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May 26-28, 2018
Clarion Hotel Sign, Stockholm



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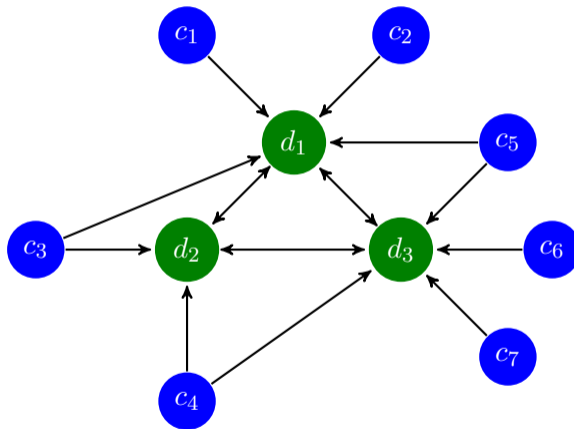
Over-the-Counter Market Efficiency

Darrell Duffie
GSB Stanford

Nobel Symposium on Money and Banking
Stockholm, May, 2018

Drawing on research with Leif B.G. Andersen, Adam Ashcraft, Antje Berndt, Piotr Dworczak, Nicolae Gârleanu, Semyon Malamud, Gustavo Manso, Lasse Heje Pedersen, Lei Qiao, Yang Song, Yeneng Sun, Chaojun Wang, Haoxiang Zhu, and Yichao Zhu

Dealer-intermediated over-the-counter markets



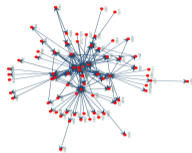
Related research issues

- ① Allocative efficiency.
- ② Price discovery and information sharing.
- ③ Market design.
- ④ Financial stability.

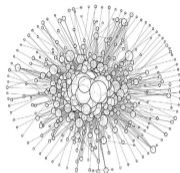
Relevance of OTC market efficiency

- ▶ OTC markets handle the majority of traded assets. Almost all of \$92t outstanding in bonds and \$217t in real estate, 88% of \$599t notional outstanding in derivatives, 17% of trades in \$72t outstanding of public equities, and essentially all trade in currencies, commodities, repos, securities lending, bank loans, and private equities. Data sources: SIFMA, SEC, Savills, Thompson-Reuters, BIS, World Federation of Exchanges.
- ▶ Governments and corporations routinely fund themselves with debt instruments. For example, in 2016, bonds accounted for 86% of U.S. corporate issuances (SIFMA, 2017).
- ▶ A small number of dealer banks intermediate almost all OTC trades in swaps (Nagel, 2016) and the majority of OTC trade in repos, securities lending, FX forwards, equities, currencies (Rime and Schrimpf, 2014), and corporate bonds.

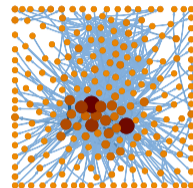
Core-Periphery Dealing Networks in OTC Markets



(a) Li-Schüerhoff



(b) Hollifield-Neklyudov-Spatt



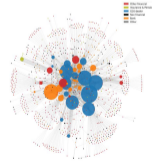
(c) Bech-Atalay



(d) ESRB: IR swaps



(e) ESRB: CDS

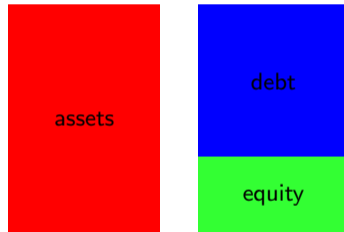


(f) ESRB: FX forwards

Impediments to OTC market efficiency

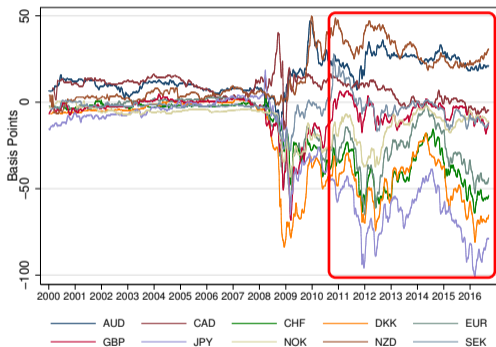
- 1 Sequential trade of assets by search and bargaining. Examples: Rubinstein-Wolinsky (1987), D-Gârleanu-Pedersen (2002, 2005, 2007), D-Sun (2007, 2012), D-Qiao-Sun (2017, 2018), Green-Hollifield-Schurhoff (2007), Li-Schürhoff (2012), Vayanos-Wang (2007), Weill (2008), Vayanos-Weill (2008), Lagos-Rocheteau (2009), Zhu (2012), Afonso-Lagos (2015).
- 2 Opaqueness: Non-dealers request quotes bilaterally or on dealer RFQ platforms, with limited post-trade price transparency. Examples: Green-Hollifield-Schürhoff (2006), D-Manso (2007), Ashcraft-D (2007), D-Manso-Malamud (2009), Goldstein-Hotchkiss-Sirri (2007), Bessembinder-Maxwell (2008), Babus-Kondor (2012), Bessembinder (2012), Asquith-Covert-Pathak (2013), Guerrieri-Shimer (2014), D-Dworczak-Zhu (2017), Chang (2018).
- 3 Limits to dealer formation and exchange migration. Chang-Zhang (2015), Hugonnier-Lester-Weill (2014), Üslü (2016), Farboodi-Jarosch-Shimer (2017), Wang (2017), Lee-Wang (2018).
- 4 High cost of dealer balance-sheet “space.” Adrian-Etula-Muir (2014), He-Kelly-Manela (2016), Du-Tepper-Verdelhan (2018), Andersen-D-Song (2018).

Dealer balance sheet

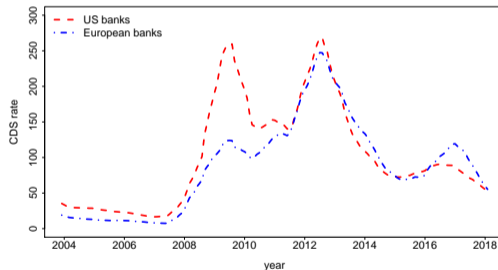


Covered interest parity violations and dealer funding costs

Post-crisis dealer balance-sheet costs leave wider arbitrage bounds on the basis



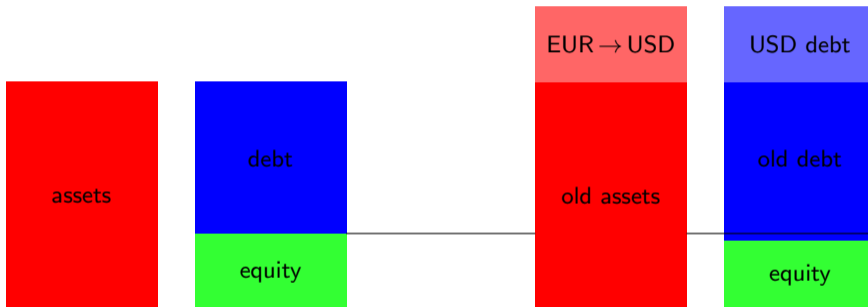
(g) 5-year USD cross-currency basis. Source: Du, Tepper, and Verdelhan (2017).



(h) 5-year dealer credit spreads

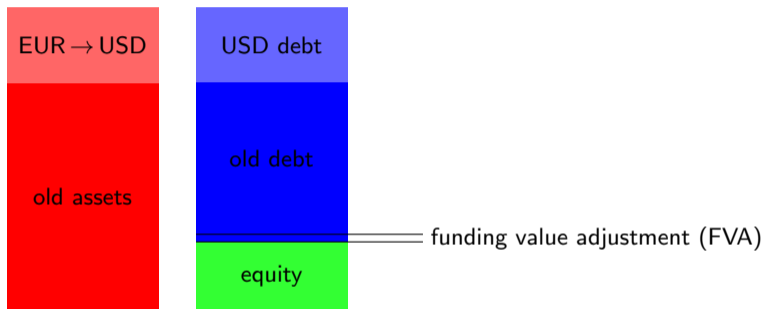
CIP arbitrage can be costly to dealer shareholders

Debt overhang cost for funding synthetic dollar deposits



To benefit shareholders, the trade profit must exceed the funding value adjustment (FVA), a debt-overhang cost.

Funding cost to shareholders



A debt-funded arbitrage is not valuable to bank shareholders unless its excess yield is above the bank's credit spread. Source: Andersen, Duffie, Song (2018)

Modeling the cost of space on a dealer's balance sheet

- ▶ At time 1, the dealer's assets pay A , and its liabilities claim L .

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- ▶ Base case: The dealer funds the trade with new unsecured debt.

Technical assumptions

- 1 There is a finite number of states and $P(A = L) = 0$.

OR

- 2 Under the risk-neutral measure P^*
 - A , L , and Y have finite expectations.
 - Either A and L have a continuous joint probability density, or A has a continuous density and L is constant.

The dealer's post-trade balance sheet

- ▶ If the dealer finances a position of size q by issuing new debt, then its total assets are

$$\mathcal{A}(q) = A + qY$$

and its total liabilities are

$$\mathcal{L}(q) = L + U(q)(R + s(q)),$$

where $R = \delta^{-1}$ is the risk-free rate and $s(q)$ is the dealer's credit spread to finance the new position.

- ▶ The limit credit spread $\lim_{q \downarrow 0} s(q)$ is the dealer's current unsecured spread S .

Marginal value of the trade to dealer shareholders

The marginal increase in the value of the firm's equity, per unit investment, is

$$G = \left. \frac{\partial E^*[\delta(A + qY - L - U(q)(R + s(q)))^+]}{\partial q} \right|_{q=0}.$$

The Funding Value Adjustment

Proposition (Andersen, Duffie, Song (2018))

The marginal increase in equity value is well defined and given by

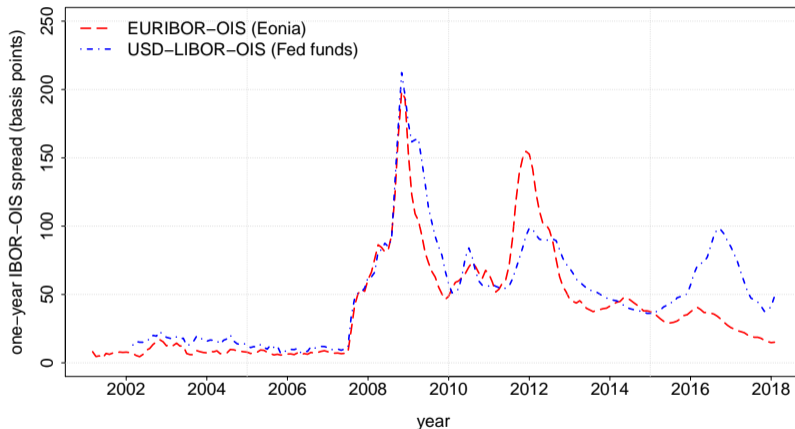
$$G = p^* \pi - \delta \text{cov}^*(1_D, Y) - \Phi,$$

where

- ▶ $p^* = 1 - P^*(D)$ is the risk-neutral survival probability.
- ▶ $\pi = \delta E^*(Y) - u$ is the marginal profit on the trade to a hypothetical risk-free dealer.
- ▶ $\Phi = \delta p^* u S$ is the funding value adjustment (FVA).

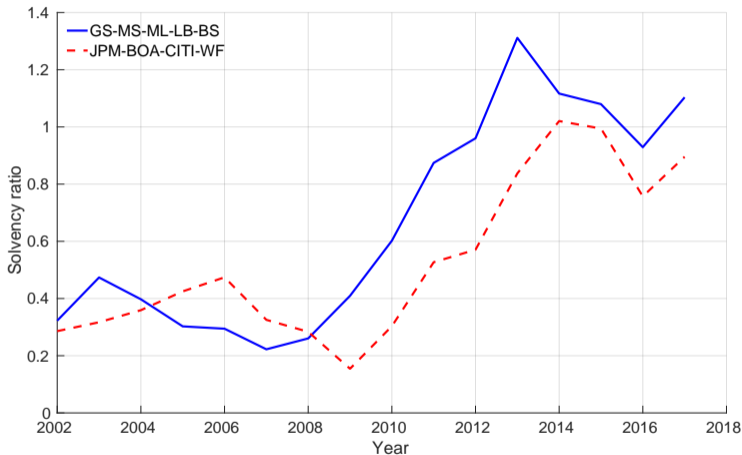
In terms of required excess yield, FVA implies a funding-cost wedge of roughly the unsecured credit spread of the dealer.

Increased dealer credit spreads imply a larger funding-cost wedge



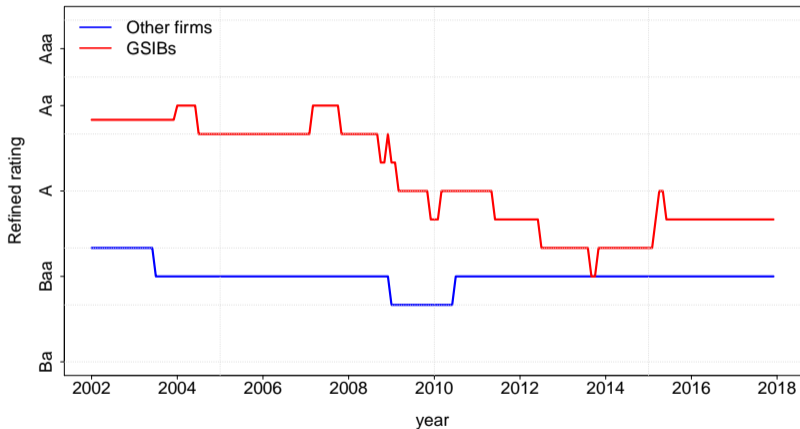
Spreads between one-year IBOR and OIS rates. Data source: Bloomberg.

But big dealer-banks now have much bigger capital buffers



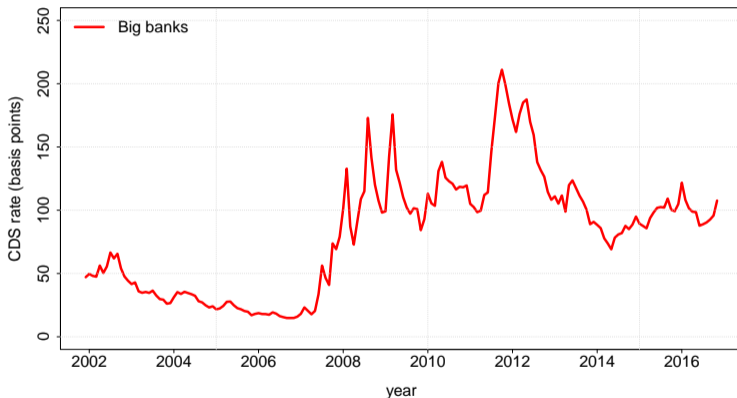
Solvency ratio: tangible equity divided by an estimate of the standard deviation of the annual change in asset value. Source: Berndt, Duffie, and Zhu (2018).

G-SIB credit ratings no longer include sovereign uplifts



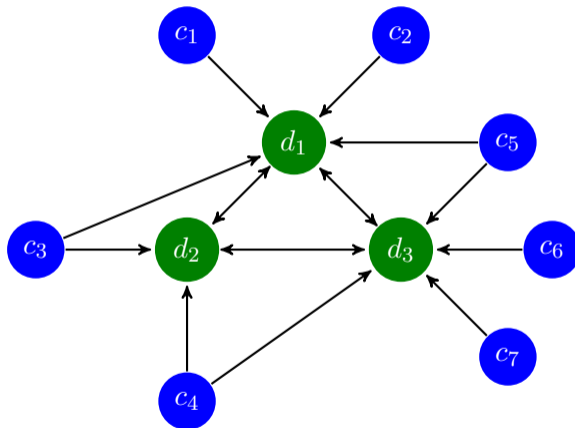
Median refined credit ratings. Data source: Moody's Investors Service.

G-SIB 5-year credit spreads at annual default probability of 0.5%

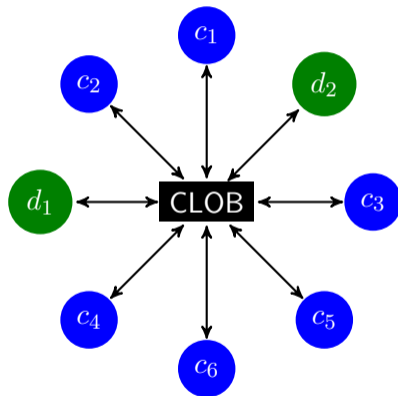


From a preliminary panel regression of log 5-year CDS rates on distance to default, for 1.6 million observations, 855 firms, 2002-2017, with interacted time and G-SIB fixed effects. Source: Berndt-Duffie-Zhu (2018).

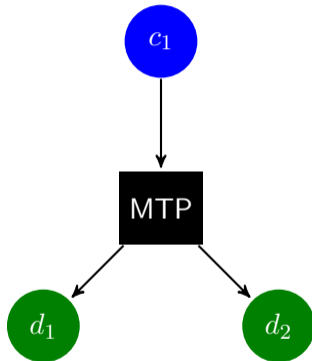
A dealer-intermediated bilateral OTC market



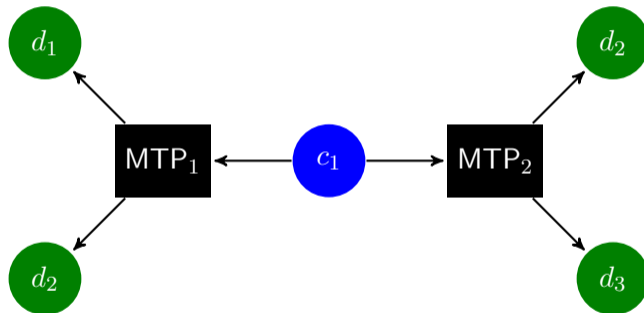
Conditions for migration of trade to exchanges



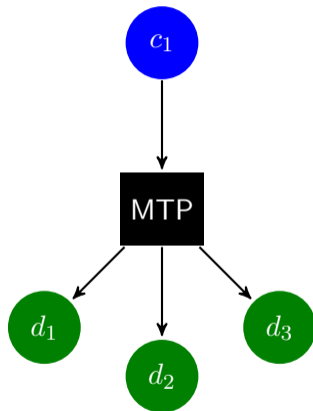
Buy-side firms request quotes at multilateral trading platforms



But with fragmentation across platforms

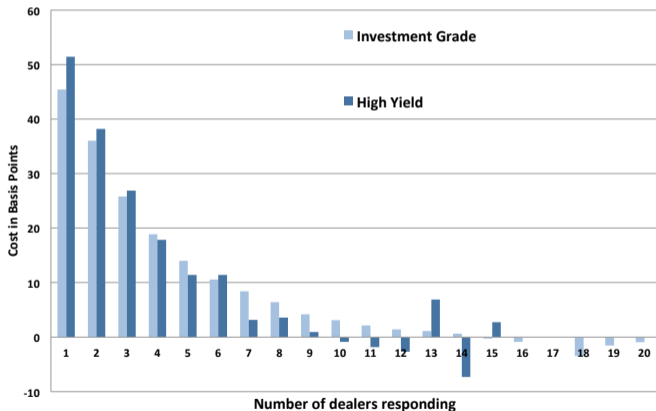


Reducing fragmentation improves competition



At corporate bond platforms

Dealer competition lowers buy-side trade costs



Source: Hendershott and Madhavan (2016)

Now typical fragmented two-tiered OTC markets

