arrives.
- Order of withdrawal opportunities is random.
- Depositors do not know their position in the order (Peck and Shell, 2003 JPE).
- Each agent can contact the bank either in period 1 or period 2.
Optimal opacity

Numerical example:

given \((\gamma, \pi, n, R_g, R_b, \rho) = (2, 0.5, 0.5, 2, 1, 0.9)\).
Modified banking problem

Given \( \hat{y}(q) \), the bank chooses \((\theta, c_1, \{c_{1j}, c_{1j}^N, c_{2j}^N, c_{2j}^R\}_{j=b,g})\) to maximize

\[
\max_{[\theta,c_1,\{c_{1j},c_{1j}^N,c_{2j}^N,c_{2j}^R\}_{j=b,g}]}
\theta u(c_1) + \Sigma j n_j \left[(\pi - \theta)u(c_{1j}) + (1 - q)(1 - \pi)u(c_{2j}^N)\right. \\
+ q(1 - \pi)[\pi u(c_{1j}^R) + (1 - \pi)u(c_{2j}^R)]
\]

subject to

\[
(1 - \pi)\frac{c_{2j}^N}{R_j} = 1 - \theta \frac{c_1}{p_u} - (\pi - \theta)\frac{c_{1j}}{p_j},
\]

\[
\pi(1 - \pi)\frac{c_{1j}^R}{p_j} + (1 - \pi)^2\frac{c_{2j}^R}{R_j} = 1 - \theta \frac{c_1}{p_u} - (\pi - \theta)\frac{c_{1j}}{p_j}, \forall j.
\]