The Liquidity of Credit Default Index Swap Networks

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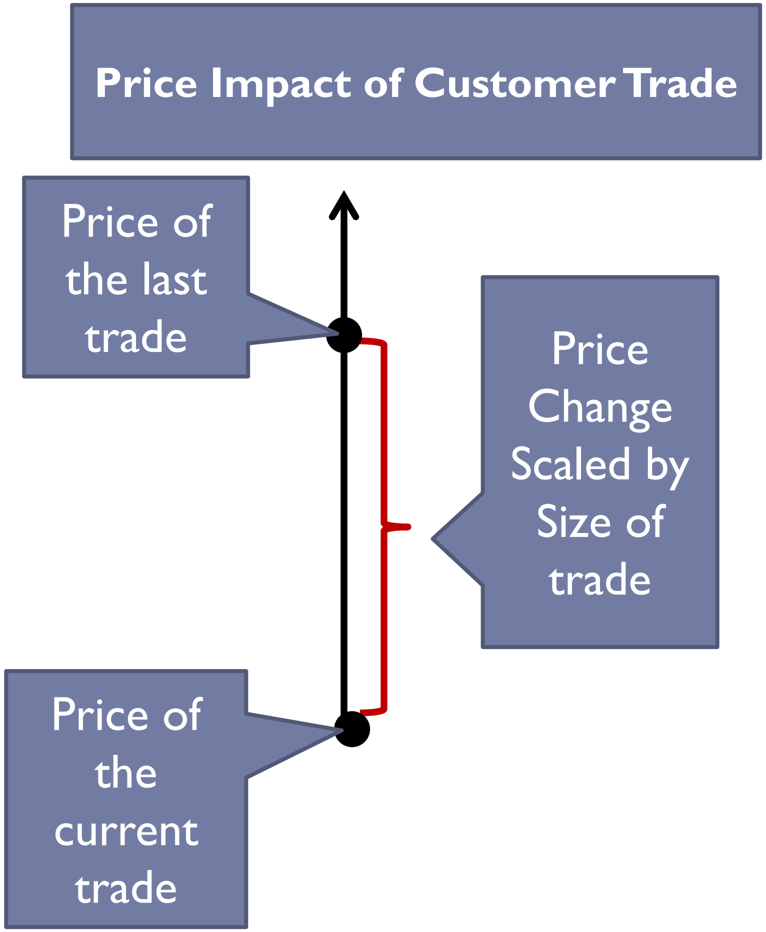
Motivation

- Single name Credit Default Swaps (CDS) are used to buy and sell credit risk. Buying CDS is similar to purchasing credit insurance. Credit Default Index (CDX) swaps or CDS indices are standalone contract to gain credit exposure to a broad portfolio.
- CDX trading has gone through dramatic changes, in part due to mandatory clearing, Swap Execution Facility (SEF) trading, and reporting; and the entrance of new liquidity providers.
- We seek to understand what drives liquidity in these markets , because these swaps provide the most efficient way to hedge or speculate on credit.
- We have details for each trade including timestamp, ticker, counterparties (name, LEI, and dealer/customer), notional, price/trade spread, and etc.

Liquidity Measure and Key Findings



- Liquidity Measure
  - Price Impact of customer trades, roughly Amihud
    - A customer may push the price up when longing CDX and push the price down when shorting CDX.
    - Larger price impact indicates less liquidity.
    - Larger price impact indicates higher customer execution costs.
  - Price dispersion as an alternative measure
- What characteristics of customers/dealers may have effects on our liquidity measure?
  - Larger sophisticated clients have less price impact or incur lower trading cost.
    - Customers trading with more dealers (high network degree) and having connections with more active dealers (high network centrality)
    - For example, from May 2014 to Sep 2016, for CDX.NA.IG, price impacts for the 10 largest customers were 13% lower than the average. For a typical trade of 100 $MN, price impact for the top 10 customers were about 0.42 bps, while those for an average customer were about 0.483 bps.

Credit Derivative indices

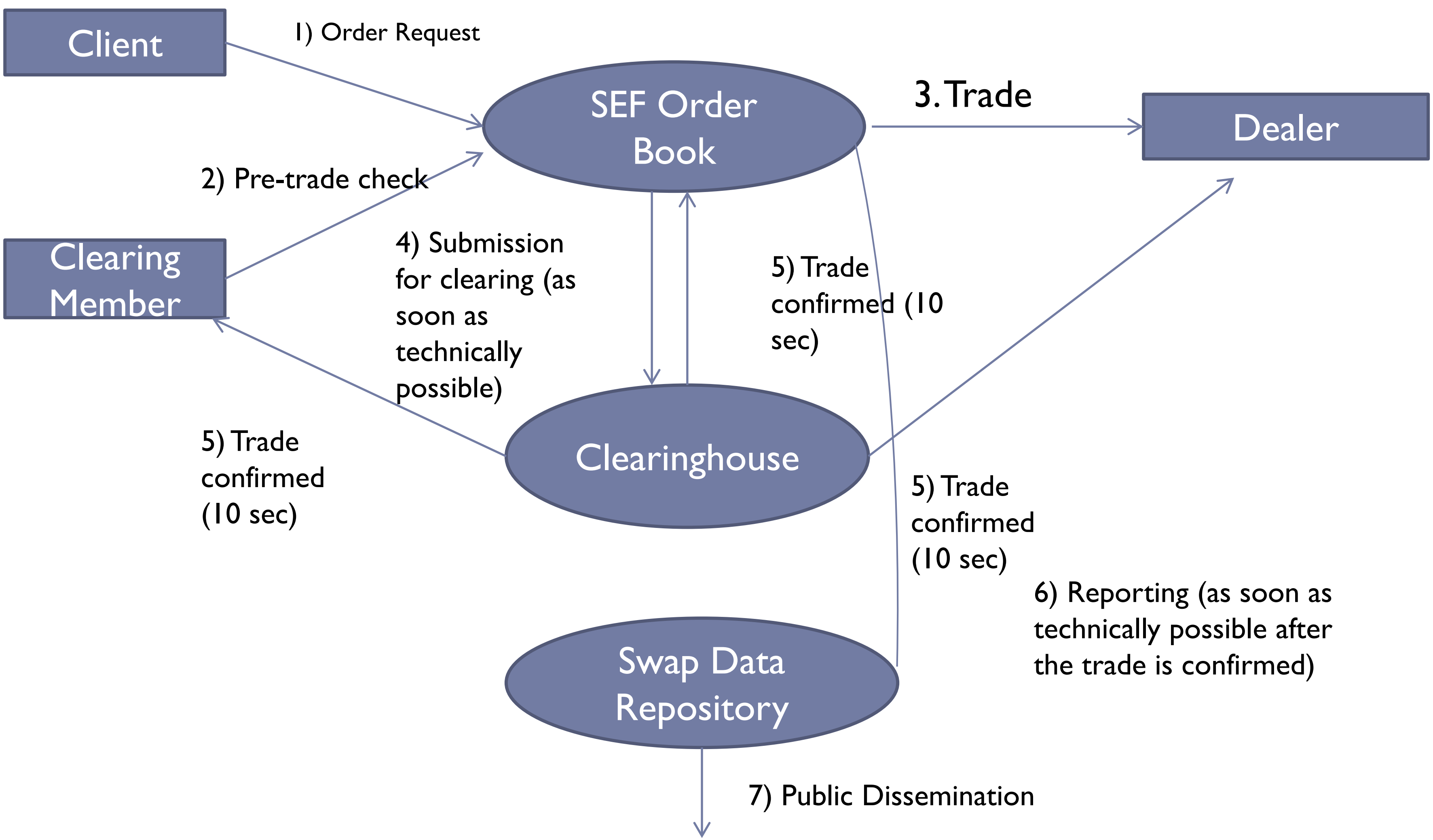
US Indices	**European Indices**
CDX.NA.IG	**iTraxx Main** + Sub Indices
CDX.NA.HY	iTraxx HiVol
	iTraxx Crossover (High Yield)
	SovX West Eur

Asia Indices	**Emerging Markets Indices**
iTraxx Japan + Sub Indices	CDX.EM
iTraxx Asia ex-Japan + Sub Indices	SovX CEEMEA
iTraxx Australia	CDX LatAm Corp
SovX Asia/Pac	

CDX Market Structure - Change due to Regulatory Reforms

- Mandatory clearing for standardized products including certain CDX swaps
  - Began on March 11, 2013.
  - Market participants no longer have ongoing credit exposure to each other, instead have exposure to CCPs.
  - Intend to encourage new liquidity providers.
- Mandatory trading on Swap Execution Facility (SEF) platform
  - Facilitates automated swap execution.
  - Provides pre-trade information.
  - Limit Order Book (LOB) or Request for Quote (RFQ)
  - Took effect on Feb. 17, 2014.
- Mandatory reporting to the Swap Data Repository (SDR)
  - Post-trade transparency
  - Trade details were sent to the SDR
- Margin requirement for uncleared swaps
  - Was finalized in 2016 and largest dealers were required to post and collect Initial Margin (IM) starting in Sep. 2016,
  - Variation Margin (VM) exchange for uncleared swaps is required for all SDs and financial end users with material swap exposure starting in Sep. 2017.

Flow Charts for Trades subject to Trading, Clearing and Reporting obligations



Agenda

- Literature
- Data and Sample Description
- Credit Index Swap Market Overview
- Regression Analysis
- Summary

Literature

1) Bank of England Staff Paper (2016) found that the introduction of SEF trading improved liquidity in interest rate swap markets, including a reduction in transaction cost and price dispersion.
2) Loon and Zhong (2016) found that execution cost related measures for single name CDS fell after the introduction of the public price feed.
3) Hendershott and Madhavan (2015) found that electronic trading technology such as RFQ that enables customers to simultaneously search many bond dealers, reduces search cost and improves execution quality.
4) Bessembinder et al (2006) found that an increase in price transparency through the TRACE system reduced transaction costs even for related bonds that are not eligible for TRACE reporting.
5) Duffie et al (2005) find that bid-ask spreads are lower when investors have easy access to multiple market makers, in part due to the relative bargaining power of investors and market makers.
6) Li and Shurhoff (2014) found that central dealers of OTC bond market could help provide execution immediacy partly through their ability to hold higher levels of inventory. As dealer centrality increases, trading costs for customers also increase, likely leading customers to a choice between the speed of execution and the cost of execution.
7) Iercosan and Jiron (2017) found that in the single name CDS market, less central clients including those that trade with fewer counterparties, are faced with higher average transaction costs.

Data and Sample Description

- Sample includes on-the-run series on most active reportable CDX: 5 Year CDX.NA.IG, CDX.NA.HY, and ITRAXX.Europe

- Trade details include timestamp, ticker, counterparties (name, LEI, and SD/NonSD classification), notional. Also includes traded spread defined below:
  - Traded spread is credit spread on corporate bonds in the index, which is additional return earned above the "risk-free" rate compensating for exposure to corporate risk
  - CDX trade like bonds:
    - 100 bps coupon/par spread for IG and 500 bps coupon for HY
    - IG is quoted in spreads while HY is quoted in prices
    - Bloomberg SDR reports spreads based on prices for HY
  - Upfront premium is also included. If trade is larger than coupon, upfront is positive (see appendix)

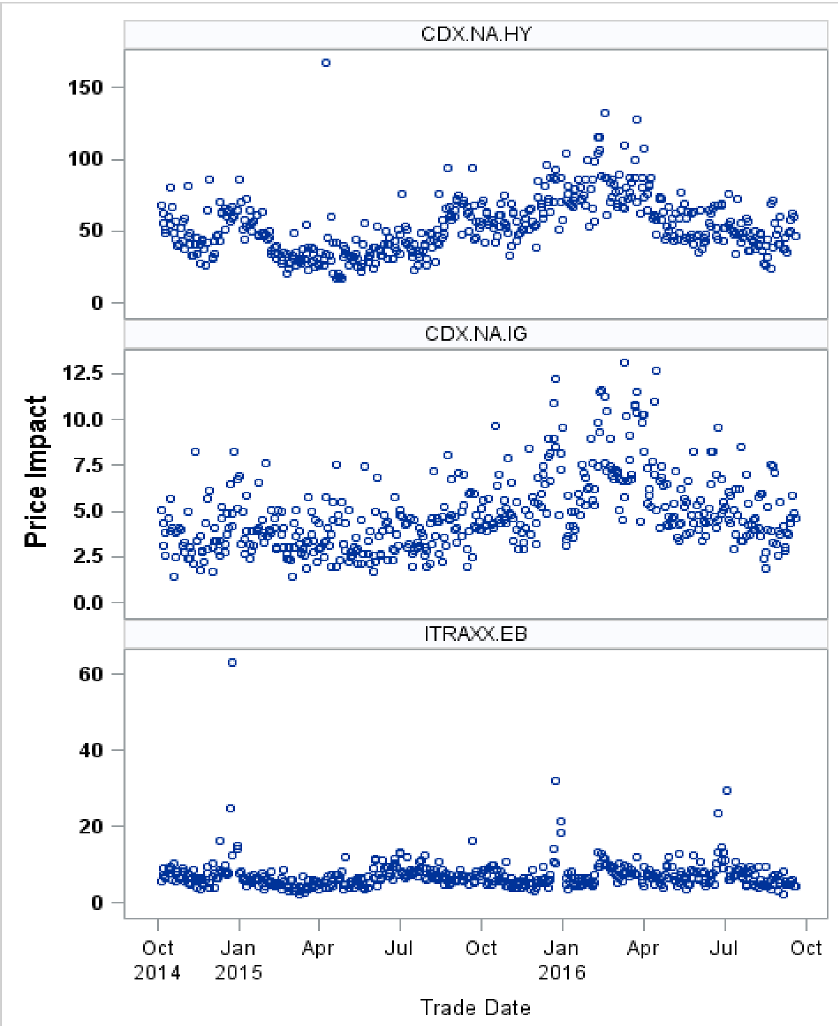
- Time period from May 2014 to September 2016.

- Filters applied
  - Filter out trades with multiple legs, and block trades.
  - Exclude trades occurred outside the time window 9:00 -15:00 ET (14:00-20:00 GMT) for CDX and 8:00-14:00 GMT for ITRAXX
  - Omit all the trades with notional less than $5 million
  - Exclude trades with extreme price impact due to data reporting errors

BSEF Market Overview 2014/05-2016/09

Series	Variable	N	Mean	Median	Min	Max	10th Pctl	90th Pctl
CDX.NA.HY	Daily trade count	490	159	146	9	478	76	259
	Daily volume of trade ($BN)	490	2.614	2.309	0.111	9.208	1.150	4.362
	Daily avg trade size ($BN)	490	0.016	0.016	0.009	0.080	0.013	0.021
	Daily avg credit spreads (bps)	490	403.547	389.747	290.426	593.490	336.571	493.837
	Daily no. of customers	490	45	44	3	95	28	62
	Daily no. of dealers	490	14	14	5	19	11	16
	Minutes between trades	77675	3.508	1.683	0.000	160.733	0.217	8.650
CDX.NA.IG	Daily trade count	490	108	99	6	331	47	182
	Daily volume of trade ($BN)	490	7.050	6.166	0.235	22.668	2.655	12.191
	Daily avg trade size ($BN)	490	0.065	0.062	0.031	0.214	0.048	0.084
	Daily avg credit spreads (bps)	490	76.571	73.670	58.117	125.841	63.328	93.842
	Daily no. of customers	490	32	32	4	63	19	45
	Daily no. of dealers	490	15	15	5	23	12	18
	Minutes between trades	52878	5.053	2.417	0.000	189.617	0.283	12.583
ITRAXX.EB	Daily trade count	495	89	81	2	313	34	149
	Daily volume of trade ($BN)	495	3.969	3.472	0.025	16.688	1.375	6.750
	Daily avg trade size ($BN)	495	0.044	0.042	0.013	0.102	0.033	0.056
	Daily avg credit spreads (bps)	495	71.313	70.056	48.060	123.572	56.849	88.183
	Daily no. of customers	495	19	18	1	45	12	27
	Daily no. of dealers	495	14	15	3	22	11	17
	Minutes between trades	43816	6.322	2.975	0.000	262.383	0.317	15.550

Daily Average Price Impact for Dealer To Customer (DTC) Trades



$$PriceImpact_i = \frac{1}{(N_i - 1)} \sum_{t=2}^{N_i} \frac{(|P_{i,t} - P_{i,t-1}|)}{Q_{i,t}}$$

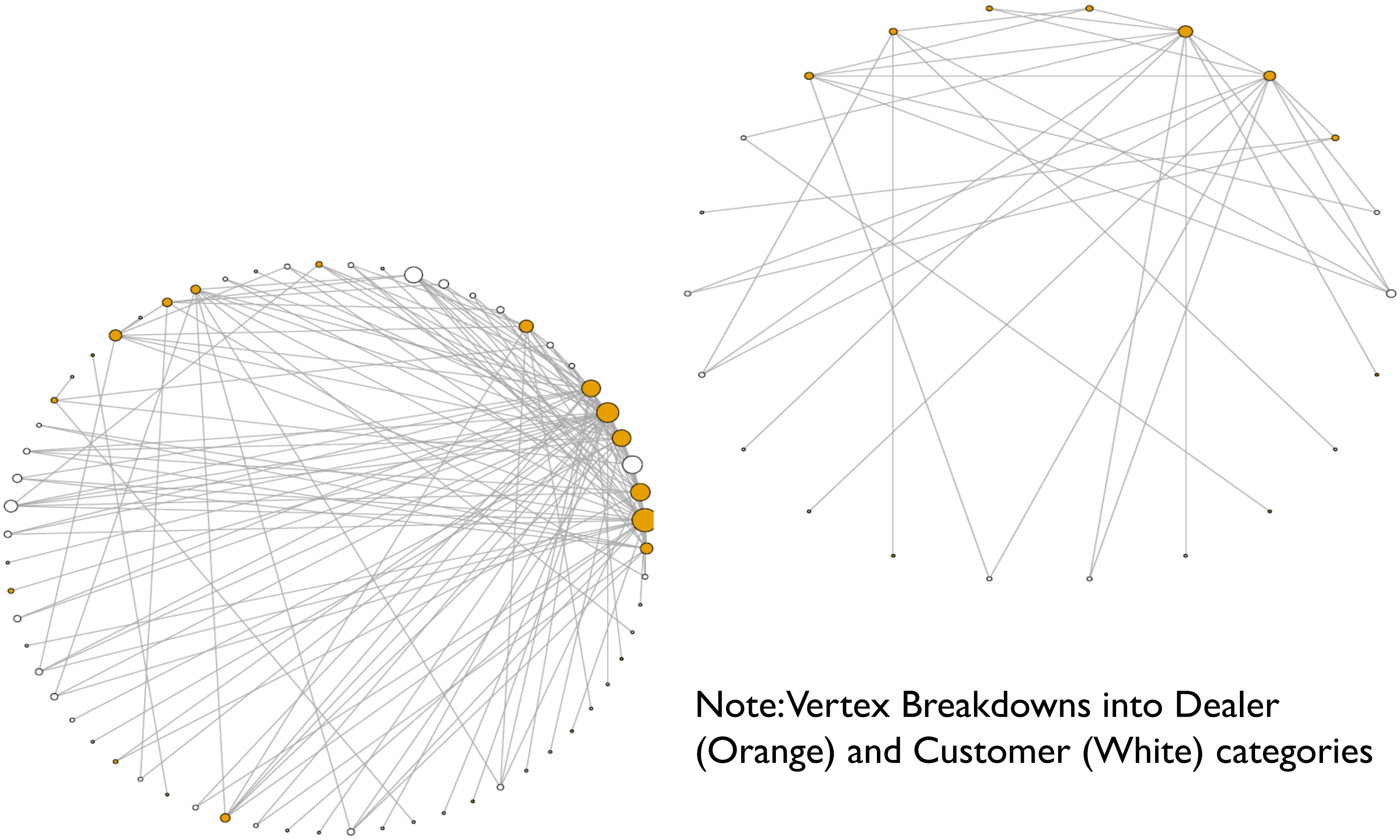
where $P_{i,t}$ and $P_{i,t}$ represent the price and the notional of the t-th trade in day i, N_i represents the total number of trades on day i. Roughly Amihud.

- For CDX.HY and CDX.IG, price impacts have been stable over the sample period, indicating stable liquidity conditions (early 2016, higher)
- For ITRAXX.EB, price impacts are lower more recently, perhaps indicating improving liquidity.

Regression Analysis

- What market wide factors explain daily variation in price impact for customer trades? We test (and then control) for:
  - Price (credit spreads/risk level)
  - VIX
  - Volume of Trade
- What characteristics of customers/dealers may have effects? We look at a few, increasingly complex, "market power" measures for customers/dealers
  - Herfindahl-Hirschman Index (HHI): measures the sum of squared market share of each player for each index market (e.g. < 0.15 competitive market; > 0.25 highly concentrated).
  - Degree: measures the number of unique CPs for each player trading in each index market (we don't know how many are asked)
  - Bonacich (1987) Centrality: takes into account the strength and the size of direct and indirect trading relationships. A player is important if it is heavily trading with other players that are important.

Examples: CDX.NA.IG Trading Network on 10/15/2014 (Left) and 01/02/2015 (Right)



Note: Vertex Breakdowns into Dealer (Orange) and Customer (White) categories

Regression on Price Impact of DTC Trades

Price Impact for Dealer to Customer Trades				
Estimates				
	4	3	2	1
DTC Volume	-0.98	-0.53	-0.70	-0.80
VIX	0.19	0.19	0.28	1.47
Daily Average Spread	0.20	0.21	0.20	
Average Dealer Degree	0.72			
Average Dealer Centrality	36.15			
Average Non-dealer Degree	-2.31			
Average Non-dealer Centrality	-41.34			
Dealer HHI		176.78		
Non-dealer HHI		-59.02		
CDXIG	-10.99	-19.19	-12.51	-17.85
CXPHY	-31.42	-39.95	-30.07	28.93
ITXEB	-6.99	-16.25	-10.21	-16.72
R-square	0.89	0.89	0.88	0.82

Note: all estimates in black are significant at 1% level except coefficients in red for Average Dealer Degree, Average Dealer Centrality, and Dealer HHI.

- Results match findings in previous literature.
- DTC volume ↑ ⇒ Price Impacts ↓
- VIX or credit spreads ↑ ⇒ Price Impacts ↑
- When the average customer trades with more CPs, or the average customer trading in the network is more important, price impact is lower
- **Concentration and network measures for dealers do not seem to have a significant effect on liquidity.**

Robustness Checks:
Regression on Price Dispersion for DTC Trades

Price Dispersion for Dealer to Customer Trades				
	Estimates			
	4	3	2	1
DTC Volume	0.000454632	0.000792	0.00082	0.000818
VIX	2.36299E-05	7.05E-05	8.25E-05	0.000109
Daily Average Spread	0.000001819	3.7E-06	4.36E-06	
Average Dealer Degree	0.000530266			
Average Dealer Centrality	-0.000127512			
Average Non-dealer Degree	0.000206666			
Average Non-dealer Centrality	-0.002047369			
Dealer HHI		-0.00302		
Non-dealer HHI		-0.0393		
CDXIG	0.000508216	0.002584	0.00137	0.00125
CXPHY	-0.000352364	0.00317	0.001851	0.003152
ITXEB	0.001758162	0.003903	0.002321	0.002174
R-square	0.217209	0.189563	0.181834	0.180526

Note: all estimates are significant at 1% level except coefficients in red.

A volume-weighted price dispersion measure where we use the daily average execution price as price benchmark. Specifically,

$$DispVW_{i,t} = \sqrt{\sum_{k=1}^{N_{i,t}} \frac{Vlm_{k,i,t}}{Vlm_{i,t}} \left(\frac{P_{k,i,t} - \bar{P}_{i,t}}{\bar{P}_{i,t}}\right)^2}$$

where $N_{i,t}$ is the total number of trades executed for contract i on day t, $P_{k,i,t}$ is the execution price of transaction k, $P_{k,i,t}$ is the average execution price on contract i and day t, $Vlm_{k,i,t}$ is the volume of transaction/notional k and $Vlm_{i,t} = \sum_k Vlm_{k,i,t}$.

Story is similar

- Higher volume, higher price dispersion.
- Higher VIX, higher price dispersion.
- Higher credit spreads/risk, higher price dispersion.
- Higher market share of the average customer, lower price dispersion.

Additional regressions include dummy indicating before and after Citadel becoming a dealer

- Did not find that Citadel becoming swap dealer improved liquidity

Daily Average Price Impacts for Customers All vs Top 10

CDX.NA.IG					
Variable	N	Mean	Std Dev	Minimum	Maximum
Price_Impact	489	4.825	2.058	1.411	13.118
Price_Impact_top10	477	4.196	3.262	0.312	30.580
diff	477	0.582	2.755	-22.109	10.586

CDX.NA.HY					
Variable	N	Mean	Std Dev	Minimum	Maximum
Price_Impact	489	53.6426	19.8206	17.4769	167.489
Price_Impact_top10	482	49.7845	22.7436	6.39772	170.253
diff	482	3.53696	16.4107	-78.312	77.3972

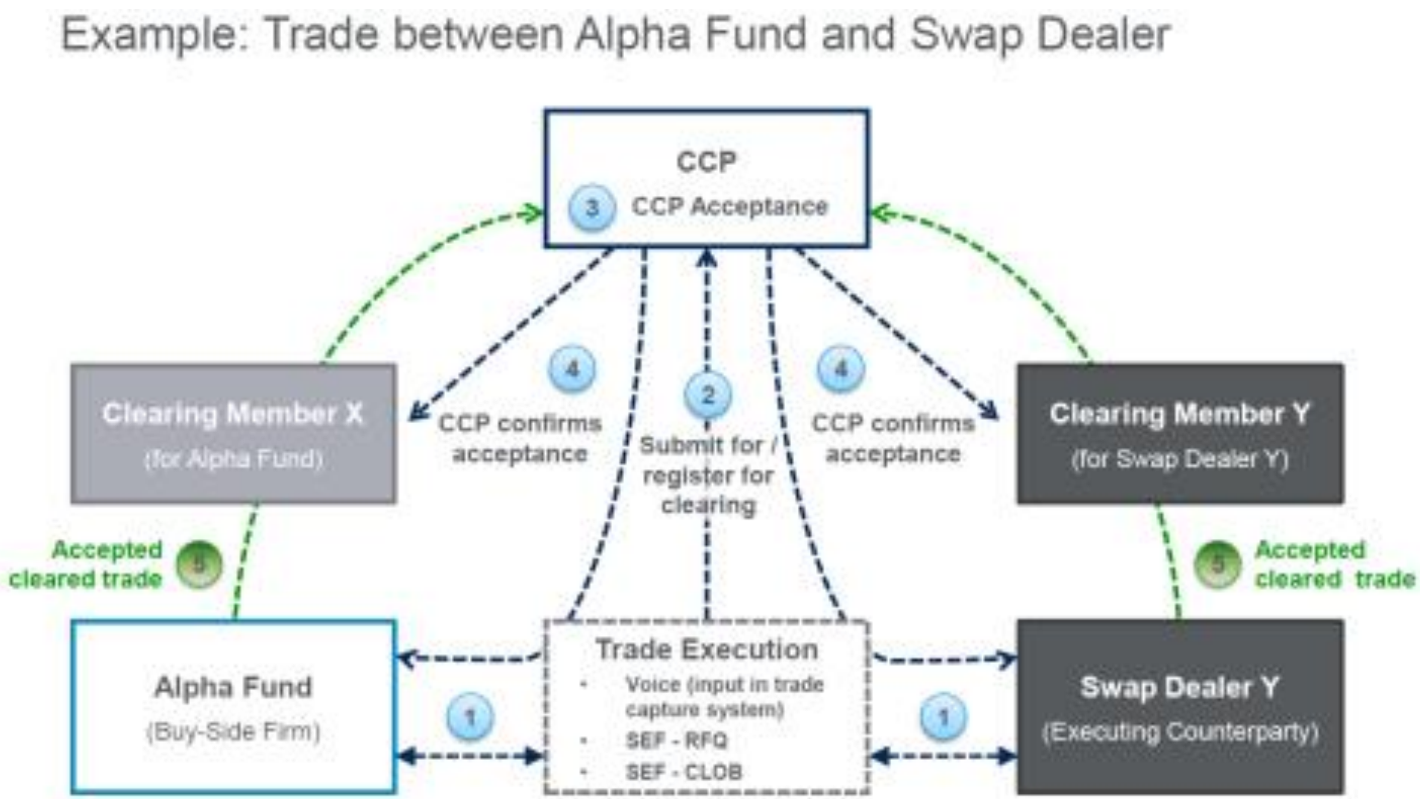
ITRAXX.EB					
Variable	N	Mean	Std Dev	Minimum	Maximum
Price_Impact	494	7.09767	3.98285	1.96585	63.1111
Price_Impact_top10	492	6.98422	5.74366	1.5417	105.833
diff	492	0.00416	4.20449	-76.582	12.4483

- Price Impacts for top 10 customers are 0.58 bps lower for CDX.IG.
- Price Impacts for top 10 customers are 3.54 bps lower for CDX.HY.
- Price Impacts for top 10 customers are only 0.004 bps lower for ITRAXX.EB.

Summary

- Stable Liquidity in CDX.NA.IG and CDX.NA.HY.
- Improved liquidity in ITRAXX.EB recently.
- VIX and credit risks are main drivers of price impacts for customer trades.
- Concentration and network measures for customers do matter. The more powerful customers are, the lower their price impacts.
- Concentration and network measures for dealers do not seem to matter.
- Citadel becoming swap dealer did not bring down price impacts for customers.
- Questions? Comments? Thank you.

Appendix

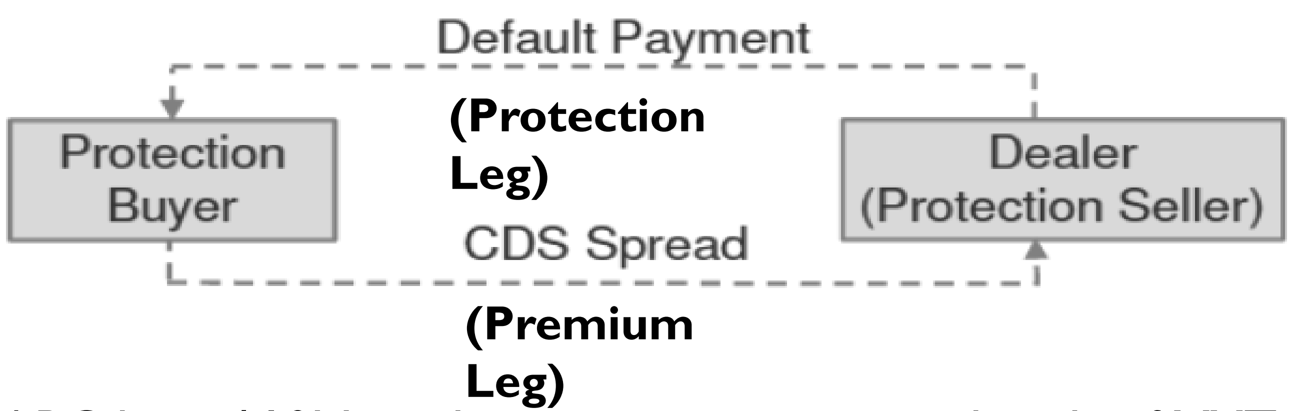

Example: Trade between Alpha Fund and Swap Dealer
CCP
3 CCP Acceptance
Clearing Member X
(for Alpha Fund)
4 CCP confirms acceptance
2 Submit for / register for clearing
4 CCP confirms acceptance
Clearing Member Y
(for Swap Dealer Y)
Accepted cleared trade 5
5 Accepted cleared trade
Alpha Fund
(Buy-Side Firm)
1
Trade Execution
Voice (input in trade capture system)
SEF - RFQ
SEF - CLOB
1
Swap Dealer Y
(Executing Counterparty)

Appendix

- Credit Default Swaps – The Basics
- Index CDS (CDX) – The basics
- CDS Settlement after Credit Event
- CDS Premiums and Profit/Loss

Credit Default Swaps – The Basics

- **Credit Default Swap (CDS):** Is insurance against default of a debt instrument.
- **CDS Spread** is the cost of the insurance paid by protection buyer to seller.
- **Default payment** (i.e. payoff) is based on the **cheapest-to-deliver (CTD)** obligation with the same seniority. Protection owner decides which bond to deliver so "cheapest" bond is given to protection seller in return for par. Default occurs if reference entity defaults on any debt that is pari passu (same rank) with reference obligation or higher



- Example: ABC buys $10M credit protection on senior bonds of XYZ. XYZ defaults on subordinated debt. How much is the default payment assuming XYZ has two senior bonds trading at 25% and 30% of par respectively?
- Answer: ABC receives payment of CTD bond = (1 – 0.25) x $10M = $7.5M

Index CDS (CDX) – The Basics

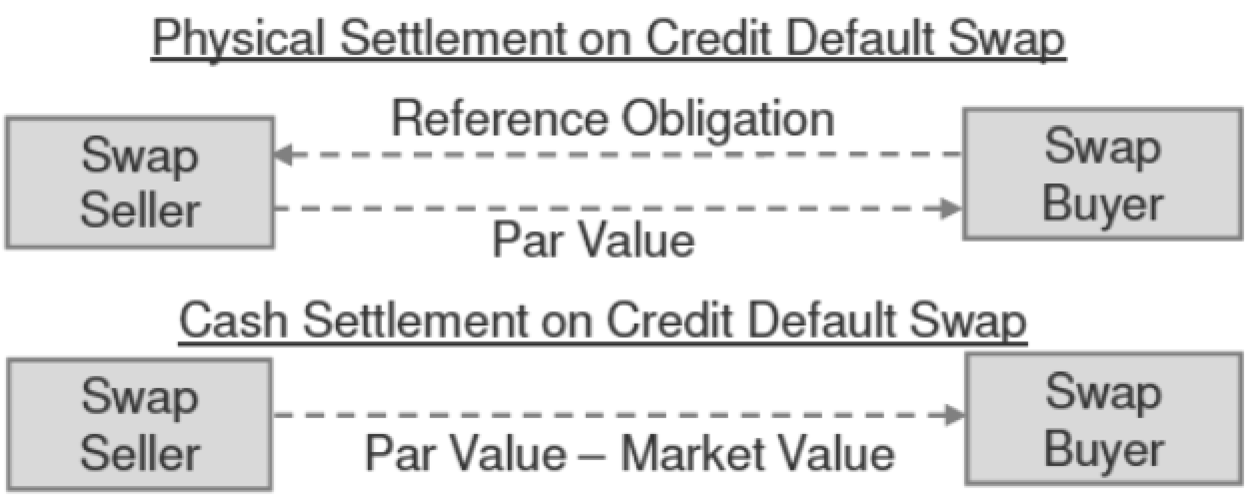
- **Index CDS (CDX):** Is an equally weighted basked of CDS. Correlation of default probabilities is a critical factor in valuing CDX.

Index	Description	Number of Entities
CDX-IG	North America—Investment Grade	125
CDX-HY	North America—High Yield	100
iTraxx Main	Europe, Asia, Australia—Investment Grade	125
iTraxx Crossover	Europe, Asia, Australia—High Yield	Up to 50

- Example: ABC buys $100M of CDX-IG. One reference entities defaults. Its bonds trade b/t 20-30% of par. Calculate: 1) Payoff of CDX-IG and 2) Notional of CDX-IG owned by ABC after payoff.
- Answer:
  - Bond trading at 20% of par is "cheapest to deliver"
  - ABC receives payoff of = (1/125)(1 – 0.2) x $100M = $0.533M
  - Notional Value = (124/125) x $100M = $99.2M

CDS Settlement after Credit Event

- **ISDA Credit Events:** ISDA's "Determination Committee" declares when a credit event has occurred. These events include bankruptcy, failure to pay, and restructuring (when issuer forces creditor to accept new terms).
- Settlement can be physical or cash



CDS Premiums and Profit/Loss

- **Upfront Premium** = PV(protection leg) – PV (premium leg)
- **Upfront Premium** ≈ (CDS Spread – CDS Coupon) x CDS Duration
- **CDS Price** (per $100 notional) ≈ $100 – Upfront Premium (%)
- **Profit for Protection Buyer** = Δ CDS Spread x CDS Duration x Notional
- **Profit for Protection Buyer** (%) = Δ CDS Spread % x CDS Duration

Intuition: Spread > Coupon means CDS value is up since origination

- Example: A CDS with notional of $10M has a coupon of 5%, spread of 3.5%, and CDS duration of 7. The spread increases to 6%. Calculate the upfront premium (%), initial CDS price, and the profit for the protection *seller*.

- Answer:
  - Upfront premium = (3.5% - 5%) x 7 = - 10.5% …negative means protection seller pays $1.05M upfront to the protection buyer.
  - Initial CDS Price = (1 – – 0.105) x $10M = $11.05M
  - Profit for Seller = –2.5% x 7 x $10M = –$1.75M …same as Δ in CDS Price