Illiquidity Commonality across Equity and Credit Markets

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Presentation Outline

1) Motivation;
2) Existing Literature on Cross-Market Illiquidity Commonality;
3) Evidence on CDS-Equity Illiquidity Commonality;
4) Preliminary Test on Dynamics of CDS-Equity Illiquidity Commonality;
5) Preliminary Test on Drivers of Illiquidity;
6) Trading Channels of CDS-Equity Illiquidity Commonality;
7) Estimation of Debt-to-Equity Hedge Ratio;
8) Test (A): Dependence of CDS-Equity Illiquidity Commonality on Hedge Ratio;
9) Test (B): Determinants of CDS Bid-Ask Spread;
10) Conclusions, Main Contributions, Recommendations.
Motivation

Illiquidity Commonality: Why do we care about this?

Cross-market Connections $\Rightarrow$ Cross-market Liquidity Linkages/Leakages

Are more integrated markets less safe because of interrelation in their functionality?
Motivation

An Explorative Journey...

- First Idea: Looking for effects of traders’ funding constraints on the liquidity of different markets.
- Selected markets: equity and credit...
- But equity and credit markets are also related in fundamentals since they trade similar corporate risks (Merton 1974 structural model).

⇒ Try to look beyond the funding liquidity story:
   - Can we observe the illiquidity commonality?
   - If yes, why?
   - Is there any relationship between the markets’ fundamental linkage and their commonality in illiquidity?
# Existing Literature on Cross-Market Illiquidity Commonality

<table>
<thead>
<tr>
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<th>Independent Markets</th>
<th>Correlated Markets</th>
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</thead>
<tbody>
<tr>
<td><strong>Segmented Trading</strong></td>
<td><strong>Traders’ Funding Constraints</strong>&lt;br&gt;(Schleifer and Vishny 1997 JF; Brunnermeier and Pedersen 2009 RFS; Gromb and Vayanos 2002 JFE, 2010)</td>
<td><strong>Traders’ Funding Constraints</strong>&lt;br&gt;(Foucault et al 2013)&lt;br&gt;&lt;br&gt;<strong>Toxic Arbitrage</strong>&lt;br&gt;(Foucault et al 2013)&lt;br&gt;&lt;br&gt;<strong>Dealers’ Hedging Activity</strong>&lt;br&gt;(Froot and Stein 1998 JFE; Cho and Engle 1999; Neri and Engle 2010)</td>
</tr>
<tr>
<td><strong>Correlated Trading</strong></td>
<td><strong>-</strong></td>
<td><strong>Traders’ Funding Constraints</strong>&lt;br&gt;(Foucault et al 2013)&lt;br&gt;&lt;br&gt;<strong>Dealers’ Hedging Activity</strong>&lt;br&gt;(Froot and Stein 1998 JFE; Cho and Engle 1999; Neri and Engle 2010)</td>
</tr>
</tbody>
</table>
Evidence of CDS-Equity Price Commonality

Average (normalized) CDS premium and inverse equity price (Bloomberg and CRSP data) 
(Weekly Frequency, March 2003 - December 2009, Cross-Section of 51 US IG Firms)

- Equity and credit markets are integrated and linked through an arbitrage relationship ⇒ Supportive theory: Merton (1974) structural model
Evidence of CDS-Equity Illiquidity Commonality (1)

Average (normalized) CDS and equity bid-ask spreads (Bloomberg and CRSP data)  
(Weekly Frequency, March 2003 - December 2009, Cross-Section of 51 US IG Firms)
Correlations between Equity and CDS bid-ask spreads

Average Pearson, Kendall and Spearman Measures
(Quarterly Frequency, March 2003 - December 2009,
Cross-section of 51 US IG Firms)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Correlation</th>
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<td>Pearson</td>
<td>0.5570</td>
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<tr>
<td>Spearman</td>
<td>0.3132</td>
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<tr>
<td>Kendall</td>
<td>0.1997</td>
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</table>

Illiquidity commonality is detected, but it varies over time:
Meaningful over periods of higher turbulence
Preliminary Test on the Dynamics of Illiquidity Commonality

- Co-movements or Spillovers (Contagion)?

- **Test:** Pair-wise Granger causality tests at the firm level for CDS and equity bid-ask spreads; VAR Analysis for robustness.

- **Results:**
  - *Illiquidity* spillovers: for most firms from CDS to Equity;
  - *Price* and *Return* spillovers: for ~ all firms from Equity to CDS;
  - *Volatility* spillovers: mixed evidence, but for more firms from CDS to Equity;
  - There is not a one-to-one correspondence between directions of Illiquidity, Return, and Volatility spillovers;
  - For 30% of the firms illiquidity and volatility spillovers have the same CDS-to-equity direction.
Preliminary Test on Drivers of Illiquidity

- Market-specific or Asset-specific Drivers?

- Test: For each firm regress CDS (equity) bid-ask spreads on CDS (equity) market average bid-ask spread and firm’s asset volatility.

- Results:
  - For almost all firms CDS (equity) bid-ask spread is affected by average CDS (equity) market illiquidity;
  - For 22 Firms out of 45 CDS bid-ask is positively affected by asset volatility; while only for 9 Firms asset volatility significantly increases Equity bid-ask.

- Observations from Preliminary Tests:
  - Different information sets are anticipated in one market and transmitted to the other one: CDS quickly impound firm-specific bad news (see Acharya and Johnson 2007, Marsh and Wagner 2010, amongst others).
  - CDS-to-equity illiquidity spillovers exist and may be the result of information flow and trading activity across the two markets.
Trading Channel of CDS-Equity Illiquidity Commonality

Why to hold positions in both markets simultaneously?
- To benefit from misalignment between equity and credit (capital structure arbitrage);
- To hedge off risk of credit positions in the equity market (and vice-versa).

Markets Participants:
- Uninformed noise traders (e.g., liquidity traders in equity, bond investors seeking protection in the CDS market);
- Informed CS arbitrageurs (e.g., hedge funds);
- Uninformed equity dealers (e.g. specialist market makers);
- Informed and uninformed CDS dealers (banks can be informed about credit risk of clients!)

The debt-to-equity hedge ratio $h$ represents a first approximation of the arbitrage relationship between equity and CDS;
When the hedge ratio $h$ increases (i.e. worse firm’s credit conditions, bad news, crisis periods):

- CDS dealers must pay more to hedge their imbalanced inventory position ($X$) in the equity market ($hX$): they may **increase CDS bid-ask spreads** ($CDS^{BA} \propto h \text{ Equity}^{BA}$).
- Some CDS dealers withdraw from the markets **unwinding both their CDS and equity positions**;
- Firm’s bad news are priced first in the CDS market and then in the equity market;
- Temporary CDS-Equity mispricing may arise:
  - Informed traders (CSA arbitrageurs) demand liquidity across equity and CDS markets;
  - Uninformed equity and CDS dealers **increase equity and CDS bid-ask** against informed trading.

$\Rightarrow$ **CDS-Equity Hedging/Arbitrage Channel.**
Possible Channels of Illiquidity Commonality

- **Traders’ Funding Illiquidity Channel:**
  Higher funding illiquidity, systematic risk and market volatility may increase CDS-Equity illiquidity commonality.

- **CDS-Equity Hedging/Arbitrage Channel:**
  Higher hedging costs and informed arbitrage trading (captured by larger debt-to-equity hedge ratio) may increase CDS-equity illiquidity commonality.
Estimation of Debt-to-Equity Hedge Ratio

▶ Merton (1974) Model:

- \[ B_0 = A_0 - E_0 = A_0 - A_0 N(d_1) - De^{-rT} N(d_2) = \]
  \[ De^{-rT} - (De^{-rT} N(-d_2) - A_0 N(-d_1)) = PV(D) - P^{BS}(A_0, \sigma_A, D, r, T) \]

- The sensitivity of debt \((B)\) to equity \((E)\) is \(h\):
  \[ h = \frac{\partial B}{\partial E} = \frac{\partial B}{\partial A} \frac{\partial A}{\partial E} = \frac{N(-d_1)}{N(d_1)} = \frac{1}{\Delta_c} - 1 \]

- The elasticity of debt to equity (hedge ratio) is \(H\):
  \[ H = \frac{\partial B}{\partial E} \times \frac{E}{B} = \frac{\partial B}{\partial A} \frac{\partial A}{\partial E} \times \frac{E}{B} = h \times \left( \frac{1}{\text{Lev}} - 1 \right) \]

- Where: \( d_1 = \frac{\ln \left( \frac{A_0}{D e^{-rT}} \right)}{\sigma_A \sqrt{T}} + \frac{\sigma_A \sqrt{T}}{2} = \frac{-\ln(L)}{\sigma_A \sqrt{T}} + \frac{\sigma_A \sqrt{T}}{2} \) and \( d_2 = d_1 - \sigma_A \sqrt{T} \)

▶ Estimate \(H\) → Estimate \(\sigma_A\) and \(A\) from \(\sigma_E\), \(D\), and \(E\):

- VX Methodology: Use \(E_0\) BS-Equation and \(\sigma_E = \frac{\sigma_A A_0 N(d_1)}{E_0}\) (from Ito’s lemma)

- SS Methodology:
  \[ \sigma_A^2(i,t) = (1 - L_i,t) \sigma_E^2(i,t) + L_i,t \sigma_D^2(i,t) + 2(1 - L_i,t) L_i,t \sigma_{ED}(i,t) \]
Estimation of Debt-to-Equity Hedge Ratio

Debt-to-equity sensitivity and hedge ratio
(Merton model calibration - SS Methodology)
(Weekly Frequency, March 2003 - December 2009, W.A. across 51 firms)
Debt-to-equity hedge ratio (Merton model calibration - SS vs. VX Methodology)
(Weekly Frequency, March 2003 - October 2008, W.A. across 51 firms)
Debt-to-Equity Hedge Ratio vs. Illiquidity Commonality

Kendall measure of illiquidity commonality and debt-to-equity hedge ratio 
(Merton model calibration - SS Methodology) 
(Quarterly Frequency, March 2003 - December 2009, W.A. across 51 firms)
Test (A): Dependence of CDS-Equity Illiquidity Commonality on Hedge Ratio

First Stage Panel Regression: \( Comm_{i,t}^{BA} = \alpha_0 + \beta_1 MktRf_t + \beta_2 SMB_t + \beta_3 HML_t + \delta_1 TED_t + \delta_2 VIX_t + \alpha_1 Firm_1 + \ldots + \alpha_{17} Firm_{17} + \nu_{i,t} \)

Second Stage: \( Res.\Comm_{i,t}^{BA} = \gamma_0 + \theta HSS_{i,t} + \gamma_1 Qtr_{2003:2} + \ldots + \gamma_{26} Qtr_{2009:3} + \epsilon_{i,t} \)

<table>
<thead>
<tr>
<th>MktRf</th>
<th>Smb</th>
<th>Hml</th>
<th>TED</th>
<th>VIX</th>
<th>F-Tests of FE</th>
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<td></td>
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<td></td>
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<td>1.69</td>
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<td>3.06</td>
<td>2.11</td>
<td>2.13</td>
<td>- 1.08</td>
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Second Stage: Dep. Var. \( Res.\Comm_{i,t}^{BA} \)

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<td>0.3825</td>
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<td>No</td>
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<td>0.3970</td>
<td></td>
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<td>No</td>
</tr>
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<td>3.38</td>
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<td>2.02</td>
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All-in Panel Regressions on Kendall Correlation between Equity and CDS
Bid-Ask:
Economic and Statistical Significance of Explanatory Variables reported.
No fixed effects ($\text{Adj} - R^2 \sim 7\%-8\%).

<table>
<thead>
<tr>
<th></th>
<th>MrkRf</th>
<th>Smb</th>
<th>Hml</th>
<th>TED</th>
<th>Hedge Ratio</th>
<th>Hedge Ratio</th>
<th>Ort</th>
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<tr>
<td>$t$-stat</td>
<td>2.51</td>
<td>2.36</td>
<td>1.96</td>
<td>3.12</td>
<td>4.37</td>
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<td>0.1049</td>
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<td>0.2413</td>
<td>0.1619</td>
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<table>
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<tr>
<th></th>
<th>MrkRf</th>
<th>Smb</th>
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<th>Hedge Ratio</th>
<th>Hedge Ratio</th>
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<tr>
<td>Coeff</td>
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<td>1.27</td>
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<td>0.1164</td>
<td>0.0476</td>
<td>0.2959</td>
<td>0.1113</td>
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</table>
Test (A): Results and Robustness Checks

- Systematic risk factors, TED, and VIX are significant explanatory variables for illiquidity commonality (Kendall measure of association between equity and CDS bid-ask spreads $Comm_{i,t}^{BA}$);
- After these controls, the hedge ratio is still a significant explanatory variable;
- Results survive to several robustness checks: e.g. All-in regression, Use of Pearson and Spearman measures of association, Use of Hedge Ratio orthogonal to market volatility and market default risk.
- Preliminary control of variables’ stationarity: Use sub-sample 18 Firms;
- SS hedge ratio has a higher impact; VX hedge ratio has also a significant effect, but with lower impact and worse fit.
Test (B): Determinants of CDS Bid-Ask Spread

The bid-ask spread in the CDS market is set by dealers upon:

- The cost of hedging the position in the equity market (represented by equity bid-ask spread times the delta-hedging factor);
- The cost of informed trading in equity and credit markets (represented by equity and CDS private information flows);
- The cost of funding needed (proxied by TED);
- The market volatility shocks (proxied by VIX).

Panel Regression Test:

\[ BA_{i,t}^{CDS} = \alpha + \gamma TED_t + \delta VIX_t + \zeta \Phi_{i,t} + \lambda (BA_{i,t}^E \times h_{i,t}^{SS}) + \epsilon_{i,t} \]

- \( BA_{i,t}^{CDS} \): residual CDS bid-ask spreads after removing the autoregressive component;
- \( h_{i,t}^{SS} \): debt-to-equity hedge ratio;
- \( \Phi_{k,t} \): private information relative to the firm which includes:
  1. Information anticipated in CDS returns (related to asset volatility)
  2. Information anticipated by stock returns (related to asset value).
Test (B): Determinants of CDS Bid-Ask Spreads

Panel Regressions: 45 Firms, 337 Weeks, No Firm and Time Fixed Effects,

$$Adj - R^2 \sim 3-4\%$$

<table>
<thead>
<tr>
<th></th>
<th>$h^{SS} \times$ Equity BA</th>
<th>$h^{SS} \times$ Equity BA $\times$ CDS Ret. (Lag 1)</th>
<th>CDS Inn</th>
<th>CDS Inn $\times$ CDS Mispricing (Lag 1)</th>
<th>Equity Inn</th>
<th>TED</th>
<th>VIX</th>
</tr>
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<tbody>
<tr>
<td><strong>Coeff</strong></td>
<td>0.00057</td>
<td>0.00018</td>
<td>0.0019</td>
<td>- 0.0001</td>
<td>0.00074</td>
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<td>6.56</td>
<td>6.25</td>
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<td>3.23</td>
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<td>0.0912</td>
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<td><strong>t-stat</strong></td>
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<td>4.90</td>
<td>6.54</td>
<td>1.90</td>
<td>-1.99</td>
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<td>0.0935</td>
<td>0.0438</td>
<td>-0.0310</td>
<td>0.0569</td>
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</tbody>
</table>
TED spread and market-wide volatility have strong positive significant effects on CDS bid-ask;

- The hedging cost component remains always significant to explain an increase in CDS bid-ask;
- Its effect is higher when CDS demand increases;
- Private information anticipated in CDS returns and related to an increase in asset volatility move upwards CDS bid-ask;
- This effect is higher when larger CDS mispricing arises;
- Private information anticipated in stock returns and related to an increase in asset value decreases CDS bid-ask, but less significantly than CDS private information (asymmetry);
- The results are mainly driven by highly volatile periods (2003 and 2007-2009), when revisions of quotes is more frequent & substantial and CDS-equity illiquidity commonality appears;
- Results survive to controls for fixed effects.
Conclusions

(1) Illiquidity co-moves in equity and credit markets, but the commonality varies in magnitude over time;

(2) There exist illiquidity spillovers across CDS and equity markets (mainly from CDS to equity), not matching with the directions of return and volatility spillovers;

(3) This illiquidity transmission is significantly explained by the firm’s hedge ratio (representing the hedging/arbitrage trading channel across the two markets), even after controlling for the effect of other common risk factors (funding and systematic risks);

(4) Hedging and information costs are significant components of CDS bid-ask spreads, even after controlling for the effect of TED and VIX.
Main Contributions

(1) First work to examine explicitly extent and causes of illiquidity linkages across equity and credit;

(2) First paper to apply the Merton (1974) structural model in market microstructure to capture the transmission of illiquidity shocks across equity and credit markets;

(3) Further investigation on the contribution of funding constraints and market volatility to explain illiquidity commonality (of critical importance since the latest crisis);

(4) Novel framework for modelling derivatives bid-ask spreads;

(5) New interesting results on illiquidity linkages which may be inputs for the development of a consistent theory of cross-market illiquidity contagion.
Recommenations

To regulators and investors:

(1) Monitor more closely the relationship between different markets and the transmission of illiquidity, in particular when markets are characterized by common fundamentals and arbitrage connections.

(2) Develop more sophisticated risk-management tools to control the level of capital available for financial intermediation and the effects of market volatility shocks.
(1) Detect and explain illiquidity commonality across other pairs of correlated assets: e.g. Equity and Equity options.

(2) Model illiquidity contagion caused by Informed Arbitrage: Need for formal model to develop a consistent theory of illiquidity contagion based on arbitrage linkages and information flows across correlated assets.

(3) Identify sources and nature of information flows across equity and credit markets and their effect on prices and bid-ask spreads.
Thank you!