When you can **measure** what you are speaking about, and express it in **numbers**, you **know** something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind: it may be the beginnings of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science.

—William Thomson (Lord Kelvin)
• Growing importance of derivatives for banks and other financial institutions
• High concentration of derivatives markets
• Large players have significant leverage ratios
• OTC derivatives markets have experienced several large credit events
• Collateral usage in OTC markets has grown significantly
Research Questions

1) What are the differences in the mechanisms for default risk mitigation observed in derivatives markets?

2) How do these mechanisms affect the wealth of market participants, market liquidity, and default risk?
Different Perspectives on Collateral

- Market Risk
  - Price

- Liquidity Risk
  - “Spread”, quantity

- Credit Risk
  - PD, LGD
Credit Risk Perspective

- Credit risk: expected loss due to changes in counterparty credit quality
- Traditional perspective on collateral: Reduces LGD → Reduces credit risk
The mechanisms by which collateral provides benefit is through improvement of the recovery rate. Collateral *does not* make it more or less likely that a counterparty will default and *does not* change the value of a defaulted transaction.
What I tell you three times is true.

—Lewis Carroll
Credit Risk Perspective (cont'd)

- Credit risk: expected loss due to changes in counterparty credit quality
- Traditional perspective on collateral: Reduces LGD → Reduces credit risk
- But what about PD?
Liquidity Risk Perspective

- Liquidity risk: expected loss due to trading costs (market) or funding needs (funding liquidity)
- Collateral imposes funding constraint on trader (funding liquidity)
- As a consequence, it might reduce market liquidity
- Both might affect a trader's ability to hedge, and might thus adversely affect her probability of default as well as loss given default
Market Risk Perspective

• Market risk: expected loss due to price changes
• Price reflects value of contract → function of credit and liquidity risk
• Effects of collateral on prices ambiguous
• Challenge: feedback effects
“Holistic” Perspective on Collateral Wealth

- Market Risk
- Liquidity Risk
- Credit Risk

Price: PD, LGD

“Spread”, quantity
Modeling Challenges

- Heterogeneity of agents
- Non-linearity of wealth
- Path-dependence
- Dynamics
Model

- 25 banks
- Exogenous demand and supply for bond, subject to both price and default risk
- Fixed-floating v. floating-fixed exposure
- Solvency and funding constraint
- Asset-based insolvency
• Banks trade swap contract to hedge price risk
• Swap contracts subject to default risk
• Three sets of default risk mitigation mechanisms:
  — Initial margin
  — Initial & variation margin
  — Initial & variation margin, CCP
## Model Parameters

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameter</th>
<th>Description</th>
<th>Values</th>
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<td><strong>Market</strong></td>
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<td></td>
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<td>Number of agents</td>
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<tr>
<td></td>
<td>$r, u, \sigma_r$</td>
<td>Term structure of interest rate</td>
<td>Empirical term structure</td>
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<td>$T_S$</td>
<td>Maturity of swaps</td>
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<td><strong>Real sector</strong></td>
<td>$h, v, \rho_{h,r}, \sigma_h$</td>
<td>Term structure of hazard rate</td>
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<tr>
<td><strong>Banks</strong></td>
<td>$m$</td>
<td>Initial amount of money</td>
<td>Empirical distribution</td>
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Interest-Rate Environment

Short-Term Interest Rate (U.S. Treasuries 3 Months)

Yield Curve (1/1/1995)

Yield (1/1/2011)

Yield Curve (4/1/1999)

Yield (12/1/2003)
A Sample Run

- Banks receive endowment in money
- At the beginning of every period, banks receive random client demand (function of wealth) and enter into a position
- Submit order for swap contract (constrained by solvency and by funding liquidity)
- Interest rate is revealed
- Positions are settled
A Sample Path of Wealth

Sample Path of a Bank's Wealth

Period
## Overall Effects of Mitigation Mechanisms

Simulation results for generic parameter configuration

<table>
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<th>IM &amp; VM</th>
<th>CCP</th>
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</table>
Model Limitations

- Assumption that banks try to hedge completely
- Derivatives market with hedgers only
- Information effects of collateral and CCP
- Externalities of derivatives markets
If you can look into the seeds of time,
And say which grain will grow and which will not,
Speak.

—Shakespeare, *Macbeth*