

Intermediation and complexity in over-the-counter (OTC) trading

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Complex Networks in Banking and Finance (CoNBaF)

Fields Institute, University of Toronto

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Outline of the presentation

1. Complexity as *relationships among relationships*



2. Topological measures for OTC trading in corporate bonds

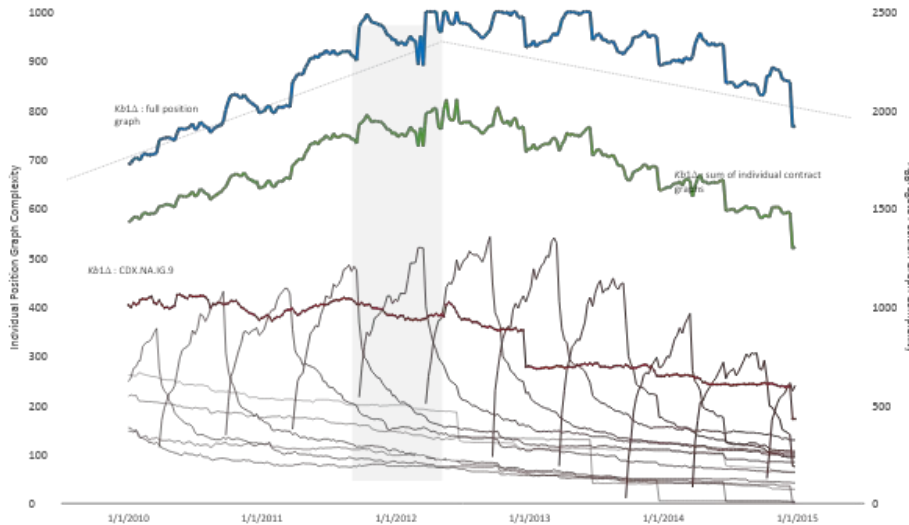
- Academic TRACE data, 2003-2018

3. Empirical application to market liquidity

- Granger causality

Related work – CDSs and BHCs

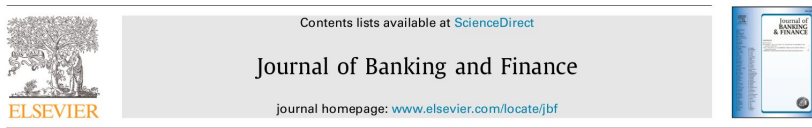
Risk exposure cycles in the market for credit default swaps (CDS) in the “London Whale” episode



The Complexity of Financial Networks Through a Topological Lens

siam
Society for Industrial and Applied Mathematics

Ownership hierarchies and resolution complexity in bank holding companies



The Complexity of Bank Holding Companies: A Topological Approach

Mark D. Flood^a, Dror Y. Kenett^{b,c}, Robin L. Lumsdaine^{d,e,f,g,h,i,j}, Jonathan K. Simon^j

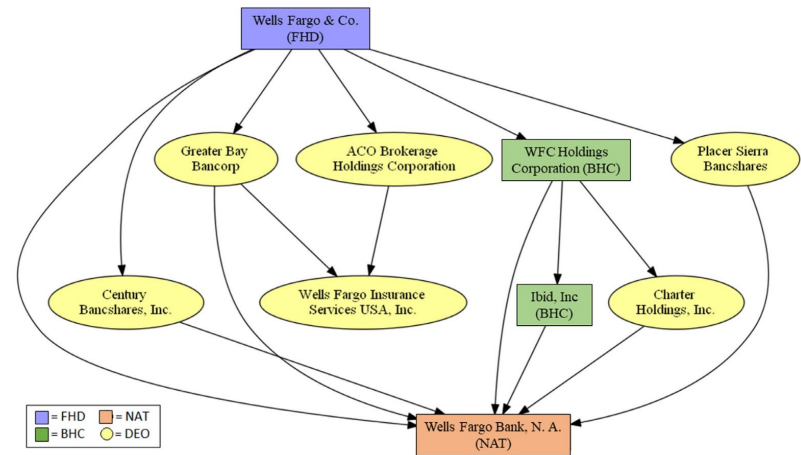
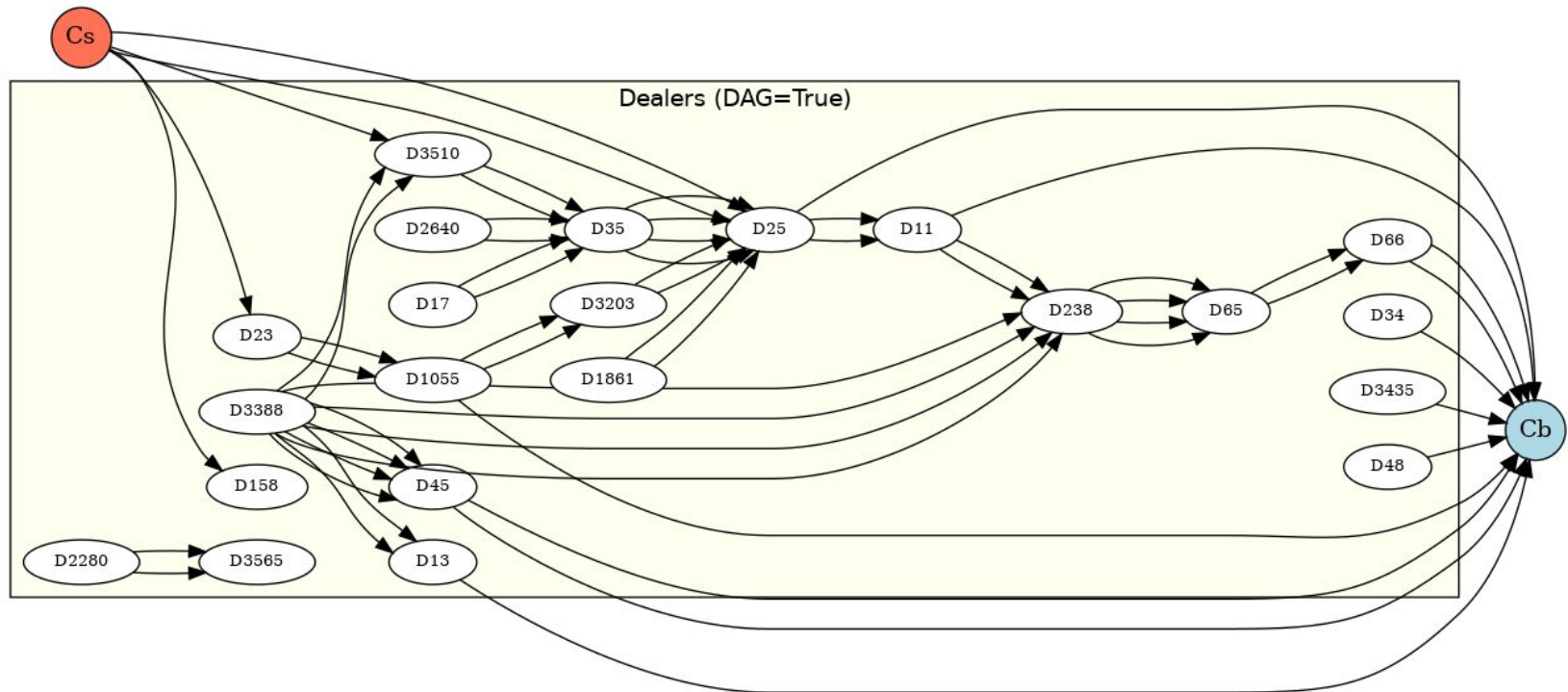


Fig. B.3. Ownership cycles in Wells Fargo BHC hierarchy, 2010, before quotienting. Source: Federal Financial Institutions Examination Council; authors' analysis.

TRACE dealer graph

Trade Reporting and Compliance Engine (TRACE)

- Corporate bond trades (or “deals”), reported to FINRA within 15 min of transaction
- All market-participant (or “dealer”) trades, including trades with customers (or “clients”)
- Typical day has ca. 70K trades, involving ca. 7K distinct CUSIPs
- Approximately 1.6M bond-day networks (or “shards”), 2003-2018



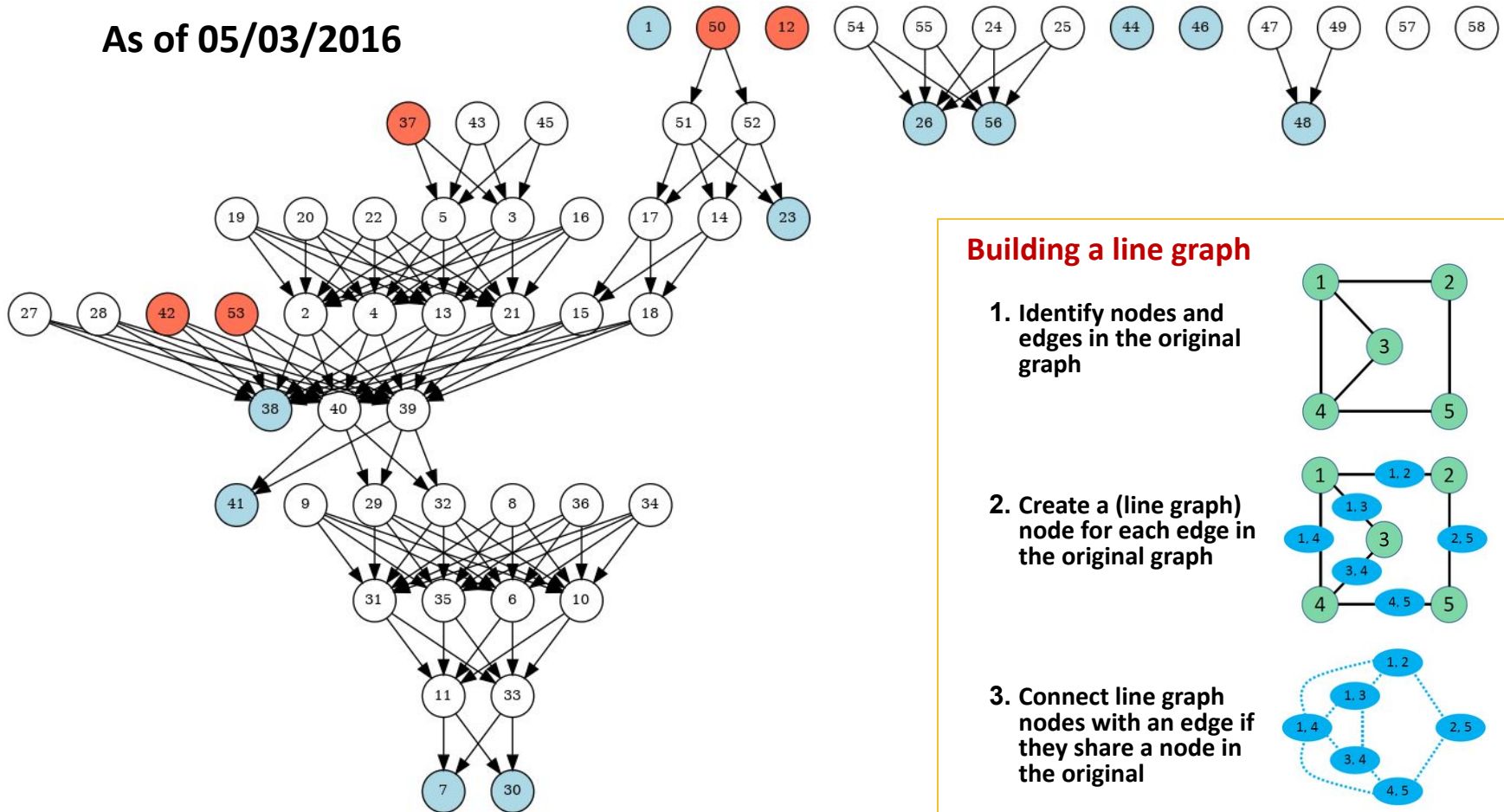
BANK AMER CORP 2.625%, 10/19/2020 maturity, non-callable (CUSIP=06051GFT1)

- **As of 05/03/2016, 58 transactions among 22 dealers (+ client buyers & sellers)**

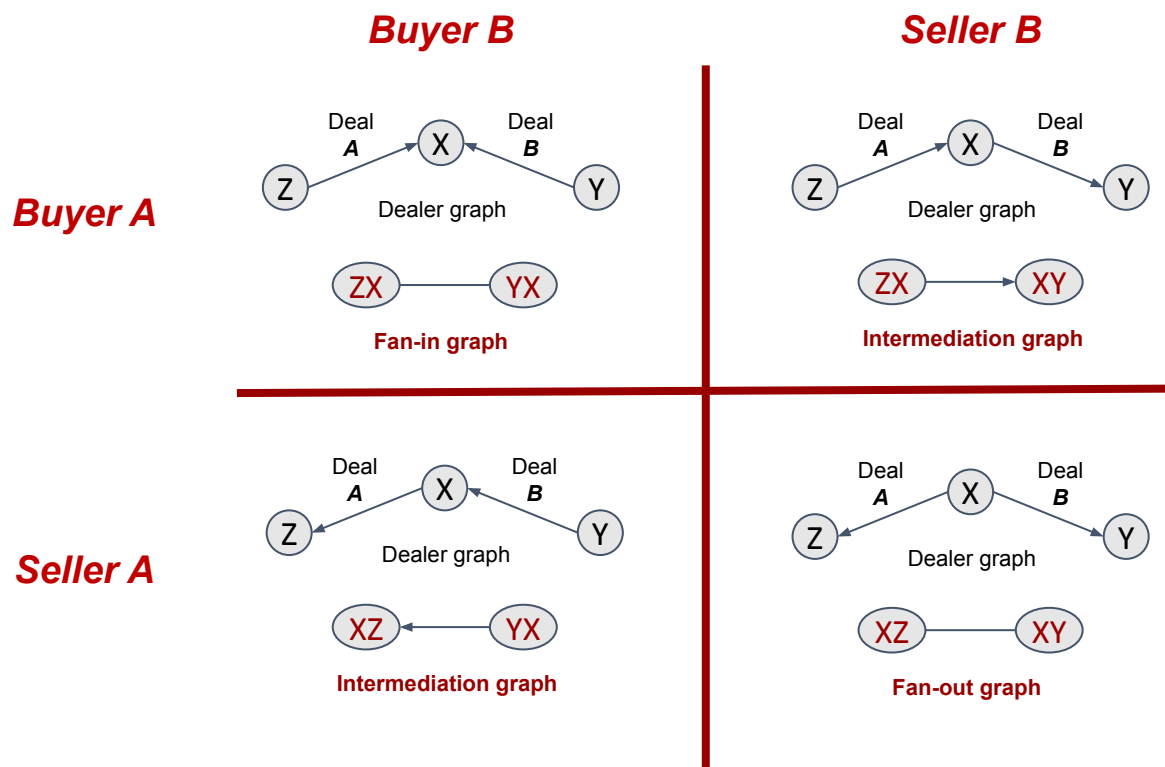
Line graph – highlighting relationships of relationships

CUSIP=06051GFT1

As of 05/03/2016



Dealer triads and the line graph



Four motifs

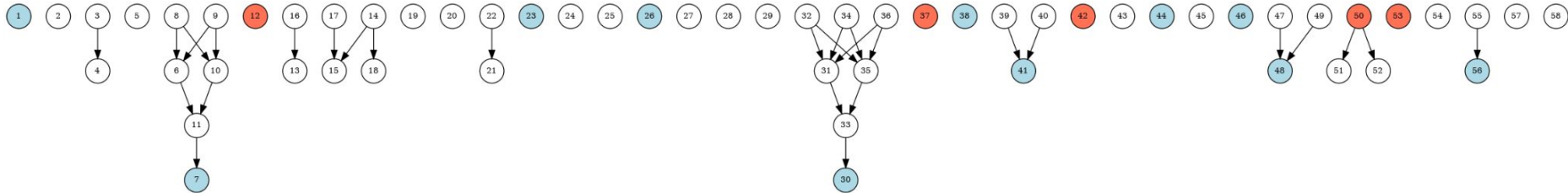
- Two deals (A, B)
- Three parties (X, Y, Z)
- Filter deals for temporal proximity (within 15 min)

Three derivations – filtered versions of the line graph

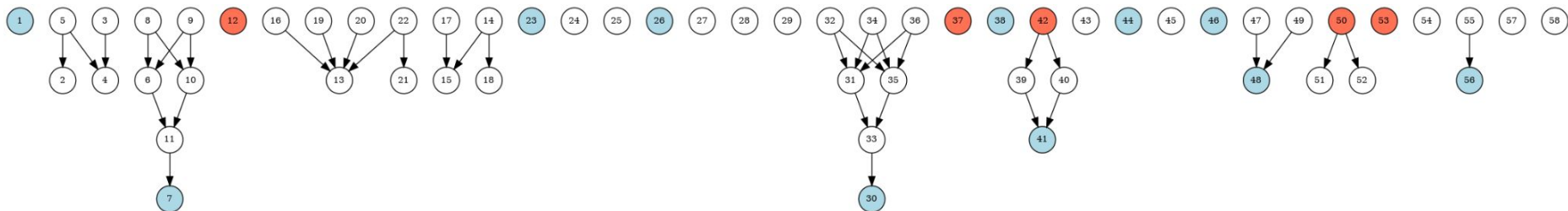
- **Intermediation graph:** volume passes through dealer X's inventory
- **Fan-in graph:** dealer X is the common buyer in two deals (no client deals)
- **Fan-out graph:** dealer X is the common seller in two deals (no client deals)

Intermediation graph

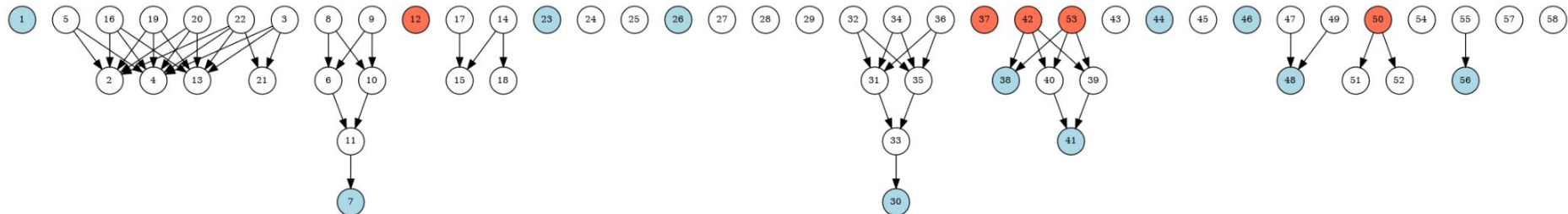
Contemporaneity: 1 minute (riskless principal)



Contemporaneity: 15 minutes (TRACE reporting)

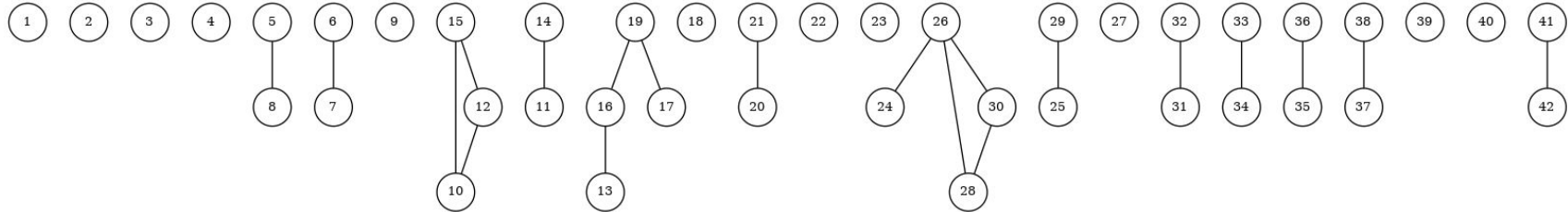


Contemporaneity: 150 minutes

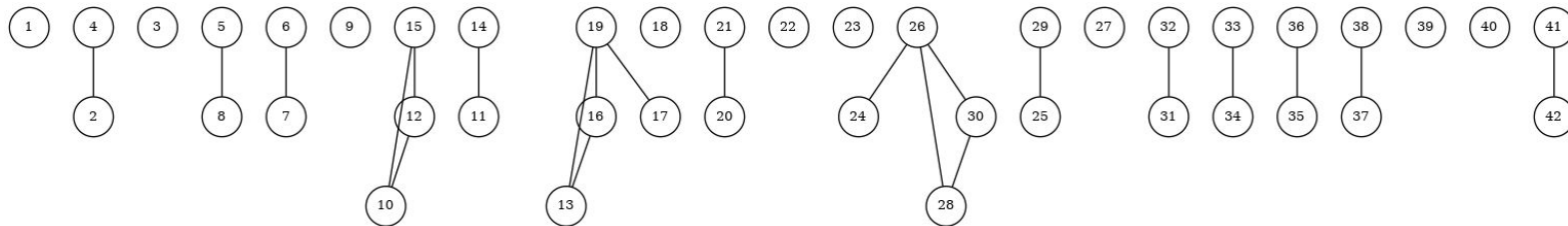


Fan-in graph

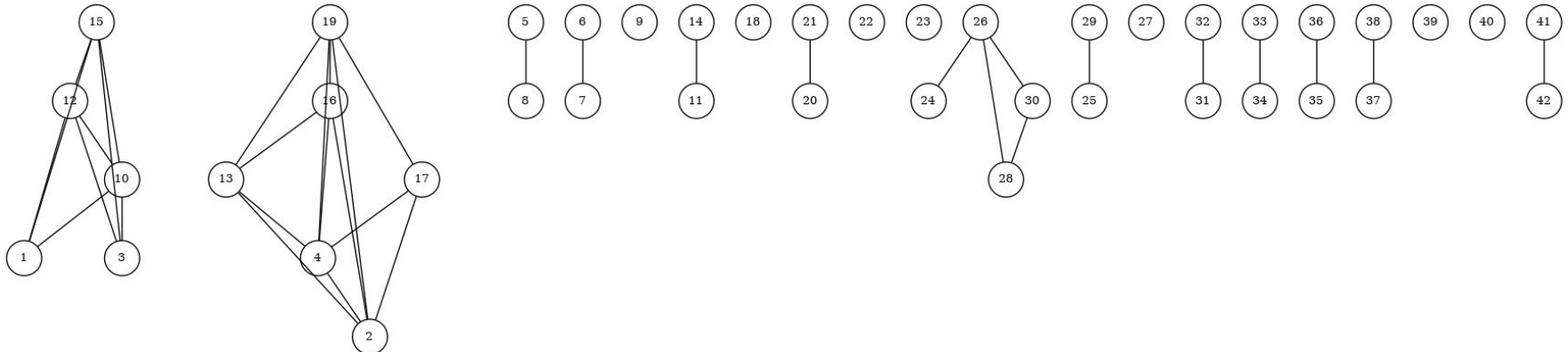
Contemporaneity: 1 minute (riskless principal)



Contemporaneity: 15 minutes (TRACE reporting)

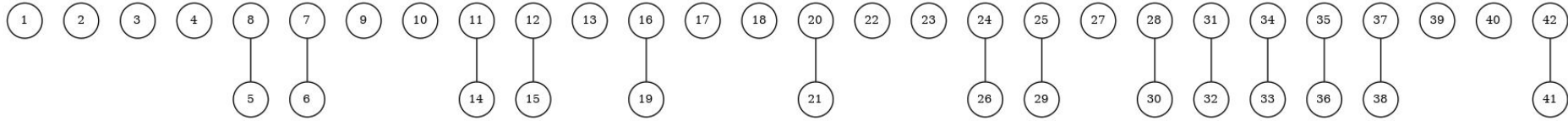


Contemporaneity: 150 minutes

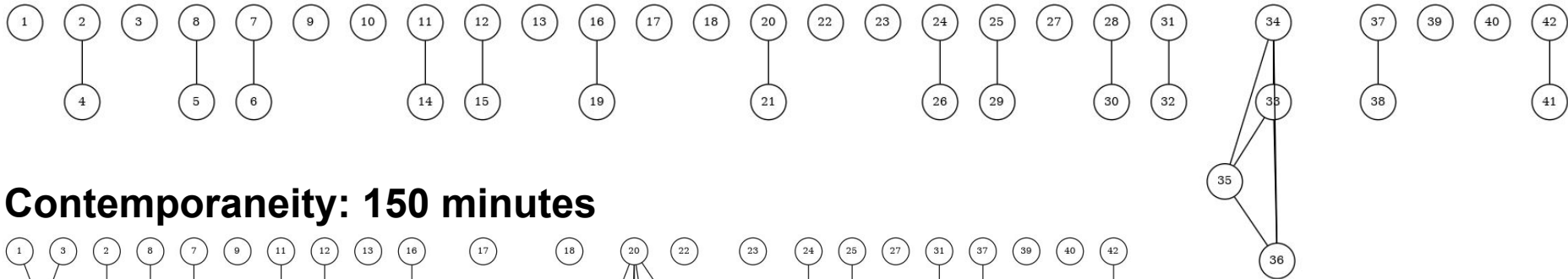


Fan-out graph

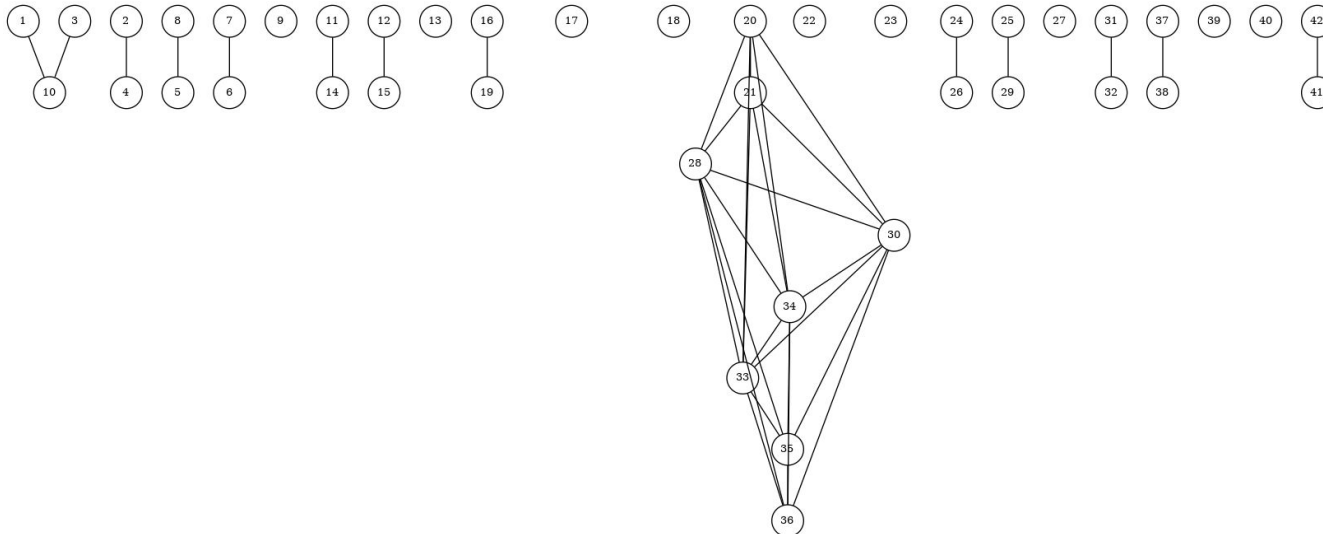
Contemporaneity: 1 minute (riskless principal)



Contemporaneity: 15 minutes (TRACE reporting)



Contemporaneity: 150 minutes



Complexity metrics

Dealer graph

- ***MXCC*** – Size (number of dealers) in the giant component
- ***NCMP*** – Number of (undirected) connected components (zeroth betti number)
- ***NCYC*** – Number of independent cycles (first betti number)
- Euler-Poincaré formula relates these as a linear combination

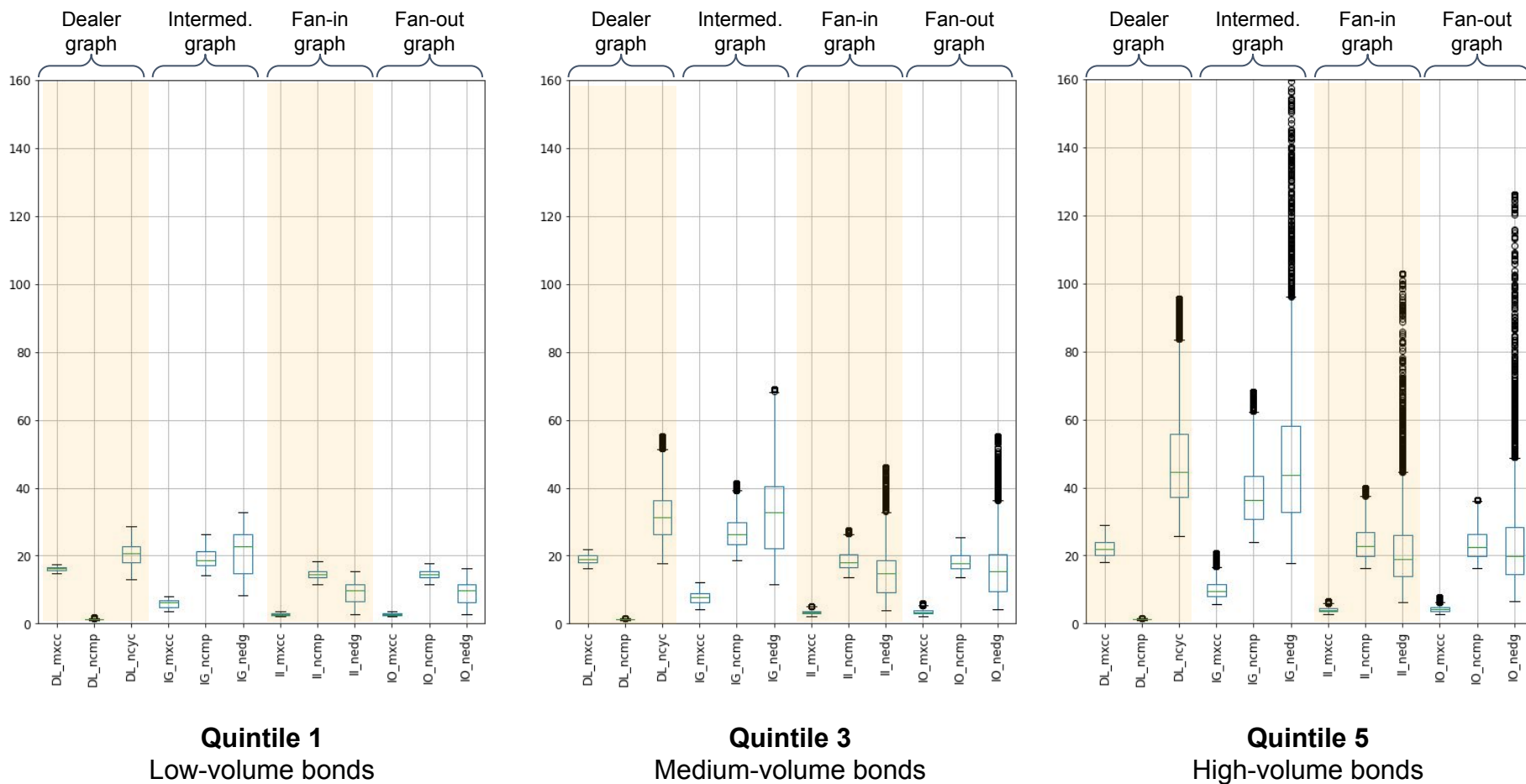
Line graph derivations – intermediation, fan-in, and fan-out graphs

- ***MXCC*** – Size (number of dealers) in the giant component
- ***NCMP*** – Number of (undirected) connected components (zeroth betti number)
- ***NEDG*** – Number of edges
- Line graph derivations use a 15 min contemporaneity window

Panel dataset

- Bucket CUSIP shards into daily quintiles by dollar volume
- Average market-activity and price-impact metrics across CUSIPs for each quintile
- 3937 daily observations per quintile

Summary of 12 complexity metrics



Three metrics for each of four graphs (dealer, intermed., fan-in, fan-out)

- **Magnitude and variability of complexity increases with volume quintile**

Liquidity metrics

Market activity

- Number of transactions per CUSIP (c) per day

$$T_c = \sum_{\tau=1}^{T_c} 1 \quad \text{where } T_c \text{ is the total number of trades involving bond } c$$

- Dollar volume per CUSIP per day

$$V_c = \sum_{\tau=1}^{T_c} P_{\tau} \rho_{\tau} \quad \text{where } P_{\tau} \text{ is the price per bond, and } \rho_{\tau} \text{ is the par value of bonds in trade } \tau$$

Price impact

- Amihud (J. Fin. Mkts., 2002) – absolute return per dollar volume

$$A_c = |R_c| / V_c \quad \text{where } R_c \text{ is the open-to-close percent return for the bond}$$

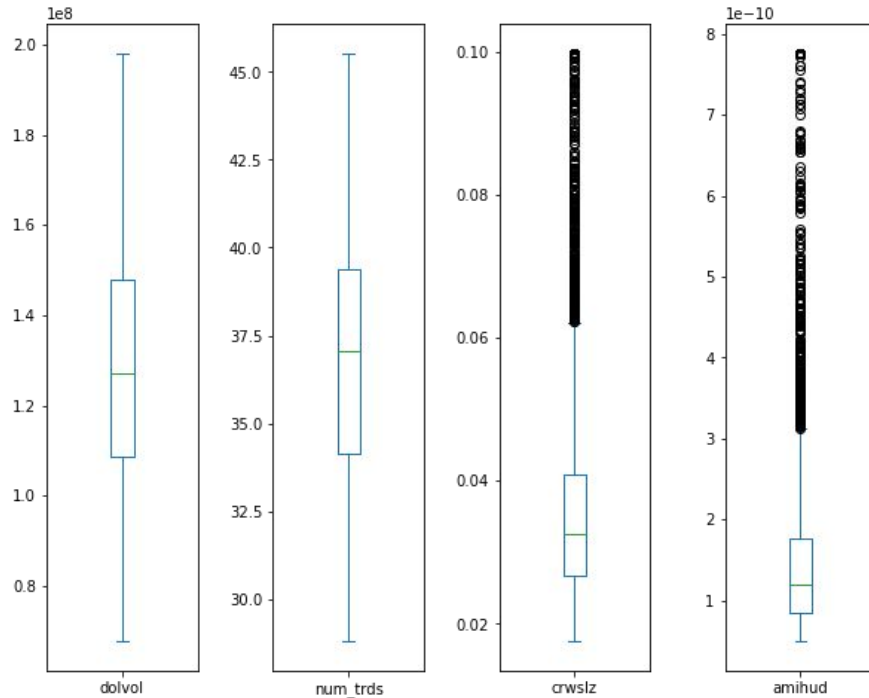
- Corwin-Schultz (J. Fin., 2012) – daily high-low spread

$$C_c = \ln(H_c/L_c) \quad \text{where } H_c \text{ (or } L_c) \text{ is the bond's high (or low) price for the day}$$

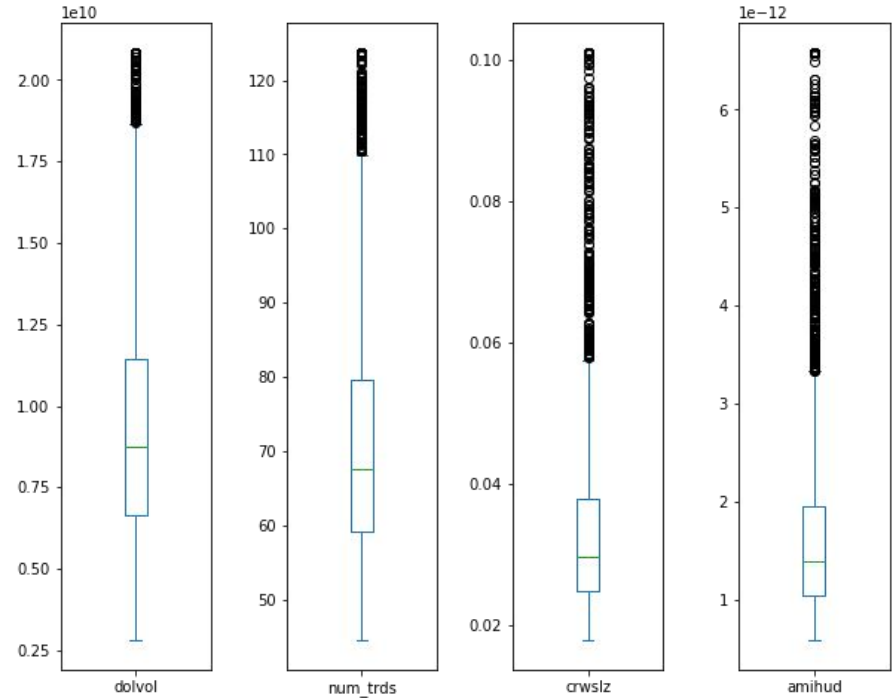
Panel dataset

- Bucket CUSIP shards into daily quintiles by dollar volume
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Summary of 4 liquidity metrics



Quintile 1
Low-volume bonds



Quintile 5
High-volume bonds

Four metrics for the dealer graph

- Dollar volume increases with volume quintile (by definition)
- Number of trades increases with volume quintile
- Corwin-Schultz high-low roughly similar across volume quintiles
- Amihud normalized return decreases by volume quintile (by construction)

Granger causality – four episodes

	amihud_x	crwsiz_x	DL_mxcc_x	DL_ncyc_x	IG_mxcc_x	IG_nedg_x	IL_mxcc_x	IL_nedg_x	IO_mxcc_x	IO_nedg_x
amihud_y	1.000000	0.022400	0.183600	0.237200	0.221600	0.341200	0.117400	0.424300	0.354500	0.782900
crwsiz_y	0.098600	1.000000	0.294800	0.578200	0.040600	0.189400	0.687400	0.368500	0.320100	0.483200
DL_mxcc_y	0.009800	0.087800	1.000000	0.057200	0.487400	0.315700	0.492300	0.532800	0.562000	0.467000
DL_ncyc_y	0.002600	0.003000	0.000100	1.000000	0.236600	0.515100	0.559100	0.330900	0.083600	0.170600
IG_mxcc_y	0.000000	0.006100	0.001500	0.000000	1.000000	0.411300	0.119500	0.398200	0.065500	0.518300
IG_nedg_y	0.000100	0.006400	0.007800	0.124000	0.283700	1.000000	0.468100	0.836700	0.531300	0.298100
IL_mxcc_y	0.000400	0.005200	0.168500	0.019200	0.150600	0.327100	1.000000	0.324300	0.207600	0.284900
IL_nedg_y	0.000000	0.006300	0.229000	0.119300	0.552800	0.759000	0.759400	1.000000	0.045500	0.181700
IO_mxcc_y	0.008800	0.013600	0.210100	0.019700	0.324700	0.023200	0.512900	0.067700	1.000000	0.024800
IO_nedg_y	0.119400	0.083400	0.205900	0.218000	0.874200	0.589600	0.837000	0.582100	0.334400	1.000000

2003-2006

	amihud_x	crwsiz_x	DL_mxcc_x	DL_ncyc_x	IG_mxcc_x	IG_nedg_x	IL_mxcc_x	IL_nedg_x	IO_mxcc_x	IO_nedg_x
amihud_y	1.000000	0.387100	0.000100	0.000400	0.000000	0.035100	0.018200	0.008200	0.002600	0.029600
crwsiz_y	0.452000	1.000000	0.033800	0.001800	0.029300	0.129000	0.263900	0.100100	0.301900	0.113100
DL_mxcc_y	0.040300	0.754800	1.000000	0.000900	0.011500	0.027700	0.019800	0.047800	0.066500	0.102800
DL_ncyc_y	0.037700	0.171700	0.539300	1.000000	0.078500	0.002000	0.279200	0.000100	0.020400	0.003600
IG_mxcc_y	0.053400	0.000000	0.006500	0.000000	1.000000	0.006500	0.450600	0.000400	0.007700	0.038900
IG_nedg_y	0.001300	0.000000	0.002300	0.000000	0.000000	1.000000	0.001100	0.000000	0.001200	0.020600
IL_mxcc_y	0.000200	0.000000	0.000300	0.000000	0.054100	0.118100	1.000000	0.004500	0.042400	0.161700
IL_nedg_y	0.000800	0.000000	0.001900	0.000000	0.000000	0.000000	0.000300	1.000000	0.005800	0.000000
IO_mxcc_y	0.000000	0.000000	0.015100	0.000000	0.000000	0.000000	0.003600	0.000000	1.000000	0.000000
IO_nedg_y	0.000200	0.000000	0.001100	0.000000	0.000000	0.010300	0.000100	0.000000	0.000000	1.000000

2007-2010

	amihud_x	crwsiz_x	DL_mxcc_x	DL_ncyc_x	IG_mxcc_x	IG_nedg_x	IL_mxcc_x	IL_nedg_x	IO_mxcc_x	IO_nedg_x
amihud_y	1.000000	0.353100	0.038100	0.355600	0.026700	0.017700	0.002300	0.112600	0.020900	0.030000
crwsiz_y	0.265900	1.000000	0.133900	0.081300	0.425900	0.176200	0.321800	0.275500	0.504300	0.144900
DL_mxcc_y	0.003000	0.076600	1.000000	0.047900	0.384000	0.260600	0.600400	0.363700	0.597300	0.544900
DL_ncyc_y	0.050900	0.019900	0.003500	1.000000	0.003900	0.118000	0.966300	0.706900	0.185200	0.463100
IG_mxcc_y	0.042900	0.365900	0.000900	0.000000	1.000000	0.091900	0.003300	0.149700	0.018300	0.215900
IG_nedg_y	0.042400	0.209500	0.000500	0.000000	0.190200	1.000000	0.224500	0.660400	0.245600	0.516100
IL_mxcc_y	0.033800	0.079200	0.056300	0.001700	0.111100	0.077900	1.000000	0.148200	0.257300	0.060200
IL_nedg_y	0.717100	0.005200	0.863500	0.108700	0.402900	0.534000	0.284600	1.000000	0.453200	0.694100
IO_mxcc_y	0.015000	0.010700	0.499400	0.161200	0.069200	0.538400	0.208400	0.549900	1.000000	0.250700
IO_nedg_y	0.497200	0.002100	0.838000	0.285400	0.417000	0.735600	0.459100	0.806400	0.355900	1.000000

2011-2014

	amihud_x	crwsiz_x	DL_mxcc_x	DL_ncyc_x	IG_mxcc_x	IG_nedg_x	IL_mxcc_x	IL_nedg_x	IO_mxcc_x	IO_nedg_x
amihud_y	1.000000	0.225100	0.009600	0.028000	0.068200	0.052500	0.008200	0.115800	0.006300	0.055000
crwsiz_y	0.072900	1.000000	0.253700	0.275400	0.277700	0.001600	0.018500	0.000200	0.005800	0.004900
DL_mxcc_y	0.026600	0.008600	1.000000	0.001100	0.068700	0.000100	0.004200	0.005000	0.001700	0.002000
DL_ncyc_y	0.000500	0.147000	0.000200	1.000000	0.000100	0.000400	0.117100	0.056700	0.133200	0.024400
IG_mxcc_y	0.151100	0.309100	0.004500	0.000000	1.000000	0.077900	0.255800	0.108400	0.274900	0.158700
IG_nedg_y	0.012000	0.189900	0.000300	0.000100	0.153000	1.000000	0.157300	0.306000	0.222000	0.250100
IL_mxcc_y	0.000500	0.136200	0.000000	0.003100	0.431300	0.446600	1.000000	0.179200	0.290400	0.073000
IL_nedg_y	0.272400	0.003300	0.009600	0.003400	0.160700	0.125600	0.186200	1.000000	0.265100	0.120700
IO_mxcc_y	0.028400	0.002000	0.000000	0.000200	0.258300	0.064200	0.047100	0.317800	1.000000	0.188300
IO_nedg_y	0.387700	0.000300	0.004700	0.000500	0.113300	0.015700	0.211000	0.216700	0.118700	1.000000

2015-2018

Granger causality captures forecast improvement from a second time series

- **Green cells indicate significant Granger causality**
 - Column variable Granger-causes the row variable
- **First two rows/columns are liquidity metrics**
- **Last eight rows/columns are complexity metrics**

Thanks!

