Relationship Trading in OTC Markets*

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December 2, 2015

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Abstract

Trading in OTC markets is bilateral between investors and dealers. Using trade-by-trade data on insurance company transactions with corporate bond dealers, we document a tradeoff between order flow concentration and dealer competition for best execution. Consistent with assortative matching, both large and small insurers trade with large dealers offering good execution. Large insurers form more relations than small, leading to better execution by fostering price competition among dealers. Low-quality insurers not establishing trading relations with large dealers receive poor execution from small regional dealers. These findings have implications for the impact of regulation and technological advances on price formation and trading outcomes in bond markets.

JEL Classification: G12, G14, G24

Key words: Corporate bonds, over-the-counter financial market, trading cost, liquidity, decentralization, market quality

There is heightened interest by the regulatory community in the functioning of over-the-counter (OTC) markets and the impact of trading frictions on execution costs and illiquidity in OTC bond markets. The recent financial crisis has led to a prolonged liquidity crisis in corporate bonds which highlighted the old-fashioned and anaemic nature of telephone-based bond trading. At the same time, an influx of market entrants attempt to radically change OTC markets by shifting trading from bilateral phone transactions to electronic platforms. An important question in the policy debate is which frictions matter most for execution costs and liquidity in corporate bonds markets—the (fixed) costs of establishing and maintaining trading relationships or the (marginal) costs of calling around for best execution?

In this paper, we use proprietary regulatory data for insurance company trading corporate bonds to address these and related questions. Our data comes from the National Association of Insurance Commissioners (NAIC) and the Financial Industry Regulatory Authority (FINRA) that collect audit trail data since 2001 and 2002, respectively. The NAIC data reveals the identities of the traders on both sides, insurers and dealers, for more than 4,300 insurers, including all health, life, and property and casualty insurers in the US between 2001 and 2014.

We use corporate bonds in our study since the corporate bond market is a classic OTC market. It is the most important source of public financing for corporations, with a $7.8 trillion market capitalization and more than 20 thousand CUSIPs traded by insurers. There is a large and active OTC secondary market, with more than 400 active broker-dealers. At the same time, the market is illiquid, fragmented, opaques. No tape existed until the early 2000s. Focusing on insurance company trading in corporate bonds is interesting for several reasons. Corporate bonds are an important investment vehicle for insurers. They own about 30% of all corporate bonds outstanding and therefore the major clientele for corporate issuers. At the same time, insurers are long-term buy and hold investors. Trading is motivated largely by liquidity shocks, while little adverse selection risk originates from insurers. Finally, insurers exhibit heterogeneous trading needs based on size and type.

We contrast our findings against two different models of the OTC markets. Both have distinct comparative statics predictions about the dealer-client relationship. We use size of both dealer and client as the dimension along which we perform comparative statics. Our choice is motivated by the high degree of heterogeneity along the size dimension for both dealers and insurers that exists in the data as well as readily available theory predictions. The first model is the competitive random search model where clients repeatedly search among other clients and dealers for best execution but do not enter into long-term relationship with dealers. There exists a large literature utilizing search frictions in OTC markets (Duffie et al., 2005/7; Weill, 2007; Lagos and Rocheteau, 2007/9; Feldhütter, 2011; Neklyudov, 2014) as well as in labor economics and economics of marriages (Acemoglu and Shimer, 1999; Shimer and Smith, 2000; Shi, 2001). The alternative approach is strategic network formation with repeated inner-network interactions, or Rolodex model. In this approach clients strategically build a fixed-size "Rolodex" of dealers and search over it each time a trading need arises. In this model clients trade-off lower search costs, exclusivity, and loyalty[1] and high costs of adding another permanent link to the network, i.e., another phone number in the Rolodex, as well as maintaining this long-term relationship, i.e., re-rooting better deals over time, taking either party to dinner or ball game when in town etc.

We use Duffie et al. (2005) to illustrate the comparative statics implications of the size of both dealer and investor/client on the probability of trade between them and price. In Duffie et al. (2005) a continuum of investors randomly and independently contact each other at some mean rate λ, a parameter that reflects search ability or sophistication. Similarly, dealers contact investors and other dealers at some intensity ρ that reflects dealer availability, i.e., higher ρ means a dealer is more efficient at finding a counterparty. There exists a single asset and both dealers and investors have endogenously determined reservation valuations of the asset denoted by RV_D and RV_I, respectively. While both interdealer and dealer-client markets are competitive, when agents meet they act strategically by bargaining over the terms of trade[2] leading to the following price

$$P = wRV_D + (1-w)RV_I,$$

where w is the investor's bargaining power. In addition, the probability of a dealer actually *buying* from a client increases with the trade surplus, $S \equiv RV_D - RV_I$, since a trade occurs upon contact if and only if $S \geq 0$. More sophisticated investors have better access to other investors or to

[1]For models of OTC network formation and contracting with externalities, see Leitner (2005), Gale and Kariv (2007), Afonso et al. (2011), Condorelli (2011), Babus (2012, Neklyudov and Sambalaibat (2015) and for models of repeat relations, relational contracts, and loyalty please see Levin (2002), Bernhardt et al. (2004), Board (2011), DiMaggio et al. (2015).

[2]Following Duffie et al. (2005) we are going to use Nash bargaining.

dealers, i.e., higher outside option, and, therefore, their reservation value, RV_I, increases with λ. Likewise, more efficient dealers have higher outside option and, therefore, their reservation value, RV_D, increases with ρ. As a result, the price offered by the dealer increases with both dealer efficiency and investor sophistication, or in other words investor execution costs decline with her sophistication while the probability of a trade increases with dealer efficiency when holding λ fixed and decreases with investor sophistication when holding ρ fixed. We associate investor size in the data with the degree of its sophistication in the model, i.e., large investors in the data have large λ in the model. Likewise, dealer efficiency in the model is the proxy for their size in the data, i.e., large dealers are more efficient than small ones. Therefore, the probability of trade is relatively high for the following dealer-investor pairwise matching: large-large, large-small, and small-small, with large-small match having the highest probability of trade. The probability of trade is low when small dealer meets large investor. It implies that in the data we should have *positive* assortive size matching where small investors trade with both small and large dealers while large investors trade only with large dealers. Large dealers offer better execution than small dealers with large investors getting the best execution. The worst execution is provided by small dealers to small investors.

While it inherits several features of the Duffie et al. (2005) type models such as more efficient dealers provide better execution, the "Rolodex" type model of the OTC market has different predictions regarding assortive size matching between dealers and investors. In this model investors trade off large fixed costs of adding extra permanent connection with the benefit from the ability to search over the larger pool of permanent connections for better execution. More sophisticated (larger) investors benefit more from larger number of connections than less sophisticated (smaller) investors and as a result build a larger Rolodex. Given a choice between more or less efficient dealers the less sophisticated investors pick more efficient dealers on average since they have a smaller Rolodex, while more sophisticated investors trade with everyone. As the result, Rolodex model predicts the following dealer-investor pairwise matching: large-large, large-small, and small-large, but not small-small. It implies that in the data we should have *negative* assortive size matching where small investors trade mostly with large dealers while large investors trade with both small and large dealers. Since this model inherits the dealer properties of the random search model, it shares predictions regarding the executions costs with it.

We establish several facts about bilateral trading and price formation in OTC markets. Consistent with search-based models of OTC trading, insurers' execution costs are dependent on the insurer type, the dealer they trade with, and their relationship networks. Execution costs are higher for smaller insurers, smaller dealers, smaller networks, and more intense relations. These patterns hold on average, but not universally. Insurer, dealer, bond, and time fixed effects explain only about 20-30% of the variation in relative trading costs. Execution costs are thus mostly relationship specific. Which connections an insurer has and how strong this relation is matters more than the identities of the counterparties. Best execution receive large insurers from any dealer. Large dealers provide modest execution costs to all insurers. Execution costs are highest for small-with-small trades. Low-quality insurers enter these suboptimal trading relations. These findings are consistent with both Rolodex-type and random search type models of OTC markets.

[Figure 1 about here]

Consistent with the Rolodex model in which fixed costs of establishing and maintaining trading relationships are economically more relevant than the marginal cost of calling around for receiving better execution, investors form few but long-lasting dealer relationship. About 50% of insurers trade with a single dealer all the time. All insurers buy bonds repeatedly from the same set of dealers to which they sell bonds. Figure 1 gives two examples of insurer-dealer trading relations over time. Panel A plots buys and sells for an insurer with a single dealer relation and Panel B for an insurer with multiple dealer relations. Such trading behavior suggests there is no random undirected search for best execution, as some OTC market models posit. Network size reflects a tradeoff between relationship scope and competition. Larger, higher quality, more active insurers possess a larger dealer network while smaller insurer concentrate their trading. There is sorting between insurers and dealers. Large insurers trade with large and small dealers. By contrast, small insurers trade mostly with large dealers. We see small-to-small matches only for low quality insurers. This evidence is also consistent with the Rolodex-type model but not with the random search model.

The remainder is organized as follows. Section 1 describes the data. Section 2 documents our findings. Section 3 concludes.

1 Data

Our primary data are insurance companies' transactions in corporate bonds, obtained from the National Association of Insurance Commissioners (NAIC). Insurance companies are required to report trades of long-term bonds and stocks to NAIC in Schedule D. The form is filed quarterly and it contains in Parts 3 and 4 of Schedule D purchases and sales made during the quarter, except for the last quarter. In the last quarter of each year, insurers file an annual report, in which all transactions during the year are reported.[3] Part 3 of Schedule D reports all long-term bonds and stocks acquired during the year, but not disposed of, while Part 4 of Schedule D reports all long-term bonds and stocks disposed of. In addition, all long-term bonds and stocks acquired during the year and fully disposed of during the current year are reported in a special Part 5 of Schedule D.

The NAIC data provide a wealth of information including the dollar amount of transactions, par value of the transaction, insurer code, date of the transaction, and the counterparty dealer name.[4] But these data are not without limitations. For example, the NAIC data do not provide time stamps of the trades, making it impossible to analyze the potential impact of intraday price movement of the transaction prices of bonds. Given that most bonds do not have multiple trades per day, we think that the impact of intraday price movement is limited to only a small set of bonds that are actively traded.

We compile the information in Parts 3, 4, and 5 of Schedule D to obtain a comprehensive set of corporate bond transactions by all insurance companies regulated by NAIC. Therefore our data does not suffer from the limitation that some third party vendor data suffer from, notably where the transaction value is typically rounded to the nearest $1,000.[5] For the main part of the analysis, we drop trades that happened less than 60 days after issuance and trades less than 90 days to maturity.

Our final sample covers all corporate bond transactions between insurance companies and dealers reported in NAIC from January 2001 to June 2014. After merging the full sample of 7.5 million bond trades with Mergent Fixed Income Security Database (FISD) to obtain the issue and issuer characteristics, we end up with a sample of 506,113 buys and 496,948 sells adding up to the total of

[3]Many prior studies use this annual report only.

[4]NAIC's counterparty field reports names in text, which can sometimes be mistakenly typed. The bank with the most variation in spelling is DEUTSCHE BANK. We manually clean the field to account for different spellings of broker-dealer names.

[5]See Paul Schultz for this information.

1 million second-market transactions. For the ease of comparisons of prices among different types of traders and for different types of bonds, we apply FISD-based filters largely based on Ellul et al. (2010) for establishing the corporate bond universe with complete data. We exclude a bond if it is exchangeable, preferred, convertible, MTN, foreign currency denominated, puttable or has a sinking fund. We also exclude CDEB (US Corporate Debentures) bonds, CZ (Corporate Zero) bonds, and all government bond (including municipal bonds) based on the reported industry group. Finally, we also drop a bond if any of the following fields is missing: offering date, offering amount, and maturity. We then restrict our sample to bonds with the offering amount greater than $10 million, as issues smaller than this amount are very illiquid and hence are rarely traded.[6] When merged, the data provide detailed information on each transaction of corporate bonds by insurance companies, including the identity of the issue and the issuing firm, the execution date, the transaction price, the par value traded, and the direction of the trade for both parties, e.g., whether the trade was an insurance company/dealer buying from a dealer, or an insurance company/dealer selling to a dealer.

We then supplement this data with data on corporate bond holdings for insurance companies[7] and quarterly bond ratings from Lipper's eMaxx database.[8] Finally, we acquire the insurers' financial information from A.M. Best.[9]

[Table 1 about here]

Table 1 reports descriptive statistics for the corporate bond trades (Panel A), insurers (Panel B), and dealers (Panel C) in our sample that ranges from January 2001 to June 2014.

There are 4,324 insurance companies in our sample. We classify all insurance companies into thee groups: (i) Health, containing 617 companies or 14% of the sample; (ii) Life, containing 1,023 companies or 24% of the sample; (iii) P&C containing the majority of the sample at 2,684 or 62%. Health insurance companies account for 166,348 (16.6% of the total) trades worth a total of $85Bn (4.7% of the total trading volume). They trade on average with 17 dealers. Life insurance companies

[6]Ellul et al. (2010) have used $50,000 which we find restrictive for our purpose.

[7]Specifically we obtain date-specific amount outstanding of corporate bonds held by the insurance companies.

[8]For detailed information on Lipper eMAXX data, refer to Manconi, Massa, and Yasuda (2012) and Becker and Ivashina (2014).

[9]A.M. Best's Financial Strength Ratings (FSR) represent the company's assessment of an insurer's ability to meet its obligations to policyholders.

account for the majority, both as a level 461,801 and a fraction of the total at 46%, of trades in our sample, as well as the total volume of $1,256Bn (69.5% of the total trading volume). They trade on average with 19 dealers. P&C insurance companies come second at 374,912 trades or 37.4% of the total number of trades valued at $467Bn (25.8% of the total trading volume). They trade on average with 14 dealers which is slightly below the sample of 16 dealers per insurer.

Top 10 insurance companies account for 6.9% of all trades and 15.7% of the total trading volume in our sample thus implying that these insurers tend to submit large orders and trade reasonably often. As a consequence they tend to use on average 69 dealers which is much higher than the sample average of 16 dealers per insurer. Top 100 insurers account for almost half of the trading volume (46.3%) as well as for 32.8% of the total trading volume. They use on average 53 dealers, which is also a quite large number. Since top 1,000 insurers use on average 33 dealers we can safely conclude that a large number of smaller insurance companies use on average less than 5 dealers.

Insurance companies trade with 439 broker-dealers with the largest dealer handling 8.6% (16.5% for largest two dealers) of all trades and top ten dealers handling 66.2% of all trades. Top 100 dealers account for 98% of all trades and 99% of all trading volume in our data.

Insurers trade in a variety of corporate bonds. The average bond issue size in our sample is quite large at $917 million and it is similar across insurer's buys and sells. The average maturity is nine years for insurer's buys and eight years for insurer's sells. Bonds are on average 2.88 years old with sold bonds being a little older at 3.09 years. Finally, 75% of all bonds are investment grade bonds while only 1% of bonds are unrated bonds with the remainder been high-yield bonds. Privately placed bonds form a small minority of our sample at 8%.

Overall, there exists a large degree of heterogeneity both on the client and dealer sides in our sample. Insurance companies buy and sell large quantities of different corporate bonds and execute these transactions with the number of dealers ranging on average from one to as many as 69. A single dealer may trade with as many as 2,300 insurance companies.

2 Results

This section reports our results. We start with a general description of the trading activity of the insurance companies and then investigating the nature of the dealer-client relationship by casting our analysis in the client-dealer trading network framework. The implications of the dealer-client relationship to execution costs concludes our analysis.

2.1 Insurers' and dealers' trading activity

We investigate the determinants of both the extensive, i.e., the number of trades, and intensive, i.e the total dollar volume traded, margins of the insurer's and dealer's trading in a given month and, where applicable, in a given year. Both margins reveal that insurers have heterogenous trading needs and dealers are specializing in satisfying these needs.

We start with the univariate analysis: Figure 2 shows the distribution of insurer trades per month, Panel A, and per year, Panel B. Both distributions follow a power law. **[NEED TO ESTIMATE POWERS HERE!]** Large number of insurers do not trade on a given month or year and we have eliminated their fraction from both panels of the figure for expositional purposes. **[NEED PERCENT OF NONTRADERS HERE!]** The majority of the insurers who do trade monthly do not do it often: Panel A shows that 41% of insurers trade just once per month and 90% of insurers trade three or less times per month. While the mean number of trades per month is just 6, with a median of 3 (conditional on any trade), quite a few insurers are very active and trade more than twice per day and up to 500 times per month. This is consistent with the evidence from Table 1 that top 100 insurers constituting while just 2.31% of the total population account for as much as 33% of all trades in our sample. Panel B reveals that the distribution looks quite similar at the annual frequency: 10% of insurers trade just once per year while 1% of the insurers make 25 trades per year or two trades per month. The mean number of trades per year is 16, with a median of 14, with several insurers making more than 1000 trades and up to the maximum of 2,200 trades per year.**[NEED TO CHECK THE ANNUAL NUMBERS!]**

[Figure 2 about here]

A natural follow-on question is what characteristics explain heterogeneity in trading needs. Table 2 documents the determinants of the intensive (trading volume in $Bn, Column 1) and extensive (number of trades in a month, Column 2) margins of the monthly trading by insurance companies using pooled regressions with time fixed effects. The specification consists of the trade par size, insurer's and bond's characteristics, as well as the variation in the trade size and bond characteristics across all trades of the insurer during a given month. Insurer's characteristics include its size, cash-to-assets ratio, type, RBC ratio,[10] and rating. Bond characteristics include most of the usual suspects such as size, age, maturity, rating, a private placement dummy, and the trade size. All variables are log-transformed and all regressors are averaged across all trades of the insurer during the period and lagged by one time period.

[Table 2 about here]

Logarithms of both measures of trade intensity are persistent; the coefficient on the lagged log-volume is 0.52 and the coefficient on the lagged log-number-of-trades is 0.63. Both coefficients are statistically significant at 1% levels. This evidence is consistent with insurance companies rebalancing their holdings over several months.

Insurer trading strongly correlates with insurer size, type, and quality, with bond types and bond varieties and these variables explain 63% of the variation in monthly trading volume and 50% variation in monthly number of trades. Larger insurance companies and insurance companies with higher cash-to-assets ratio trade more often and submit larger orders. **[NEED STD OF INSURER'S SIZE]** Insurers with higher RBC ratio submit larger orders but do not trade more than insurers with low RBC ratio. Both margins of trading increase with the insurer's rating but the size of the regression coefficients is inversely related to the rating quality, i.e., unrated insurers and insurers with the lowest rating (C-F) trade larger quantities and more often then higher rated insurers. Lower rated insurers been hit by the liquidity shocks more often (they may have different clientele) than higher rated insurers may account for this result. Life insurers tend to submit larger orders than P&C insurers.

Both margins of bond turnover increase as bond ratings declines; lower rated bonds are traded more often and in larger quantities. Insurers tend to trade privately placed bonds less since potentially they just own fewer of them than publicly placed bonds. Both margins of bond turnover decline with par size and bond age indicating that the majority of insurers are long-term investors demanding specifically structured cash flows from their bond holdings. Both measures of trade

[10]Risk-Based Capital (RBC) is a method of measuring the minimum amount of capital appropriate for a reporting entity to support its overall business operations in consideration of its size and risk profile. RBC limits the amount of risk a company can take and, therefore, it is intended to be a minimum regulatory capital standard. It requires a company with a higher amount of risk to hold a higher amount of capital.

intensity does not depend on bond issue size and remaining life as their regression coefficients are not statistically significant.

Finally, both trading volume and number of trades declines if overall more bond varieties are traded, i.e., trading is concentrated around few bonds with similar characteristics. However, a specific variety can have an opposite effect on the trading intensity. For instance, both measures of trading intensity increase with variation in bond rating and bond life. Once again this finding is consistent with insurers increasing trading intensity when rebalancing their portfolios, i.e., shifting from high-yield to lower yield bond or from younger to older bonds.

We are going to switch our attention to the determinants of dealer-insurer relationship.

2.2 Who trades with who and how frequently?

We next explore how insurers trade with different dealers, how many dealer links they form over time, and how persistent are these networks. There are two hypotheses proposed in the literature for how investors search for best execution in decentralized opaque OTC markets. Random search for best execution requires time delay in obtaining price quotes but assumes low or nonexistent costs of relationship formation. By contrast, the recent literature on strategic network formation in OTC markets highlights the importance of link formation costs. This strand of the literature predicts persistent trading networks.

The examples in Figure 1 suggest that insurers do not trade randomly with a dealer from a large pool of corporate bonds dealers. Instead, insurers buy from the same dealers that they sell bonds to. Insurers possess long-run repeat relations with dealers even if theses relations are non-exclusive. We now document how representative are the examples in Figure 1 and which insurer characteristics determine network size.

Figure 3 shows the degree distribution for insurer-dealer relations by month (Panel A) and year (Panel B). We use a log-log scale. The plots show insurers trade with up to 40 (50) dealers every month (year). The maximum degree is 80 over the entire 2001-14 sample period. Exclusive relations are dominant. Almost 50% (30%) of insurers trade with a single dealer in a given month (year). The monthly degree distribution follows approximately a Power law ($\approx .43 \times N^{1.4}$) with exponential tail starting at about 10 dealers. The annual degree distribution is more fat tailed but still exhibits overdispersion at one.

[Figure 3 about here]

Table 3 reports the determinants for the size of insurers' dealer network. The specifications use pooled regressions with time fixed effects. Insurer size and type, bond characteristics, and bond varieties matter for the size of the dealer network. Large insurers with more trading needs have more dealers. These findings suggest insurers' network choice is endogenous and dependent on multiple factors. Competition and specialization jointly determine investors' trade choices.

[Table 3 about here]

The size of the trading network across insurers is not chosen to equalize trading intensity across all insurers and dealers. The relation between extensive and intensive margin is U-shaped. Insurers with smaller network have more intense, repeat relations.

Table 4 reports statistics for the frequency with which insurers switch dealers. We compute the likelihood that an insurer uses a certain number of dealers in a given month or year and compare it the corresponding number in the next period. This yields conditional probabilities for using a network size given an insurer's past behavior:

$$Pr(\text{No. of dealers in } t+1 | \text{No. of dealers in } t), \tag{1}$$

where t = month or year. The transition probabilities in Table 4 suggest insurers have preferred dealers. Trading relations are persistent from month to month.

[Table 4 about here]

Figure 4 maps out the trading networks between investors and dealers and illustrates where order flow is concentrated. Panel A depicts the trading activity over the entire sample period in terms of the number of trades between any insurer-dealer pair. Panel B depicts the corresponding trade concentration for each insurer. On the horizontal (vertical) axis, we sort insurers (dealers) by their frequency of trading from low to high. The figure shows trading is concentrated between large insurers and large dealers. Large insurers split their orders between large and small dealers. By contrast, small insurers concentrate order flow with few dealers, most with the large dealers. The assortative matching is negative in that the types of matches that occur are large-large, small-large, and large-small, but only rarely small-small. Combined with the persistence in relations, there is endogenous concentration of trading with large dealers.

[Figure 4 about here]

Tables 5 and 6 explore more systematically which insurers trade with bigger dealers and in what bonds. Table 5 documents the insurer-dealer trading networks that exist during our sample period. The table reports in Panel A the fraction of insurers of different size that trade with dealers of different size. We split insurers and, respectively, dealers into size-based quartiles. Panel B reports the fraction of dealers trading with different insurers. Table 6 reports the determinants of insurers' choice to trade with bigger or smaller dealers.

[Tables 5 and 6 about here]

2.3 Execution costs and investor-dealer relations

To adjust trading costs for bond, time, and bond-time variation, we compare trade prices to Merrill Lynch sell quotes at the time of the transaction. BAML is the largest corporate bond dealer. On top, we clean buys and sells from residual bond and time fixed effects in most of the regression specifications. Our relative execution cost measure is defined as

$$\text{Execution cost (bp)} = \frac{\text{ML Quote} - \text{Trade Price}}{\text{ML Quote}} * (1 - 2 * \mathbf{1}_{Buy}) * 10^4, \tag{2}$$

where $\mathbf{1}_{Buy}$ is an indicator for whether the transaction is by an insurer buying or selling. Since not all bonds quoted and some quotes are stale, we truncate the distribution at 1% and 99%.

Execution costs may depend on the bond being traded, on time, on whether the insurers buys or sells, on the insurer's identity, on the dealer, and on the nature and intensity of the insurer-dealer relation. To capture all these effects, we estimate the following panel regression to decompose execution costs in their components:

$$\text{Execution cost}_{it} = \alpha_i + \alpha_t + X'_{it}\beta + \epsilon_{it} \tag{3}$$

for bond i at time t. The set of explanatory variables X includes characteristics of the bond or bond fixed effects, time fixed effects, features of the insurer, dealer, and the insurer-dealer relation.

Tables 7 and 8 summarize the estimates.

[Tables 7 and 8 about here]

We can estimate the bond- and time-specific execution cost component $\widehat{\alpha}_i + \widehat{\alpha}_t$ and the relation-specific costs $E[X'_{it}\widehat{\beta}]$ for bond i at time t from (3). Coefficient estimates are obtained from specification (4) in Table 7. Using the predicted execution cost components for each trade, we aggregate each cost component for each insurer-dealer pair by taking averages over time. The maps in Figure 5 depict the quantiles of the execution cost distribution. On the horizontal (vertical) axis, we sort insurers (dealers) by their frequency of trading from low to high. We perform the decomposition separately for all insurer buys and insurer sells.

[Figure 5 about here]

3 Conclusion

[To be completed]

Appendix

Data description:

The following table summarizes the number of observations affected by each step of the data filters:

	All trades	Insurer buys	Insurer sells
Raw NAIC data			
...			
Merged and cleaned data set			

Table 1: Descriptive statistics

The table reports descriptive statistics for the corporate bond trades (Panel A), insurers (Panel B), and dealers (Panel C) in our sample from 2001 to 2014. Panel A reports the average across all trades over the sample period. Panels B and C report the total over the sample period. In the first and second column, the total is aggregated over the insurers and, respectively, dealers, while in the third column it is the average number of relations.

Panel A: Trades			
	All trades	Insurer buys	Insurer sells
No. of trades (k)	1,003	506	497
Trade par size ($mn)	1.80	1.73	1.87
Bond issue size ($mn)	916.66	921.37	911.87
Bond age (years)	2.88	2.67	3.09
Bond remaining life (years)	8.54	8.94	8.13
Private placement (%/100)	0.08	0.08	0.07
Rating (%/100)			
IG	0.74	0.76	0.72
HY	0.25	0.23	0.28
Unrated	0.01	0.01	0.01

Panel B: Insurers (N= 4,324)			
	Total volume ($bn)	Total no. of trades (k)	Avg. no. of dealers
Top 10 insurers	284 (15.7%)	69 (6.9%)	69 (15.8%)
Top 100 insurers	838 (46.3%)	329 (32.8%)	53 (12.1%)
Top 1,000 insurers	1,656 (91.6%)	834 (83.1%)	33 (7.5%)
All insurers	1,808 (100.0%)	1,003 (100.0%)	16 (3.6%)
Insurer type (N, % of total)			
Health (617, 14%)	85 (4.7%)	166 (16.6%)	17 (3.9%)
Life (1,023, 24%)	1,256 (69.5%)	462 (46.0%)	19 (4.4%)
P&C (2,684, 62%)	467 (25.8%)	375 (37.4%)	14 (3.2%)

Panel C: Dealers (N= 439)			
	Total volume ($bn)	Total no. of trades (k)	Avg. no. of insurers
Top dealer	168 (9.3%)	86 (8.6%)	2,302 (53.2%)
Top 10 dealers	1,349 (74.6%)	664 (66.2%)	2,396 (55.4%)
Top 100 dealers	1,788 (98.9%)	984 (98.1%)	641 (14.8%)
All dealers	1,808 (100.0%)	1,003 (100.0%)	155 (3.6%)

Table 2: Insurers' trading activity

The table reports the determinants of insurance company trading activity. We measure trading activity by the total dollar volume traded in a given month and, alternatively, by the number of trades over the same time horizon. All dependent variables are log-transformed by 100*log(1+x). All regressors are averaged across all trades of the insurer during the period and lagged by one time period. Estimates are from pooled regressions with time fixed effects. Standard errors are adjusted for heteroskedasticity and clustering at the insurer and time level. Significance levels are indicated by * (10%), ** (5%), *** (1%).

	(1) Volume ($bn)	(2) No. of trades
Insurer size	20.17***	14.66***
Insurer RBC ratio	2.04***	-0.87
Insurer cash-to-assets	0.09***	0.10***
Life insurer	5.74***	-2.18**
P&C insurer	-0.47	-5.82***
Insurer rated A-B	1.16	2.21***
Insurer rated C-F	5.00**	5.70**
Insurer unrated	6.54***	6.87***
Trade par size	-3.80***	-2.71***
Bond issue size	-0.00***	-0.00
Bond age	-0.44***	-0.63***
Bond remaining life	0.00	0.06**
Bond high-yield rated	5.81***	9.16***
Bond unrated	-4.02**	-4.44***
Bond privately placed	-4.22***	-1.62**
Variation in trade size	5.41***	1.82***
Variation in issue size	0.00	0.00
Variation in bond age	0.17**	0.12
Variation in bond life	0.66***	0.60***
Variation in bond rating	0.35**	0.98***
Variation in rated-unrated	-24.49*	-80.92***
Variation in private-public	8.51***	7.57***
No varieties traded	8.10***	10.32***
Lagged volume	0.52***	
Lagged no. of trades		0.63***
Month fixed effects	Yes	Yes
r2	0.628	0.497
N	165,766	165,766

Table 3: Size of insurers' trading network

The table reports the determinants of the size of insurers' trading network. We measure the size of the trading network by the number of different dealers that an insurance company trades with in a given month. All dependent variables are log-transformed by 100*log(1+x). All regressors are averaged across all trades of the insurer during the period and lagged by one time period. Estimates are from pooled regressions with time fixed effects. Small are insurers in the bottom three size quartiles. Large are insurers in the top quartile of the size distribution. Standard errors are adjusted for heteroskedasticity and clustering at the insurer and time level. Significance levels are indicated by * (10%), ** (5%), *** (1%).

	(1) All insurers	(2) Small insurers	(3) Large insurers
Insurer size	11.64***	4.54***	9.37***
Insurer RBC ratio	-0.88	-1.00*	-0.26
Insurer cash-to-assets	0.07***	0.03**	0.08***
Life insurer	-0.90	0.48	-2.38**
P&C insurer	-3.94***	-1.58***	-4.12***
Insurer rated A-B	1.43**	2.96***	0.15
Insurer rated C-F	2.86*	4.03***	1.30
Insurer unrated	4.67***	4.04***	2.36**
Trade par size	-2.08***	-0.70***	-1.76***
Bond issue size	-0.00*	-0.00**	-0.00
Bond age	-0.51***	-0.21***	-0.67***
Bond remaining life	0.04*	0.02	0.00
Bond high-yield rated	6.81***	-0.61	7.81***
Bond unrated	-4.18***	-0.96	-5.41**
Bond privately placed	-1.38**	-0.38	-1.46
Variation in trade size	1.21***	0.37	1.12***
Variation in issue size	0.00	-0.00	0.00
Variation in bond age	0.19***	0.26***	0.17**
Variation in bond life	0.48***	0.23***	0.40***
Variation in bond rating	0.63***	0.17	0.61***
Variation in rated-unrated	-50.77***	-14.59	-48.46***
Variation in private-public	6.26***	1.82	4.85***
No varieties traded	4.96***	0.18	6.84***
Lagged no. of dealers	0.61***	0.29***	0.63***
Month fixed effects	Yes	Yes	Yes
r2	0.489	0.092	0.441
N	165,766	64,288	101,478

Table 4: Persistence in insurers' trading network

The table reports the probability that an insurer uses a dealer network with given size next period, conditional on the same insurer using a given network size this period:

$$Pr(\text{No. of dealers in } t+1 | \text{No. of dealers in } t).$$

We compute these dealer switching probabilities for each month (Panel A) and year (Panel B)

Panel A: Monthly switching probabilities

	No. of dealers next month			
No. of dealers this month	1	2-5	6-10	>10
1	0.61	0.35	0.04	0.01
2-5	0.27	0.55	0.15	0.03
6-10	0.07	0.36	0.41	0.15
>10	0.02	0.12	0.34	0.52

Panel B: Annual switching probabilities

	No. of dealers next year			
No. of dealers this year	1	2-5	6-10	>10
1	0.61	0.30	0.06	0.03
2-5	0.20	0.54	0.20	0.06
6-10	0.06	0.31	0.40	0.24
>10	0.01	0.07	0.17	0.75

Table 5: Insurer-dealer trading networks

The table reports the fraction of insurers of different size that trade with dealers of different size. We split insurers and, respectively, dealers into size-based quartiles.

Panel A: Fraction of insurers trading with different dealers

	Insurer size			
Dealer size	Very small	Small	Medium	Large
Large	0.96	0.99	1.00	1.00
Medium	0.11	0.27	0.42	0.70
Small	0.03	0.07	0.14	0.33
Very small	0.02	0.02	0.04	0.12

Panel B: Fraction of dealers trading with different insurers

	Insurer size			
Dealer size	Very small	Small	Medium	Large
Large	0.91	0.99	0.99	1.00
Medium	0.47	0.76	0.86	0.90
Small	0.19	0.50	0.66	0.77
Very small	0.18	0.24	0.32	0.61

Table 6: Who trades more with dealers of different rank?

The table reports the determinants of the insurers' choice to trade with bigger or smaller dealers. The dependent variable is the dealer's rank in terms of overall trading activity, ranging from the least active dealer (1) to the most active dealer (439). Estimates are from pooled regressions with day fixed effects. Standard errors are adjusted for heteroskedasticity and clustering at the insurer, dealer, bond, and day level. Significance levels are indicated by * (10%), ** (5%), *** (1%).

	(1) Very small dealer	(2) Small dealer	(3) Medium dealer	(4) Large dealer
Insurer size	0.08***	0.31***	1.18***	14.70***
Insurer RBC ratio	0.02	0.09	-0.02	-3.93***
Insurer cash-to-assets	0.00	0.00	0.02***	0.12***
Life insurer	0.00	-0.05	0.23	-1.35
P&C insurer	0.02	-0.09	-0.31	-5.50***
Insurer rated A-B	0.04	0.25**	0.50	2.67***
Insurer rated C-F	0.11	0.04	1.83	3.53
Insurer unrated	0.05	0.40***	0.86**	6.77***
Trade par size	-0.02***	-0.07***	-0.34***	-2.34***
Bond issue size	-0.00	-0.00***	-0.00***	-0.00***
Bond age	-0.00	-0.00	0.01	-0.86***
Bond remaining life	-0.00	0.00	0.02	0.10***
Bond high-yield rated	0.01	0.19*	0.59*	5.24***
Bond unrated	0.05	0.26	0.48	-5.77**
Bond privately placed	-0.06	-0.04	-0.58*	-3.96***
Variation in trade size	0.01	0.03	0.40***	0.34*
Variation in issue size	0.00	-0.00	0.00	0.00***
Variation in bond age	-0.00	0.03*	0.21***	0.90***
Variation in bond life	0.00	0.01	0.02	0.61***
Variation in bond rating	0.02	0.03	0.12**	1.32***
Variation in rated-unrated	-1.58	-2.82	-11.79**	-108.67***
Variation in private-public	0.17**	0.22	1.95***	9.79***
No varieties traded	0.06**	0.06	0.21	-10.29***
Lagged dealer choice	0.08***	0.15***	0.27***	0.28***
Month fixed effects	Yes	Yes	Yes	Yes
r2	0.011	0.039	0.113	0.203
N	165,766	165,766	165,766	165,766

Table 7: Execution costs and investor-dealer relations

The table reports the determinants of execution costs on insurance company trades. Execution costs are expressed in basis points relative to the Merrill Lynch quote at the time of the trade. Estimates are from panel regressions with day fixed effects or, respectively, day and bond fixed effects. Standard errors are adjusted for heteroskedasticity and clustering at the insurer, dealer, bond, and day level. Significance levels are indicated by * (10%), ** (5%), *** (1%).

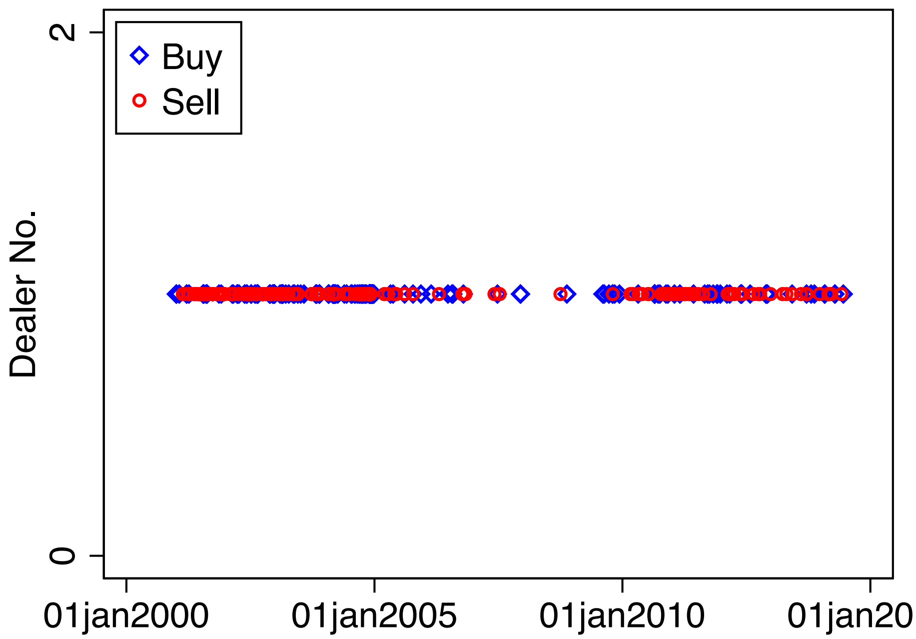
	(1)	(2)	(3)	(4)	(5)
Dealer size	-26.47***	-23.19***	-25.11***	-12.47***	-13.39***
Insurer size	-21.97***	-20.88***	-21.91***	-4.52**	-4.21*
Dealer size × Insurer size	3.68***	3.43***	3.63***	0.35	0.27
Insurer no. of dealers				-1.21***	-1.30***
Dealer size × No. dealers				0.22***	0.24***
NYC dealer		-3.39***	-3.52***	-3.08***	-3.20***
Local dealer		0.23	0.17	0.40	0.34
Dealer distance		-0.33	-0.39	-0.16	-0.19
Insurer RBC ratio		-4.37***	-4.86***	-4.27***	-4.75***
Insurer cash-to-assets		-0.03*	-0.03*	-0.01	-0.01
Life insurer		5.75***	7.34***	5.08***	6.58***
P&C insurer		3.01***	3.50***	2.08**	2.48**
Insurer rated A-B		-0.65	-0.86	-0.31	-0.53
Insurer rated C-F		12.99**	13.01*	11.83*	11.79
Insurer unrated		0.62	0.59	0.37	0.31
Insurer buy		40.24***	40.72***	39.79***	40.28***
Trade size × Buy		-0.21**	-0.15	-0.31***	-0.25***
Trade size × Sell		0.58***	0.59***	0.49***	0.48***
Bond issue size			-0.00***		-0.00***
Bond age			0.66***		0.64***
Bond remaining life			0.80***		0.81***
Bond HY rated			3.69***		4.02***
Bond unrated			-6.66***		-6.62***
Bond privately placed			3.22***		3.33***
Bond fixed effects	Yes	Yes	No	Yes	No
Day fixed effects	Yes	Yes	Yes	Yes	Yes
r2	0.091	0.150	0.096	0.152	0.098
N	1,004,338	891,360	892,097	891,360	892,097

Table 8: Execution costs and investor-dealer relations—split by insurer size

The table reports the determinants of execution costs on insurance company trades. Execution costs are expressed in basis points relative to the Merrill Lynch quote at the time of the trade. Estimates are from panel regressions with bond and day fixed effects. Small are insurers in the bottom three size quartiles. Large are insurers in the top quartile of the size distribution. Standard errors are adjusted for heteroskedasticity and clustering at the insurer, dealer, bond, and day level. Significance levels are indicated by * (10%), ** (5%), *** (1%).

	(1)	(2)	(3)	(4)
	Small insurers		Large insurers	
Dealer size	-12.03*	-9.20	-17.41***	-10.69***
Insurer size	-16.78***	-8.56*	-15.57***	-3.30
Dealer size × Insurer size	1.13	0.41	2.58***	0.25
Insurer no. of dealers		-1.88***		-1.03***
Dealer size × No. dealers		0.15		0.19***
NYC dealer	-5.18**	-3.84**	-2.96***	-2.75***
Local dealer	2.56	2.41	-0.25	-0.07
Dealer distance	-0.29	0.07	-0.29	-0.17
Insurer RBC ratio	-10.49***	-10.18***	-2.96	-2.83
Insurer cash-to-assets	-0.02	-0.00	-0.01	0.00
Life insurer	10.07***	9.60***	4.30***	3.67***
P&C insurer	7.25***	6.05***	1.95**	1.28
Insurer rated A-B	-2.02	0.28	0.02	0.22
Insurer rated C-F	0.24	0.11	17.98*	16.66*
Insurer unrated	0.14	-0.37	0.56	0.06
Insurer buy	37.15***	36.60***	40.62***	40.30***
Trade size × Buy	-0.68**	-1.41***	-0.26***	-0.32***
Trade size × Sell	0.47	-0.21	0.54***	0.48***
Bond and day fixed effects	Yes	Yes	Yes	Yes
r2	0.296	0.307	0.150	0.151
N	122,521	122,521	767,076	767,076

Panel A: Insurer with single dealer relation



Panel B: Insurer with multiple dealer relations

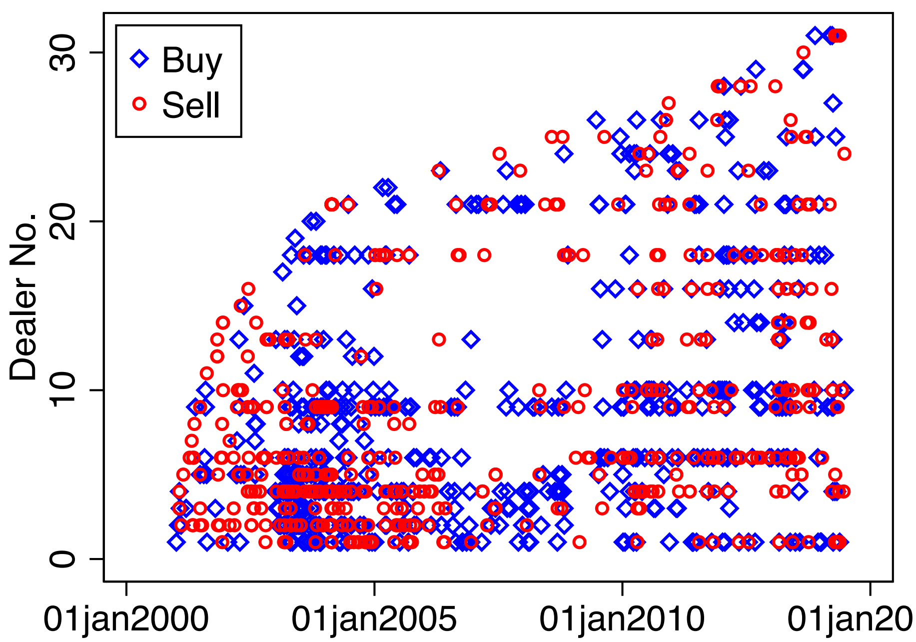
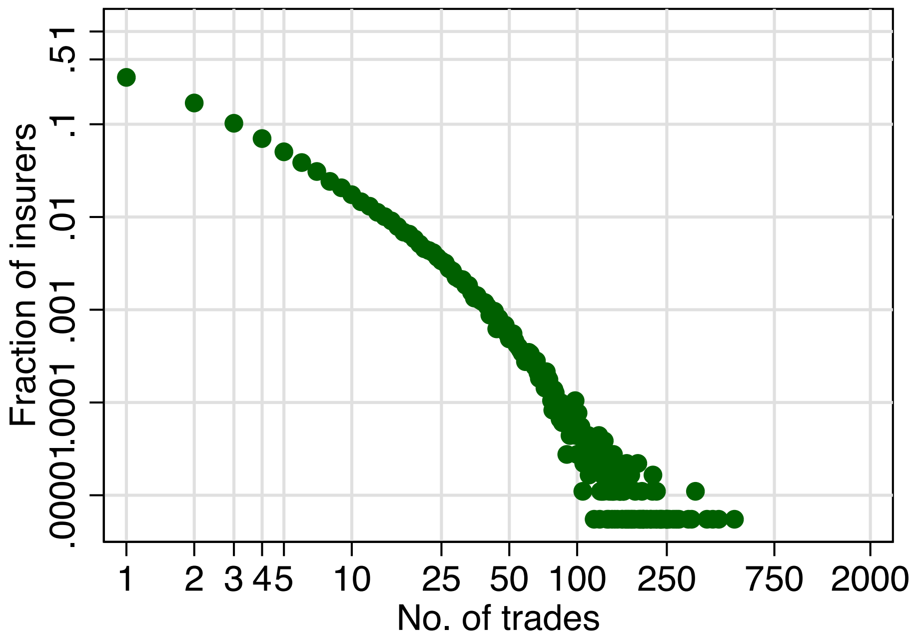


Figure 1: Example of insurer-dealer trading relations
The figure shows the buy (blue squares) and sell (red circles) trades of two insurance companies with different dealers. We sort the dealers on the vertical axis by the first time they trade with the corresponding insurance company.

Panel A: Distribution of insurer trades per month



Panel B: Distribution of insurer trades per year

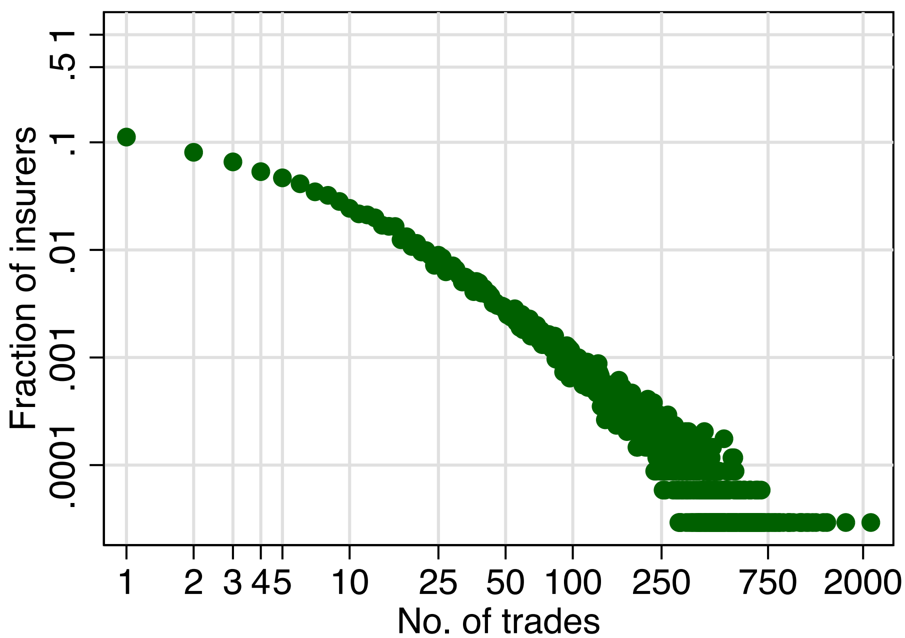
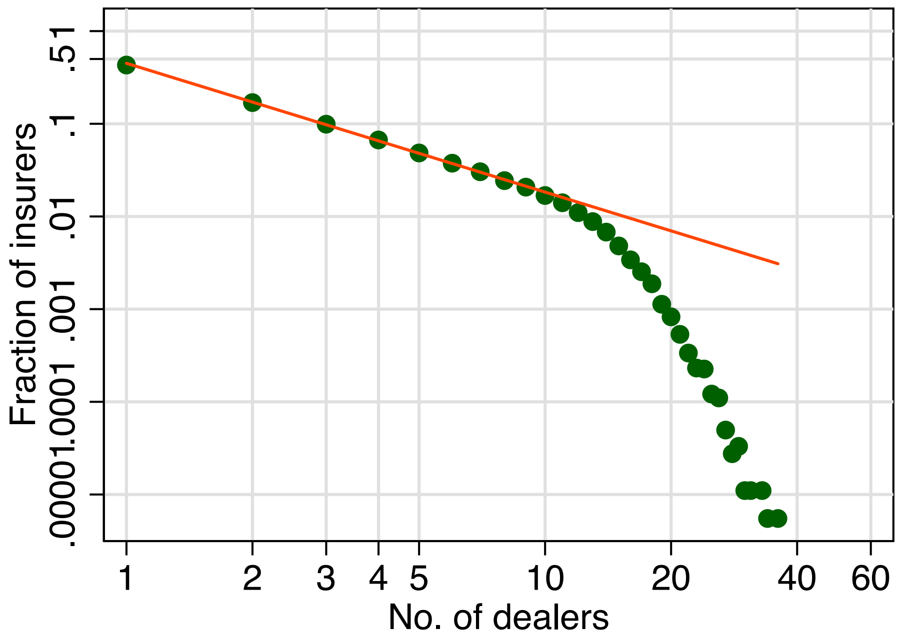


Figure 2: Trading needs by insurers

The figure shows the distribution of insurer trades per month (Panel A) and year (Panel B).

Panel A: Degree distribution for insurer-dealer relations by month



Panel B: Degree distribution for insurer-dealer relations by year

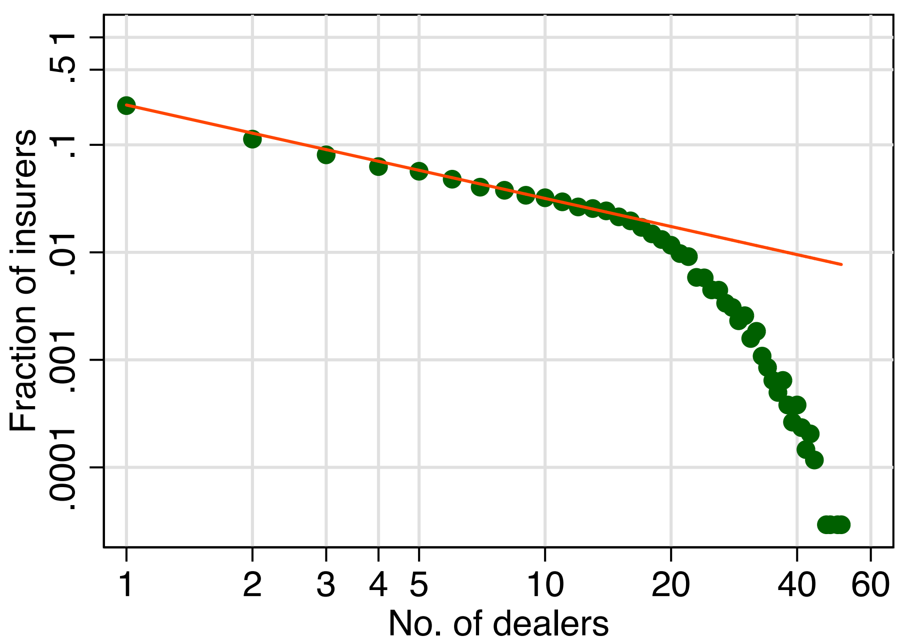
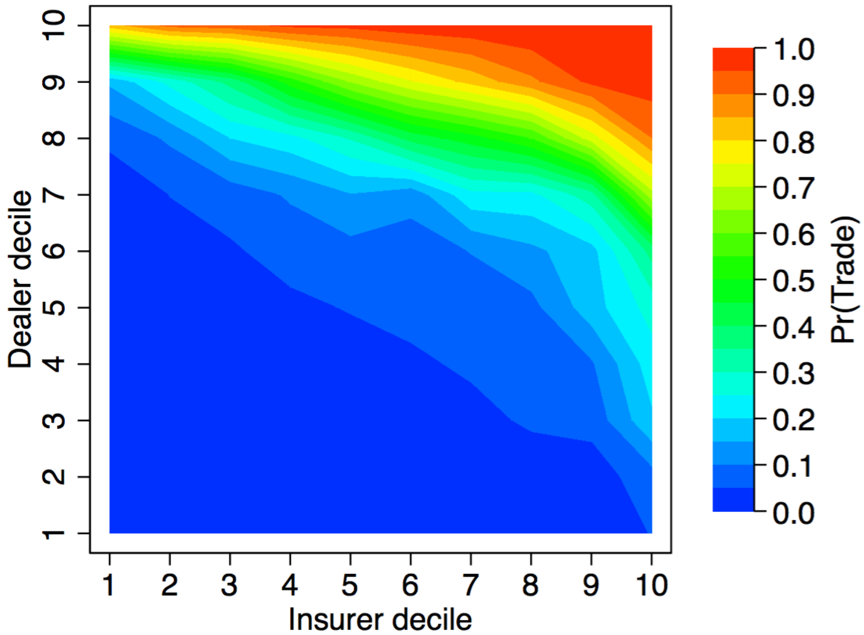


Figure 3: Size of insurer-dealer trading networks

The figure shows the degree distribution for insurer-dealer relations by month (Panel A) and year (Panel B). We use a log-log scale.

Panel A: Probability that insurer trades with dealer in size bin 1-10



Panel B: Trade concentration when insurer trades with dealer in size bin 1-10

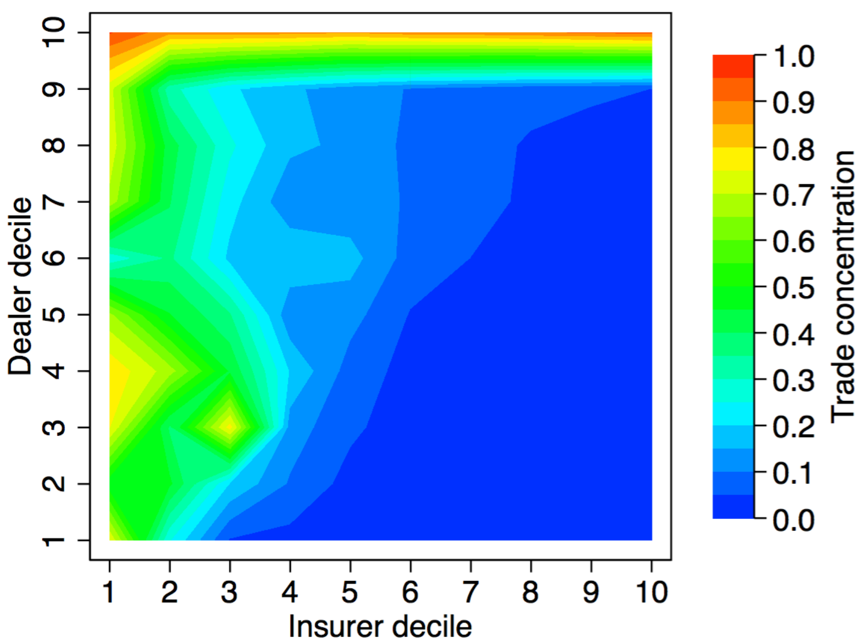
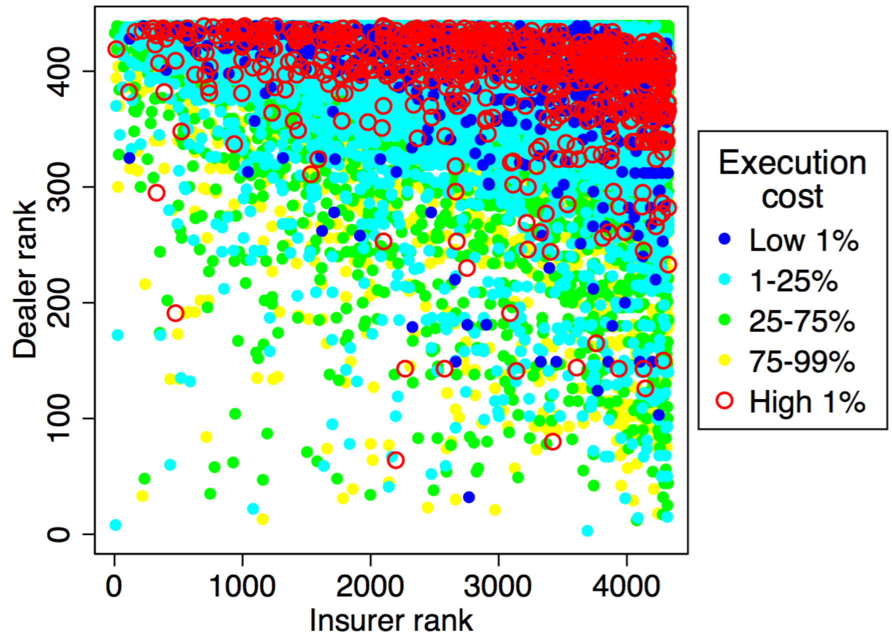


Figure 4: Investor-dealer trading networks and insurers' order flow concentration

The figure illustrates the trading networks of each insurer and, respectively, dealer. Panel A depicts the trading activity in terms of the probability that an insurer trades with a dealer of given size over the entire sample period. Panel B depicts the corresponding trade concentration for each insurer. On the horizontal (vertical) axis, we sort insurers (dealers) from low to high by their frequency of trading over the sample period.

Panel A: Execution cost specific to bond and time



Panel B: Execution cost specific to insurer, dealer, and investor-dealer relation

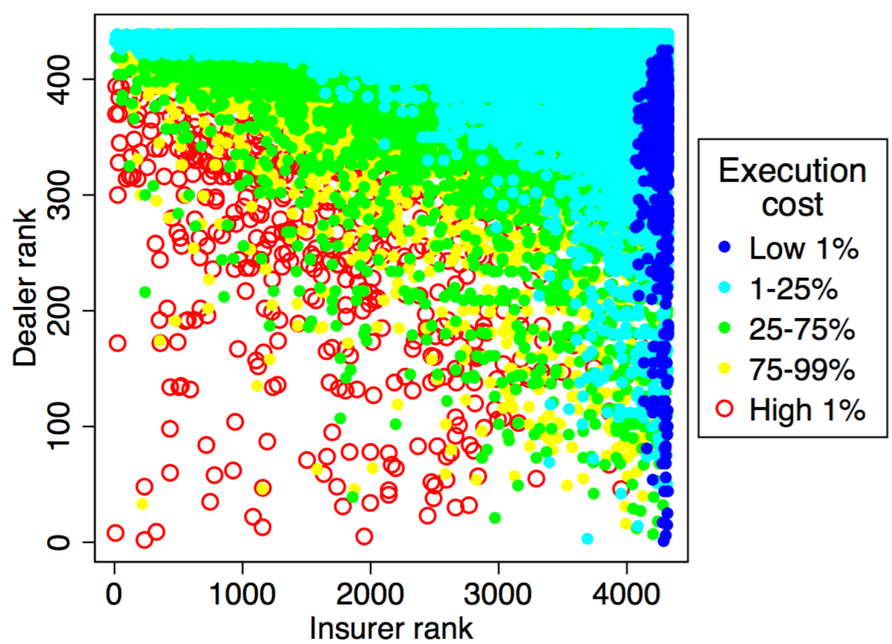


Figure 5: Investor-dealer trading relations and execution cost components
The figure illustrates the decomposition of execution costs specific to bond and time (Panel A) and, respectively, to insurer, dealer, and investor-dealer relations (Panel B). We estimate the bond- and time-specific costs $\widehat{\alpha}_i + \widehat{\alpha}_t$ and the relation-specific costs $E[X'_{it}\widehat{\beta}]$ for bond i at time t from Execution $\text{cost}_{it} = \alpha_i + \alpha_t + X'_{it}\beta + \epsilon_{it}$. Coefficient estimates are obtained from specification (4) in Table 7. Using the predicted execution cost components for each trade, we aggregate each cost component for each insurer-dealer pair by taking averages over time. The map depicts the quantiles of the execution cost distribution. On the horizontal (vertical) axis, we sort insurers (dealers) by their frequency of trading from low to high.