The Value of Value Investors[*]

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Abstract

We examine the role of insurance companies as value investors in the corporate bond market. We show that during the COVID-19 liquidity crisis, insurers acted as "buyers of last resort" and increased their corporate bond positions, particularly in bonds facing fire sales by mutual funds. Insurers with more stable insurance funding were more likely to buy, and they bought more from dealers with whom they had prior trading relationships. We find that the stability of the insurance funding of insurers plays an important role for the liquidity conditions in the corporate bond market. Dealers improve their liquidity provision when they have trading relationships with insurers with more stable insurance funding. Our work demonstrates the value of value investors during times of stress.

JEL classification: G10, G12, G20, G22, G23, G24

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1. Introduction

Who buys when everyone else is selling? In over-the-counter (OTC) fixed income markets, the answer is generally the dealers – except for when they don't. During the COVID-19 financial crisis when U.S. bond markets faced extraordinary selloffs by investment funds, a raft of research studies found that dealers shifted from buying to selling, exacerbating the liquidity crises.[1] Yet, this behavior should not be unexpected. Treynor (1987), and more recently Levine (2015), make the point that dealers are actually buyers of "first resort", acting to smooth short-term temporal imbalances, with neither the capital nor the inclination to stop market meltdowns. Instead, the buyers of "last resort" are value investors, whose long-term investment horizons allow them to step in and buy when illiquidity and temporary dislocations in risky asset prices present investment opportunities.

In this paper, we study insurance companies in the role of value investors in the corporate bond market. Our particular focus is on insurance companies' trading activities during times of market stress as well as on the implications of their trading on corporate bond liquidity. Insurance companies are the largest domestic investors in corporate bonds. By the end of 2019, they held about 30% of the outstanding corporate bonds.[2] Koijen and Yogo (2022) propose that, compared to households and other institutional investors, insurers' cheap access to leverage through their underwriting activities is integral to their central role in the corporate bond market. Importantly, insurance companies bear the essential hallmarks of a value investor: They are dedicated, long-term fixed-income investors who are able to consider investment opportunities that arise from temporary price dislocations. Their ability to ride out market fluctuations originates from their funding structure (Hanson, Shleifer, Stein, and Vishny (2015), Chodorow-Reich, Ghent, and Haddad (2021), and Knox and Sørensen (2021)). Unlike other major bond investors, such as mutual funds who finance their assets through short-term liabilities that can be subject to runs, insurance companies tend to have stable liabilities due to the long contractual horizon of their

[1] For studies on selloffs by investment funds, see Falato, Goldstein, and Hortacsu (2021), Haddad, Moreira, and Muir (2021), and Ma, Xiao, and Zeng (2022). For evidence on fixed income dealers' trading in the crisis see Boyarchenko, Kovner, and Sharchar (2020), Kargar, Lester, Lindsay, Liu, Weill, and Zúñiga (2021), O'Hara and Zhou (2021), He, Nagel, and Song (2022), and Li, O'Hara and Zhou (2022).

[2] According to data from SIFMA and S&P Global Market Intelligence, U.S. and foreign corporations had about $9 trillion of corporate bonds outstanding in the U.S. corporate bond market by the end of 2019. U.S. insurers held about $3 trillion of these corporate bonds.

insurance policies. Their funding stability sets them apart, affecting not only their asset allocation decisions but also their ability to extract value from "last resort" liquidity provision in a one-sided market.[3]

Our analysis focuses on four main questions: First, did insurers' trading activities during the COVID-19 market sell-off contribute to stabilizing the corporate bond market? Specifically, how did insurance companies trade relative to dealers and mutual funds? Second, how did firm characteristics affect insurers' trading behavior? In particular, were insurers with more stable insurance funding more likely to step in and provide liquidity? Third, which dealers did insurance companies trade with? Did prior insurer-dealer relationships affect insurers' liquidity provision? Fourth, how did insurers' liquidity provision through dealers affect the liquidity conditions in the U.S. corporate bond market?

In addressing these questions, we take advantage of information on both insurer and dealer identities included in our corporate bond transaction data. Using data from the National Association of Insurance Commissioners (NAIC), we are able to track every bond purchase or sale by U.S. insurance companies and their counterparties (or dealers) during our 2017 to 2020 sample period. Using the regulatory version of the Trade Reporting and Compliance Engine (TRACE) data, we have detailed information on all secondary market bond transactions, including dealer identities. The two-sided identification of counterparties and the ability to link the two databases allows us to connect insurers' characteristics, trading activities, and trading relationships to dealers' intermediation efforts and transaction costs in the corporate bond market. Our goal is to identify and quantify the benefits that insurance companies, acting as value investors, provided for corporate bond trading during a period of extreme market stress.

Our analysis reveals at least four novel findings: First, we find that insurance companies did play an important stabilizing role in the March 6 to March 19 crisis period.[4] While corporate bond dealers' inventories during the crisis period fell by about $5 billion dollars, insurers were net buyers of about $2.5 billion in bonds. On balance, insurance companies traded more in bonds that

[3] Insurance companies, particularly life insurers, also derive stability from being subject to statutory accounting principles (SAP) as opposed to GAAP accounting. Statutory accounting essentially lowers the volatility on insurers' asset holdings which in turn reduces the volatility of their liability funding needs. For more discussion, see https://content.naic.org/cipr-topics/statutory-accounting-principles.

[4] Bond market conditions deteriorated on March 6, 2020 and the market continued to exhibit exceptional trading volumes and volatility until the Federal Reserve instituted several facilities to stabilize the corporate bond market on March 20, 2020.

experienced higher dealer intermediation, a relationship that strengthened during the crisis period. Importantly, insurers' trading activities were highly concentrated in bonds facing mutual fund selloffs due to massive redemptions. Insurers' purchases, but not their sales, were significantly associated with mutual fund bond ownership during the crisis period.

Second, we show that insurers with lower variation in funding were more likely to be net buyers in the crisis period. The illiquidity and bond price dislocations during the COVID-19 selloff presented investment opportunities for investors with long-term investment horizons and stable funding structures. To relate an insurer's funding stability with its bond trading, we compute a proxy for funding stability that captures the five-year standard deviation of the insurer's net cash flows from underwriting and financing relative to the size of its underwriting business. In the cross-section, we find that an insurer's inclination to buy on net during the crisis significantly decreases for higher levels of variation in insurance funding. This link between funding stability and bond purchases is not present during the pre-crisis period. Our finding is robust to the inclusion of a host of balance sheet variables, an alternative proxy of funding stability that is based on an insurer's underwriting profitability (Knox and Sørensen (2021)), and it holds for both life and property and casualty (P&C) insurers.

Third, we examine insurers' trading behavior with dealers and find strong evidence of relationship trading. During the crisis, insurers bought more from (and sold less to) dealers with whom they had prior relationships. This buy-sell asymmetry in insurers' trading indicates that insurance companies were not simply turning to their relationship dealers to establish desired bond positions, but instead were tilting their trading in a way that helped to offset those dealers' inventory imbalances. This finding is robust to controlling for both time-varying dealer and insurer characteristics and is not driven by dealers acting in their role as bond underwriters.

Fourth, dealers with relations to insurers with more stable insurance funding were executing trades at lower transaction costs when bond prices came under pressure from mutual fund fire sales. Connecting our results on insurers' funding stability with their relationship trading, we explore whether dealers with trading relationships to more stable funded insurance companies were able to charge lower transaction costs. If insurance companies tend to buy from their relationship dealers, then dealers with trading relationships to more stable funded insurance companies could provide more liquidity to other clients, knowing that they might be able to offset some of these positions with their relationship insurers. To test this empirically, we construct a dealer-level measure capturing the average funding stability of a dealer's relationship insurers, weighting each insurer's funding stability by the trading volume with a particular dealer over the past three years. We find that a bond's transaction costs increased when a trade was intermediated by a dealer whose relationship insurers had less stable insurance funding. This effect increases substantially during the crisis period, is stronger for customer sales to dealers, and intensifies in bonds potentially subject to larger selloffs by mutual funds. This finding is robust to a host of time-varying bond and trade characteristics and holds after controlling for dealer characteristics. In fact, this result continues to hold when we include dealer-day fixed effects to mitigate the concern about the impact of any unobservable time-varying dealer characteristics.

Our findings make clearer the important synergy between the asset and liability side of insurers' balance sheets and their implications for financial markets. A large literature has studied insurers' asset allocation and their liability pricing (see for example, Koijen and Yogo (2015), Ellul, Jotikasthira, Lundblad, and Wang (2015), Ge and Weisbach (2021), Ellul, Jotikasthira, Kartasheva, Lundblad, and Wagner (2022), Koijin and Yogo (2022)). Particularly related to our paper are studies that analyze the role of insurance funding in supporting insurers' investments in illiquid fixed-income securities. Hanson, Shleifer, Stein, and Vishny (2015) show that stable funding facilitates commercial banks and insurance firms in holding fixed-income securities that can be subject to transitory price movements. Chodorow-Reich, Ghent, and Haddad (2021) show that life insurers' stable long-term liabilities reduce the pass-through of asset value fluctuations to insurers' equity. Knox and Sørensen (2021) show that insurance companies with more stable insurance funding tend to take more investment risk.[5]

Our work adds to the insurance literature by delineating how funding stability supports insurers in their role as liquidity providers of "last resort" during a systemic liquidity crisis. More importantly, we demonstrate how insurers' funding stability can stabilize bond liquidity in times of market stress. While contemporaneous work by Aramonte and Mano (2022) also documents that insurance companies tend to trade in the opposite direction of bond mutual funds, our work quantifies the ultimate impact of insurers on bond market liquidity during a major liquidity crisis and explores the economic channels behind the stabilizing influence brought on by insurers' investment activities. More broadly, our findings also add to the literature that studies the role of

[5] Relatedly, Cherkes, Sagi, and Stanton (2009) note that closed-end funds, not facing the typical redemption risks of open-end funds, specialize in holding illiquid assets.

insurance companies in the wider financial system (see for example, Becker and Ivashina (2015), Greenwood and Vissing-Jorgensen (2018), Foley-Fisher, Gissler, and Verani (2019), Becker, Opp, and Saidi (2021), and Ozdagli and Wang (2022).[6]

Our paper provides new insights into the financial fragility risks in bond markets. A large body of literature studies the liquidity transformation performed by mutual funds, and its potential risks to financial stability (Chen, Goldstein, and Jiang (2010), Chernenko and Sunderam (2016), Goldstein, Jiang, and Ng (2017), Zeng (2017), Jiang, Li, and Wang (2020), Choi, Hoseinzade, Shin, and Tehranian (2020), Falato, Hortacsu, Li, and Shin (2020), and Jiang, Li, Sun, and Wang (2021)). Anand, Jotikasthira, and Venkataraman (2020) find that although mutual funds on balance demand liquidity, a subset of mutual funds leans against the wind and provides liquidity when most mutual funds are faced with substantial investor redemptions. Focusing on the COVID-19 crisis, recent work has studied the unprecedented outflows in corporate bond funds, and the substantial selling pressures these outflows posed to the underlying bond markets (see for example, Falato, Goldstein, and Hortacsu (2021), Haddad, Moreira, and Muir (2021), and Ma, Xiao, and Zeng (2021)). Meanwhile, several studies find that dealers did not step up and increase their liquidity provisions during the crisis (see for example, O'Hara and Zhou (2021), Kargar, Lester, Lindsay, Liu, Weill, and Zúñiga (2021), He, Nagel, and Song (2021)). On the contrary, they shifted from buying to selling, particularly in bonds with large exposures to mutual funds, exacerbating the dire liquidity conditions (Li, O'Hara and Zhou (2022)).

We contribute to the literature on fragility risks by highlighting the stabilizing role insurance companies played during a systemic liquidity crisis. For one, our results illustrate how insurers mitigated the fragility risks posed by open-end mutual funds facing sudden and substantial redemptions. For another, the results emphasize the importance of funding stability relative to investment horizons when it comes to facilitating this stabilizing role. Our findings also broaden our understanding of the insurance industry as a group of investors that can mitigate financial fragility risks, especially in light of research papers showing that insurers' own regulatory constraints, through various channels, can become the source of fire sale risks in the bond market (see for example, Ellul, Jotikasthira, and Lundblad (2011), Acharya, Philippon, and Richardson

[6] A related literature has studied other financial intermediaries (broker-dealers) and analyzed the impact of constraints on the liability side of balance sheets on their asset preferences, and ultimately market prices. See for example, Brunnermeier and Pedersen (2009), He and Krishnamurthy (2013), Brunnermeier and Sannikov (2014), Adrian, Etula, and Muir (2014), and He, Kelly, and Manela (2017).

(2017), Nanda, Wu, and Zhou (2019), Girardi, Hanley, Nikolova, Pelizzon, and Sherman (2021), and Ellul, Jotikasthira, Kartasheva, Lundblad, and Wagner (2022)).

Our paper also relates to the literature on the determinants of liquidity in the corporate bond markets. Several papers study how various post-crisis reforms and regulations affect dealer behavior and liquidity conditions in corporate bond markets (see for example, Adrian, Boyarchenko, and Shachar (2017), Trebbi and Xiao (2017), Schultz (2017), Bao, O'Hara, and Zhou (2018), Bessembinder, Jacobsen, Maxwell, and Venkataraman (2018), Dick-Nielsen and Rossi (2019), Macchiavelli and Zhou (2020), and Choi and Huh (2022)). Recent research focuses on the demand for liquidity, linking bond market liquidity conditions to investor compositions (Cai, Han, Li, and Li (2019), Chen, Huang, Sun, Yao, and Yu (2020), Coppola (2021), Li and Yu (2022a, 2022b)). Our paper contributes to this literature by exemplifying ultimate liquidity provision by insurance companies and by highlighting the source of value investors' ability to provide liquidity in the corporate bond market.

Lastly, our paper speaks to the literature on relationship trading in the OTC corporate bond market. Existing research has primarily focused on the value of repeat business for building insurer-dealer relationships and has explored how insurance companies benefit from such relationships in terms of execution quality.[7] For example, Hendershott, Li, Livdan, and Schürhoff (2020) model the choice of an insurer's trading network using trade-offs between the benefits of repeat business and dealer competition and link these trade-offs to the prices that insurers receive from their dealers. O'Hara, Wang, and Zhou (2020) find that although execution quality tends to be lower for less active insurers, it can be improved when these insurers form more concentrated trading networks with dealers. In contrast to these research studies, we focus on the opposite end of the insurer-dealer relationship, studying how dealers benefit from their relations with investors. Our results suggest that in addition to repeat business, trading support during liquidity crises can serve as another important channel through which dealers benefit from relationships with insurers.

This paper is organized as follows. Section 2 sets out the data and sample construction. Section 3 details the financial position of insurance companies and examines insurer trading behavior during the crisis relative to dealers and bond mutual funds. Section 4 analyses insurers' decision to become net buyers in the cross-section and highlights the importance of funding stability in their

[7] For trading relationships in the inter-dealer market, see Di Maggio, Kermani, and Song (2017), Li and Schürhoff (2020), and Colliard, Foucault, and Hoffmann (2021).

trading behavior. Section 5 investigates how prior relationships affect insurer trading behavior across dealers and examines whether relationship trading matters in case of non-underwriter dealers. Section 6 examines whether trading relationships to more stable funded insurance companies affect the transaction costs dealers charge during the crisis. Section 7 is a conclusion.

2. Data and Sample Construction

Our analysis relies on data from multiple data sources. Our first primary source of data are insurance companies' corporate bond transactions, which insurers report on a quarterly basis to the National Association of Insurance Commissioners (NAIC). For the period from 2017 to 2020, we compile the transaction records in corporate bonds reported in Parts 3 to 5 of Schedule D of life and P&C insurance companies' raw filings to the NAIC. Whereas Parts 3 and 4 of Schedule D contain long-term acquisitions and dispositions, respectively, Part 5 contains positions acquired and fully disposed of within the current year. The NAIC data provides detailed information on bond transactions, including issue and issuer identifiers, the execution date, the dollar amount and the par value of the transaction, and a buy/sell indicator which specifies whether the trade was an insurance company buying from or selling to a dealer. Importantly, the data provides the identities of both the insurance company and the dealer between whom each transaction took place. This two-sided identification of counterparties is essential to our analysis, as it allows us to identify trading relationships between insurance companies and dealers, and link dealers' liquidity provisions to their relationship insurers' funding stability.

For bonds included in the NAIC data, we use the Mergent Fixed Income Securities Database (FISD) to obtain information on the characteristics of each bond, such as the issue and maturity date, the history of the par amount outstanding, credit ratings, as well as the names of the lead underwriters who brought the bond to the market. For bonds' credit ratings, the FISD data provide a complete history of rating changes by each of three major rating agencies: Standard & Poor's (S&P), Moody's, and Fitch. For each bond on each day, we construct a composite rating that combines the ratings assigned by the three agencies.[8]

[8] Specifically, we give a numeric value to each notch of an S&P rating, with 1, 2, 3, 4, …, denoting AAA, AA+, AA, AA-, …, respectively. We then follow the same approach and assign numeric values for Moody's and Fitch ratings. If a bond receives only one rating, then the one rating becomes its composite rating. If a bond is rated by two rating agencies, we use the lower of the two ratings as the bond's composite rating. For a bond rated by all three rating agencies, its composite rating is determined by the median of the three ratings.

We start with all corporate bonds issued by firms domiciled in the United States. To be included into our sample, we require a bond to be denominated in U.S. dollars and rated by at least one of the three rating agencies. We then take a few steps to clean the NAIC transaction data to remove data discrepancies.[9] The NAIC data covers insurance companies' corporate bond trades in both the primary and the secondary market. Since the data do not indicate whether a trade occurred in the primary or the secondary market, we take the following steps to exclude primary market trades from our sample. All trades executed on the issuance date and at the offering price of the bond are classified as primary market trades. As the NAIC data do not include the price of the bond transaction, we compute the product of a bond's offering price (obtained from Mergent FISD) and the par amount purchased by the insurance company and round it to the nearest dollar. If it is equal to the dollar amount reported by the insurance company for the trade, then the trade is classified as a primary market trade. After excluding primary market trades, our NAIC sample consists of a total of 947,124 bond trades. These trades occurred in 15,941 bonds issued by 2,924 corporate issuers.

Next, we obtain insurers' statutory financial data from S&P Global Market Intelligence (formerly SNL Financial) to analyze their funding structures. For insurance companies in our NAIC sample, we obtain data on their quarterly cash flows from underwriting and financing activities over the five years prior to the 2020 COVID-19 crisis (that is, from 2015 to 2019).[10] We also obtain quarterly balance sheet data on insurers' total assets, surplus, liabilities, cash holdings, and average bond portfolio ratings as well as insurer's annual risk-based capital (RBC) ratios.[11] All balance sheet data and financial ratios are winsorized at 0.5th and 99.5th percentile. To ensure that insurers in our final sample are relatively large and active, they must have data over the five

[9] Because insurers record transactions manually, we first clean the counterparty (dealer) field with respect to name variations and misspellings. We then drop transaction records without a dealer name match and remove records that do not represent insurer buys or sells (such as bonds maturing, a paydown, redemptions, corrections). This includes dropping transactions if the counterparty field is "VARIOUS" or "DIRECT". We then filter the remaining transactions with respect to potential data issues concerning the price (missing, negative, or unreasonably large prices), the par value (missing, negative, or larger than the amount outstanding), or the timing of trades (trades before a bond's offering date or after its maturity date, and trades on weekends and trading holidays).

[10] We do not consider cash flows that are linked to insurers' investment activities or operative net investment income. Similarly, we exclude operative cash flows linked to capital gains taxes.

[11] Surplus (or equity in case of publicly owned firms) is an insurer's assets minus its liabilities. The RBC ratio is a capital adequacy ratio, measuring an insurer's capital relative to the riskiness of its business. Higher RBC ratios reflect better capitalization. Moreover, the NAIC designates bonds into six rating categories (1 through 6) based on their credit ratings. Higher categories reflect higher credit risk. Level 1 covers ratings AAA-A, level 2 covers BBB, level 3 covers BB, level 4 covers B, level 5 covers CCC, and level 6 is all other credit ratings.

years before 2020, have an RBC ratio above the regulatory threshold of 200 percent, total assets of at least $10 million, and positive assets, surplus, and liabilities. After applying these filters, we end up with a final sample of 1,744 insurers.

To analyze the impact of insurers' funding structures on dealer liquidity provision, we use the regulatory version of corporate bond transaction data from the Trade Reporting and Compliance Engine (TRACE), provided by the Financial Industry Regulatory Authority (FINRA). The TRACE data provide detailed information for each secondary market corporate bond trade, including a bond identifier, trade execution date and time, trade price and quantity, and a buy/sell indicator which specifies whether a trade was a dealer buy or sell. Importantly, the regulatory version of the TRACE data also provides the dealer identity for each bond trade, which allows us to link insurers' balance sheet information and their trading activities to dealers' overall intermediation and transaction costs in corporate bond trading.

Lastly, we work with two supplementary data sources. First, to link insurers' trading with bonds' exposure to mutual fund fire sales, we obtain data on mutual funds' corporate bond holdings from Refinitiv's eMaxx database. For U.S. corporate bonds, the eMaxx data provide security-level holding information by a comprehensive sample of U.S. institutional investors, including mutual funds, leading pension funds, and almost all insurance companies. Second, to control for potential impact of dealer characteristics on market making, we use data from SEC's Financial and Operational Combined Uniform Single (FOCUS) Reports.[12] The FOCUS data provide annual dealer-level balance sheet and income statement data.

3. Insurance Companies' trading around the COVID-19 Crisis

In March 2020, the COVID-19 pandemic struck the world economy and brought many financial markets under strain. In the U.S. corporate bond market, the concerns over the coronavirus sparked a surge in the demand for liquidity. Faced with sudden and unprecedented investor redemptions, open-end bond mutual funds were forced to liquidate their asset holdings, which further amplified the need for liquidity (Haddad, Moreira and Muir (2021), Ma, Xiao, and Zeng (2021)).[13] However, this surge in the demand for liquidity was not met by a corresponding

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[12] The FOCUS report is also known as SEC Form X-17A-5. As mandated by Section 17 of the Securities Exchange Act of 1934 Rule 17a-10(a)(1), broker-dealers that are registered with the SEC and meet the minimum net capital requirement set forth in Rule 15c3-1 are required to file this report.

[13] Several studies have examined disruptions in other financial markets. See Duffie (2020), Fleming and Ruela (2020), He, Nagel, and Song (2020), Schrimpf, Shin, and Sushko (2020) for Treasuries, Li, O'Hara, and Zhou (2020) for

increase in the supply of liquidity. Dealers, who are the primary liquidity providers in corporate bond markets, pulled back their liquidity provision at the height of the crisis. Instead of buying bonds they shifted to selling them, further exacerbating market conditions (see Boyarchenko, Kovner, and Sharchar (2020), Kargar, Lester, Lindsay, Liu, Weill, and Zúñiga (2021), and O'Hara and Zhou (2021)). Without dealers leaning against the wind, an important question arises: Who was buying when most institutional investors were selling?

We examine insurance companies as potential buyers of corporate bonds during the COVID-19 crisis. Unlike most other major investors in corporate bond markets, insurance companies, in particular life insurers, have stable, long-term liabilities. Hanson, Shleifer, Stein, and Vishny (2015) show that stable funding sources give rise to some financial intermediaries' comparative advantages in holding illiquid assets.[14] Knox and Sørensen (2021) show that insurance companies with more stable insurance funding take more investment risk within their credit portfolios. Consequently, stable insurance funding may have allowed some insurers to exploit profitable investment opportunities during the COVID-19 bond market selloff.

Contributing to insurers' role as buyers of last resort during the crisis is that most of them were able to maintain a healthy financial position. Chodorow-Reich, Ghent, and Haddad (2020) point out that insurers' ability to ride out financial market fluctuations depends on how much they were directly affected by the crisis. In fact, insurance companies weathered the COVID-19 crisis quite well. With the onset of the pandemic, the anticipated flood of insurance claims did not materialize, leaving pressures to cover claims manageable. Many who succumbed to the coronavirus were those least likely to have medical or life insurance coverage, namely older Americans and minorities who were disproportionately affected by the disease. In addition, lockdown measures limited the amount of motor and medical claims, as large parts of the labor force worked remote and health providers as well as patients opted to cancel elective procedures or non-urgent care. Also, following the SARS outbreak of 2003, much of the insurance industry introduced pandemic exclusion clauses, preventing immediate payouts in 2020. With the re-insurance sector bearing the

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municipal bonds, Chen, Liu, Sarkar, and Song (2020) for mortgage-backed securities, and Li, Li, and Macchiavelli (2020) for short-term funding instruments.

[14] While other financial intermediaries with similarly stable liabilities, such as commercial banks, might have also absorbed part of the liquidity shock during the COVID-19 crisis, it is worth noting that they are a much smaller player in the corporate bond market relative to insurance companies.

brunt of the remaining COVID-19-related losses, insurance companies were spared forced liquidations and overall performance did not deteriorate materially.

As shown in Table 1, insurers' balance sheet conditions were little changed between the last quarter of 2019 and the first quarter of 2020. On average, their assets, liabilities and surplus exhibit only small changes heading into the first quarter of 2020. Similarly, insurers' cash holdings and their bond portfolio ratings were little changed. Breaking down the sample of insurers by insurer types, we observe a similar pattern across life and P&C insurers. With largely unaffected balance sheets, most insurers maintained a robust financial condition, allowing them to seize the benefits of their stable funding structures and explore the investment opportunities presented by price dislocations during the COVID-19 crisis.

We start our analysis by studying the aggregate trading activity of insurance companies during the crisis period and link it to dealer inventory changes. Figure 1, Panel A, plots dealers' cumulative inventory changes, defined as the difference between their cumulative purchases and cumulative sales in secondary markets from February to March 2020. Dealer inventory changes are calculated using the TRACE data, and hence capture all of dealers' secondary market trades. With the onset of the bond sell-off on March 6, dealers' cumulative inventories decline substantially. In fact, dealers did not accumulate inventories until the Primary Dealer Credit Facility (PDCF) started operations on March 20, and more significantly so following the announcement of the Secondary Market Corporate Credit Facility (SMCCF) on March 23. During the two-week crisis period from March 6 to March 19, 2020, dealer inventories fell by about $5 billion on net. This suggests that dealers were not fully absorbing the selling pressure onto their books.

In contrast, insurance companies were leaning against the wind and increasing their positions in corporate bonds during a time when most institutional investors were under heavy selling pressure. In Figure 1, Panel B, we use the NAIC sample to plot insurers' cumulative net purchases, defined as cumulative buys minus cumulative sales. Over the same two-week crisis period from March 6 to March 19, 2020, insurers, on net, bought about $2.5 billion in bonds. This finding suggests that insurance companies were able to step up to exploit the trading opportunities that arose from the market disruptions. And, in doing so their trading might have supported dealer liquidity provision at the height of the COVID-19 crisis.

To empirically establish the relationship between insurer and dealer trading, we examine whether insurance companies traded more in bonds in which dealers' potential demand for liquidity support was higher. For this purpose, we construct a sample at the bond-day level that spans a two-week pre-crisis period (February 21 to March 5, 2020) as well as the two-week crisis period (March 6 to March 19, 2020). We then estimate the following empirical model:

$$\begin{aligned} Insurer\ Trades_{b,t} &= \beta_1\ Dealer\ Trades_{b,t} + \beta_2\ Dealer\ Trades_{b,t} \times Crisis_t \\ &+\ Controls_{b,t}^{T}\,\boldsymbol{\gamma}\ + \mu_r + \mu_t + \epsilon_{b,t}\ , \end{aligned} \tag{1}$$

where *b* refers to bond *b*, and *t* refers to the transaction date. In Model (1), the dependent variable, $Insurer\ Trades_{b,t}$, refers to the logarithm of one plus the par amount of bonds traded by insurance companies in bond b on day *t*, and it is calculated using the NAIC sample. The independent variable, $Dealer\ Trades_{b,t}$, refers to the logarithm of one plus the par amount of bonds traded by dealers in bond b on a day *t*, and it is calculated using the TRACE data. The dummy variable $Crisis_t$ takes the value of one for trades executed during the crisis period. We add bond age, time to maturity, and the amount outstanding into a vector of $Controls_{b,t}^{T}$ and further include credit rating fixed effects, μ_r, as well as day fixed effects, μ_t, in the regression. Standard errors are double clustered at the bond and the day levels.

Column I of Table 2 presents the results from estimating Model (1). Consistent with insurers being relevant counterparties in the corporate bond market, we find that the coefficient on $Dealer\,Trades_{b,t}$ is positive and highly significant, suggesting that insurers traded higher volumes in bonds with more active dealer trading during the pre-crisis period. Importantly, the positive and significant coefficient on the interaction term of $Dealer\,Trades_{b,t}$ and $Crisis_t$ suggests that the link between insurer trading and dealer trading strengthened during the crisis. This result provides first support to our hypothesis that insurers helped to absorb selling pressures and mitigated the liquidity shock during the COVID-19 crisis.

Next, we turn to insurers' trading activity in light of mutual funds' selling pressures. Several studies analyze the role of bond mutual funds as liquidity shock amplifiers during the COVID-19 crisis. Falato, Goldstein, and Hortaçsu (2021) show that the illiquidity of mutual funds' assets and their vulnerability to fire sales drove substantial investor redemptions. Mao, Xiao, and Zeng (2021) show that in response to outflows, mutual funds sold their most liquidity assets, including U.S. Treasuries and high-grade corporate bonds, generating unusually high selling pressures in these markets. In a similar vein, Haddad, Moreira, and Muir (2021) find that bonds held by funds suffering more outflows experience larger increases in yield spreads. Moreover, Li, O'Hara, and Zhou (2021) find that mutual fund fragility risks were amplified by dealers at the height of the crisis and drove significant price pressures in the municipal bond market.

If insurers acted strategically to profit from the temporary price dislocations caused by mutual fund fire sales, they should have stepped in as buyers when bond prices came under pressure. Figure 2 illustrates the univariate relationship between insurers' net purchases during the two-week crisis period and mutual funds' bond ownership. Specifically, Figure 2 separates insurers' net purchases across three groups of bonds, which we form based on bonds' mutual fund holdings at the end of 2019. The graph suggests that insurers' net purchases appear to be strongly concentrated in bonds with larger mutual funds holdings.

To control for additional factors that might have influenced insurers' trading decisions during the crisis, we use a bond-day level sample that spans the period from February 21 to March 19, 2020 and estimate the following empirical model:

$$\begin{aligned} Insurer\ Trades_{b,t} &= \beta_1\ MF\ Holdings_{b,t} + \beta_2\ MF\ Holdings_{b,t} \times Crisis_t \\ &\quad + Controls_{b,t}^T \boldsymbol{\gamma} + \mu_r + \mu_t + \epsilon_{b,t}\ . \qquad (2) \end{aligned}$$

Similar to Model (1), the dependent variable $Insurer\ Trades_{b,t}$ refers to the logarithm of one plus the par amount of bonds traded by insurance companies in a given bond on a given day. $MF\ Holdings_{b,t}$ refers to the logarithm of one plus the total par amount held by mutual funds as of the end of 2019. $Crisis_t$ and $Controls_{b,t}^T$ are defined as in Model (1). Again, we include credit rating fixed effects, μ_r, as well as day fixed effects, μ_t, and double clustered standard errors at the bond and the day levels.

In Table 2, Column II, we document no significant relationship between insurers' trading activities and mutual fund bond ownership for the pre-crisis period. This suggests that insurers were not actively trading bonds with large mutual fund holdings before investor redemptions triggered the mutual fund selling pressure. However, this association changes in the two-week crisis period, during which insurers' aggregate trading activities exhibit a weak positive relation with mutual funds' bond holdings.

To understand whether insurance companies primarily bought bonds with large mutual fund ownership, we further separate insurers' total trading volumes into buys and sells and re-estimate

Model (2). Columns III shows that the coefficient on the interaction effect, $MF\ Holdings_{b,t} \times Crisis_t$, becomes positive and significant at the 5 percent level for $Insurer\ Buys_{b,t}$ as the dependent variable. Meanwhile, the interaction term has no significant impact on $Insurer\ Sells_{b,t}$ as the dependent variable. These results show that only insurers' purchases but not their sales were significantly associated with mutual fund bond holdings during the crisis period. In addition to bond characteristics, we also control for issuer-day fixed effects, which allows us to compare the trades of insurers in similar bonds that are issued by the same firm and traded on the same day but may be subject to varying mutual fund ownership. As shown in Columns V and VI, controlling for issuer-day fixed effects does not materially change our results. Overall, our findings suggest that insurance companies contributed to stabilizing the bond market by acting as counterparties to dealers, especially in bonds that were likely facing selling pressure from mutual funds.

4. Funding Stability and Insurer Trading in Crisis

If insurers' ability to buy bonds on net during the crisis arises due to their stable funding structures, then we would expect insurers with more stable funding to be more active buyers during the COVID-19 bond market selloff. To investigate this hypothesis, we develop a measure of individual insurer funding stability. We compute the five-year standard deviation of an insurer's net cash flows from underwriting and financing relative to the size of the underwriting business. In doing so, we build on Knox and Sørensen (2021) who define underwriting profitability for P&C insurers as the ratio of profits from underwriting activities to the size of the underwriting business. Specifically, they use the following ratio,

$$Underwriting\ Profitability_t = \frac{Premiums_t - Losses_t - Expenses_t}{Liablities_{t-1}}\ , \qquad (3)$$

and take the metric's past five-year volatility as a proxy for insurance funding stability. For our purposes, we extend Equation (3) to account not only for cash flows from underwriting but also cash flows from financing, which combines the funds raised or repaid from the debt and equity of an insurer. While cash flows from financing account for a relatively small share of total cash flows, they generalize the concept of insurance funding to all but cash flows from investment activities. That is, an increase in an insurer's funds available for investments can come from higher premiums relative to expected claims and payouts, realized claims and payouts that are lower than insurer expectations, and an inflow of debt and equity raised from capital markets relative to repayments of outstanding funds. Broadening the sources of cash available for investment beyond the underwriting activities adds cross-sectional variation to the measure across insurer types, which allows us to analyze life and P&C insurance companies separately. Our measure of insurance funding stability is then given by the five-year historical standard deviation of the following ratio:

$$Insurance\ Funding_t = \frac{Net\ Cash\ from\ Underwriting_t + \ Net\ Cash\ from\ Financing_t}{Liablities_{t-1}}. \qquad (4)$$

To calculate $Net\ Cash\ from\ Underwriting_t$, we start with an insurer's profits from underwriter activities (i.e., $Premiums_t - Losses_t - Expenses_t$) and add the insurer's miscellaneous income unrelated to investment activities, such as its net cash flows related to its reinsurance activities. Then, we subtract taxes and, if applicable, dividends to policyholders. For life insurers, we focus on general accounts and exclude cash to their separate accounts. $Net\ Cash\ from\ Financing_t$ is the net cash raised from debt (bonds and loans) and equity (capital and surplus) minus, if applicable, dividends to stockholders.

Using both our measure of variation in insurance funding and the measure proposed by Knox and Sørensen (2021), we explore whether insurers with more stable funding were more likely to become net buyers. We postulate that insurers with high variation in insurance funding will have been less likely to act as net buyers during the crisis period. We start the cross-sectional analysis with a simple tabulation of balance sheet characteristics for the insurers in our sample. As shown in Table 3, our final sample contains 1,744 insurance companies of which about a third are life insurers (n=481) and two thirds are P&C insurers (n=1,263). Insurer characteristics differ along their respective insurance types. On average, life insurers are significantly larger, more leveraged, have lower capital adequacy ratios, and hold riskier bond portfolios than P&C insurers, reflecting in part their line of business and the frequency with which they pay out claims. Related to the latter, we find that life insurers on average show lower variation in underwriting profitability and insurance funding than P&C insurers. Beyond the difference in means, we also see a slightly wider interquartile range in both proxies of funding variation within the respective insurer types. In the last four rows of Table 3, we compare insurers average trading activity in the pre-crisis and crisis period. On average, we find a higher share of net buyers among life insurers. While life insurers trade more in absolute terms, the increase in the share of net buyers from the pre-crisis to the crisis period is more pronounced among P&C insurers.

To more directly relate insurers' trading behavior in the crisis period to their funding stability, we use cross-sectional regressions involving a host of insurance characteristics to explain insurers' decision to become net buyers. For this purpose, we construct a sample at the insurer-period level, aggregating an insurer's net trading in the pre-crisis period (February 21to March 5, 2020) and crisis period (March 6 to March 19, 2020), respectively. We then estimate specifications of the following simple linear probability model:

$$Net\ Buyer_{i,t} = \beta_1\ Variation\ in\ Insurance\ Funding_{i,19:Q4}$$

$$+Controls_{i,19:Q4}^{T}\, \boldsymbol{\gamma} + \mu_k + \epsilon_{i,t}\ , \qquad (5)$$

where i refers to the insurer, and t refers to the period. The dependent variable in Model (5), $Net\ Buyer_{i,t}$, reflects insurers' decision to be a net buyer and is equal to one in case insurer *i*'s aggregate net trading is positive over period *t* and 0 otherwise. This variable is calculated using the NAIC sample. The independent variable, $Variation\ in\ Insurance\ Funding_{i,19:Q4}$, refers to the historical standard deviation of insurer *i's* total insurance funding calculated over the past five years through 2019:Q4, and it is calculated using the S&P Global Market Intelligence data. We add the logarithm of an insurer's assets, five-year asset growth, the logarithm of an insurer's RBC ratio, the leverage ratio, the cash-to-assets ratio, and the weighted average bond portfolio rating all through 2019:Q4 into a vector of $Controls_{i,19:Q4}^{T}$ and further include insurer type fixed effects, μ_k in the regression. Standard errors are clustered at the insurer level. We run Model (5) separately for the pre-crisis and crisis period, allowing each insurer characteristic to have a differentiated effect on the dependent variable across the two periods.

If, as hypothesized, higher variation in insurance funding impedes an insurer's ability to exploit profitable trading opportunities during times of temporary price dislocations, we should expect to find a negative relationship between the decision to be a net buyer and our measure of funding stability. Our results, reported in Table 4, support this hypothesis. As shown in Table 4, Columns I and II, an insurer's decision to be a net buyer is unrelated to variation in insurance funding in the pre-crisis period, but it becomes significantly negatively correlated with variation in insurance funding in the crisis period. These estimates imply that a one standard deviation increase in funding variation lowers the probability of being a net buyer by 3.2% (that is, 0.36 times -8.9%), or about a tenth of the unconditional probability. Furthermore, we find that the difference between the pre-crisis and crisis coefficients to be significant at the 5% significance level (t-stat=-2.17, p-value=0.030).

Overall, these results suggest that insurers with high variation in insurance funding were less likely to be net buyers in the corporate bond market during times of stress. The negative relationship in Column II is robust to the inclusion of other established balance sheet characteristics that can affect insurer risk taking. Besides funding variation, only insurer size and bond rating appear to have a sizeable and positive impact on an insurer's decision to be a net buyer. In Column IV, we show that the negative relationship between funding variation and the likelihood to buy on net also holds when we use the variation in insurers' underwriting profitability as a proxy for funding stability. The results are qualitatively similar, producing effects of comparable magnitude, significance, and regression fit.

To investigate further the negative relationship between the variation in insurance funding and an insurer's decision to be a net buyer, we split the sample and run cross-sectional regression by insurer types. Table 5 contains the regression results for life insurers, Columns I and II, as well as P&C insurers, Columns III and IV. For both types of insurers, we find a negative and significant relationship between the variation in funding stability and the net buyer indicator variable during the crisis period. While the crisis period estimate for life insurers is more pronounced, the marginal effect of a one standard deviation increase in funding variation is comparable across insurer types, slightly increasing to about 5.3% for life insurers and to 4% for P&C insurers. This still reflects a tenth of the unconditional probability for life insurers and about an eighth of the unconditional probability for P&C insurers. Once more, the relationship is robust to the inclusion of established insurer balance sheet control variables. Overall, our evidence is consistent with the notion that insurers' funding stability played an important role for their ability to act as net buyers during the crisis period.

5. Insurer Liquidity Provision through Dealers

Our analysis so far shows that insurance companies as a whole were net buyers of corporate bonds, supporting the market making activities of dealers during the COVID-19 crisis. Importantly, we also show that it was insurers with more stable insurance funding that were more likely to step in as net buyers. Of further interest is the question: Which dealers did insurers trade with when they provided liquidity? In this section, we analyze how prior trading relationships influenced insurers' counterparty choices. We also evaluate the potential impact of underwriter commitments on insurer-dealer trading relationships.

5.1 Relationships and Insurer Trading during Crisis

In OTC bond markets, institutional investors build trading relationships with dealers to reduce search frictions.[15] Recent studies highlight the benefits of repeat business and show that insurer-dealer trading relationships can positively affect execution quality for insurers.[16] During transitory dislocations in bond prices, as witnessed during the COVID-19 bond sell-off, insurers' capability of taking long positions can be of particular value to dealers who are temporarily absorbing external selling pressures. If insurers can support relationship dealers in their liquidity provision during times of stress, this may strengthen the reciprocity of their relationships. If the latter is true, we would expect that an insurer' liquidity support to a dealer increases with the extent of their prior trading relationships.

To test this conjecture, we calculate the daily trading volume of each insurer-dealer pair between February 21 and March 19, 2020 and link the pairs' trading volumes to their prior relationships. Restricting the sample to only insurer-dealer pairs with nonzero crisis trading volumes excludes all those insurer-dealer pairs that decided against trading, which can introduce a potential selection bias. To address this concern, we consider any insurer-dealer pair as a possible pairing for trade in the crisis period as long as the pair traded with each other at least once during the three-year period from 2017 to 2019. We then estimate the following regression:

$$\begin{aligned} Insurer\ Buys\ from\ Dealer_{i,j,t} &= \beta_1\ Crisis_t + \beta_2\ Past\ Trading_{i,j} + \beta_3\ Crisis_t \times Past\ Trading_{i,j} \\ &+ Controls_{i,19:Q4}^{T}\,\boldsymbol{\gamma} + \mu_j + \epsilon_{i,j,t}\ , \end{aligned} \tag{6}$$

where $Insurer\ Buys\ from\ Dealer_{i,j,t}$ refers to the logarithm of one plus the total par amount of bonds that insurer *i* bought from dealer j on day t. $Crisis_t$ takes the value of one for the crisis period. The prior trading relationships between insurer i and dealer j is captured by $Past\ Trading_{i,j}$, which refers to the logarithm of one plus the average monthly trade volume

[15] Following the seminal work of Duffie, Gârleanu, and Pedersen (2005), a large literature that applies search-and-matching theory to the study of OTC markets has emerged. See Weill (2020) for a review.
[16] See O'Hara, Wang, and Zhou (2018), and Hendershott, Li, Livdan, and Schürhoff (2020).

between insurer i and dealer j between 2017 and 2019. The vector $Controls^{T}_{i,19:Q4}$ contains the logarithm of an insurer's assets, five-year asset growth, the logarithm of an insurer's RBC ratio, the leverage ratio, the cash-to-assets ratio, and the weighted average bond portfolio rating all through the last quarter of 2019 to address the potential impact of insurer characteristics on the trading relationship. To control for the potential impact of dealer characteristics on the trading activities, we include dealer fixed effects, μ_j. Standard errors are double clustered at the day and dealer-insurer levels.

If, as hypothesized, an insurer's liquidity support to its relationship dealers increases in times of stress, we should expect the insurer to increase its bond purchases from but not its bond sales to, its relationship dealers. Our results, reported in Table 6, support this hypothesis. As shown in Column I, an insurer's purchases from a dealer are positively associated with the extent of the prior trading relationship, as the coefficient on $Past\ Trading_{i,j}$ is positive and highly significant. This is consistent with relationship trading in the pre-crisis period. More importantly, the coefficient of the interaction term of $Crisis_t$ and $Past\ Trading_{i,j}$ is also positive and highly significantly, despite the negative coefficient on $Crisis_t$ itself. This result suggests that, compared to the pre-crisis period, the positive impact of a prior trading relationship on an insurer's purchases with a dealer increased in the crisis.[17]

In Table 6, Column II, we turn our attention to insurers' sales to dealers. Similar to the above results, we find a positive and highly significant coefficient on $Past\ Trading_{i,j}$, suggesting that insurers were selling more in the pre-crisis period to dealers with whom they had stronger prior relationships. Importantly, this positive relation between sales and the prior relationship reverts during the crisis period, as the coefficient on the interaction term of $Crisis_t$ and $Past\ Trading_{i,j}$ turns negative and significant at the 10% significance level. So, relative to the pre-crisis period, insurers decreased the intensity of their sales with relationship dealers once the two-week bond sell-off unfolded. This asymmetry in insurers' buying and selling intensities indicates that insurance companies were not simply turning to their relationship dealers to establish the desired

[17] We examine the possibility that some insurers' trades with relationship dealers were quickly reversed by trading with non-relationship dealers or other insurers. We analyze insurers' bond turnover and find that on a given day and for a given bond, insurers on average retain about 99% of their trades during our sample period. This suggests that almost all of insurers' trades are conducted on a principal basis, highlighting the importance of insurers' funding structures for establishing bond positions.

bond positions. Instead, they helped to absorb part of the selling pressures that met their relationship dealers during the crisis period.

To address the potential concern that the insurers balance sheet controls included in Model (6) do not fully capture the factors determining the insurer-dealer trading behavior, we replace the vector of insurers control variables with insurer fixed effects. Furthermore, to account for the potential impact of time progression on the trading relationships during the two-week crisis period, we add day fixed effects to Model (6). These estimates can be found in Table 6, Columns III and IV. For insurers purchases, the regression coefficients are little changed, confirming an increase in the buying intensity from relationship dealers. For insurers sales, however, the coefficient on the interaction term of $Crisis_t$ and $Past\ Trading_{i,j}$ further decreases and becomes significant at the 1% significance level, underscoring the earlier finding that insurers created an asymmetry in their buying and selling intensities when they were trading with relationship dealers.

A final concern is that the impact of insurer and dealer characteristics on the trading relationship might be time-varying. For example, the COVID-19 crisis could have affected the financial conditions of insurers differently, which in turn could have altered the liquidity support those insurers were able to grant to their relationship dealers. The same holds true for dealers, who, as the crisis progressed, might have changed their trading behavior towards insurers due to changes in their own financial conditions. To address this concern, we re-estimate Model (6) with insurer-day and dealer-day fixed effects. This allows us to test the effect of prior trading relationships on insurers' trading activities by comparing the buys and sells of the same insurers on the same trading day across different dealers. In Table 6, Columns V and VI, we show that our results are robust to the inclusion of insurer-day and dealer-day fixed effects, as the coefficients of interest are little changed in both magnitude and significance. Together, these results provide strong support to our hypothesis that insurers provided more liquidity support to dealers with whom they had stronger trading relationships in the past.

5.2 Underwriting and Relationship Trading

For many financial securities, the lead underwriters who organize a security offering are also the most active dealers in secondary market trading.[18] In the corporate bond market, Dick-Nielsen,

[18] For equity markets, see for example, Aggarwal (2000), Benveniste, Busaba, and Wilhelm (1996), Chowdhry and Nanda (1996), Ellis, Michaely, and O'Hara (2000), Hanley, Kumar, and Seguin (1993), or Schultz and Zaman (1994).

Feldhütter, and Lando (2012) find that during the 2007-2008 financial crisis, bonds were more illiquid when their lead underwriter was in financial distress. Bessembinder, Jacobsen, Maxwell, and Venkataraman (2021) find that underwriters use overallocation to stabilize prices and facilitate the redistribution of new issues to retail investors. Flanagan, Kedia, and Zhou (2021) and Goldstein, Hotchkiss, and Nikolova (2021) show that underwriters account for the vast majority of after-market intermediation for new corporate bond issues. If underwriters are implicitly committed to stabilize secondary market trading, how does it affect insurers' trading with their relationship dealers? In other words, could our results on insurers' trading with their relation dealers in a given bond be affected by the possibility that these dealers may also be the underwriters of the bond?

To verify that the prior relationship with a dealer rather than the potential underwriter commitments explain an insurer's liquidity support during the crisis period, we specifically examine insurers' trading activities with non-underwriter dealers. For this purpose, for each bond in our sample, we obtain the list of lead underwriters from the FISD database. We then hand mapped underwriter names with dealer names in NAIC and classify the dealers trading a particular bond into underwriter dealers and non-underwriter dealers. We then reconstruct the $Insurer\ Buys\ from\ Dealer_{i,j,t}$ measure by aggregating the trading volumes, separating buys and sells, between insurer *i* and a non-underwriter dealer *j* on day *t*, across all bonds for which dealer *j* is not one of the lead underwriters. Since the new sample only includes insurers' trading activities with dealers that have no underwriter commitments, the sample allows for a clean test of the link between insurer liquidity support and prior relationships absent of any benefits that might come from trading with underwriter dealers.

Using this subsample, we re-estimate Model (6). Columns VII and VIII of Table 6 show that prior trading relationships had a positive effect on both insurer purchases and sales to relationship dealers in the pre-crisis period. For the crisis period these effects change, confirming an asymmetry in trading intensities even for non-underwriter dealers. In Column VII, the coefficient on the interaction term of $Crisis_t$ and $Past\ Trading_{i,j}$ is positive and highly significant, suggesting that insurers increased their buying intensity in case of prior relationships. At the same time, the interaction term in Column VIII is negative and highly significant for insurer sells, indicating that insurers reduced the selling to relationship dealers. This confirms that dealers without any underwriter commitments also received insurers' liquidity support in case of prior trading relationships. Overall, these results lend support to our hypothesis that prior insurer-dealer relationships, independent of underwriter commitments, shaped insurers' trading behavior during the crisis.

6. Insurer Funding Stability and Corporate Bond Liquidity

Our findings in Sections 3 and 4 demonstrate that insurance companies, in particular those with stable insurance funding, were net buyers of corporate bonds, supporting dealers' market making activities during times of intense selling pressure. Our results in Section 5 highlight that insurers' liquidity support was largely reserved for their relationship dealers, markedly tilting their trading in a way that helped to offset inventory imbalances. In this section, we focus on the implications of insurers' funding stability on bond market liquidity. Given the importance of funding stability for insurers' trading behavior, we explore whether stronger trading relationships to more stable funded insurance companies affect the transaction costs dealers were charging during the crisis period.

6.1 Insurers' Funding Stability and Transaction Costs

How do dealers' relationships with insurance companies affect their pricing strategies during the crisis? If insurers with more stable funding are better able to take on long bond positions and thereby facilitate dealer liquidity provision, then dealers with trading relationships to more stable funded insurance companies could quote aggressively to attract more business, knowing that they can eventually offset some of the additional business with their relationship insurers. This type of competitive pricing strategy would lead to lower transaction costs for dealers whose relationship insurers have more stable funding, suggesting we should see lower transaction costs for dealers whose relationship insurers have more stable funding (i.e., lower variation in insurance funding).

To empirically test how variation in insurance funding of a dealer's relationship insurers affects the dealer's pricing strategy, and hence the transaction costs for investors, we use the TRACE data and construct a sample that includes all secondary market customer-dealer trades executed between February 21 and March 19, 2020. Just like in the NAIC sample, we apply the same filters on bond characteristics, and keep dollar-denominated bonds issued by U.S. firms and rated by at least one of the three major rating agencies. We then adopt a trade-level transaction cost measure as in Hendershot and Madhavan (2015):

$$Cost_k = ln(Trade\ Price_k\ /\ Benchmark\ Price_l) \times Trade\ Direaction_k, \qquad (7)$$

where $Trade\ Price_k$ refers to the transaction price for trade k executed by dealer j, and $Benchmark\ Price_l$ is the transaction price of the most recent inter-dealer trade l. $Trade\ Direction_k$ captures the direction of the trade from the customer's perspective, taking the value of one for a customer buy order and minus one for an customer sell order. Lastly, we multiply $Cost_k$ by ten thousand to compute transaction costs in basis points. As some corporate bonds trade infrequently, the most recent inter-dealer trade might have occurred days before the customer-dealer trade and could thus be a stale benchmark price. We therefore winsorize the top and the bottom 1% of the transaction cost measure to limit the potential impact of noisy measurements. We then estimate the following empirical model:

$$\begin{aligned} Cost_k = {} & \beta_1 Crisis_t + \beta_2\ Variation\ in\ Insurance\ Funding_j \\ & + \beta_3\ Crisis_t \times Variation\ in\ Insurance\ Funding_j \\ & + Controls_{b,t}^T\,\boldsymbol{\gamma} + \mu_r + \mu_d + \mu_s + \varepsilon_k. \end{aligned} \qquad (8)$$

In Model (8) the variable $Variation\ in\ Insurance\ Funding_j$ captures the *average* variation in insurance funding (see Section 4 for details) of dealer j's relationship insurers, weighted by the total trading volume of an insurer with the dealer over the period from 2017 to 2019. For our estimation we rely on dealer identities provided in both the regulatory TRACE data and the NAIC data. Specifically, for each dealer in the TRACE sample, we identify the same dealer in the NAIC sample using their names. We then aggregate a dealer's trading volume with insurance companies between 2017 and 2019 using the NAIC data. $Crisis_t$ takes the value of one for the crisis period. In addition, the vector $Controls_{b,t}^T$ contains bond-level characteristics, such as bond age, time to maturity, the amount outstanding. Lastly, we also include rating fixed effects, μ_r, trade direction fixed effect, μ_d, and a trade size fixed effect, μ_s, to control for other relevant trade characteristics.[19] Standard errors are double clustered at the bond and day levels.

Our results in Table 7, Column I, support the hypothesis that dealers' relationships with stable funded insurers allowed them to charge lower transaction costs for the execution of trades. The coefficient on $Variation\ in\ Insurance\ Funding_j$ is positive and highly significant, suggesting

[19] Trade size fixed effects are based on the four trade size categories: micro ($1 to $100,000), odd lot ($100,000 to $1,000,000), round lot ($1,000,000 to $5,000,000), and Block (above $5,000,000).

that lower variation in insurance funding across a dealer's relationship insurers leads to lower transaction costs in the pre-crisis period. More importantly, the coefficient on the interaction term of $Variation\ in\ Insurance\ Funding_j$ and $Crisis_t$ is also highly significant, indicating that during the crisis, dealers whose relationship insurers had more stable insurance funding (i.e., lower variation in insurance funding) were able to lower their transaction cost further. The impact of insurer funding stability on dealer liquidity provision is also economically significant. A one standard deviation reduction in $Variation\ in\ Insurance\ Funding_j$ during the crisis is associated with an additional 13 basis point reduction in transaction cost, which is about 18% of the average cost in bond trading during the crisis period. Therefore, after controlling for trade and bond characteristics, trades executed by dealers with access to more stable funded insurers typically took place at lower transaction costs.

To mitigate concerns that we are omitting relevant bond-level controls or that our results might be driven by time-variation during the two crisis weeks, we introduce bond and day fixed effects and combine them into a composite bond-day-trade size-trade direction fixed effects before we re-estimate Model (8). As shown in Table 7, Column II, although the bond-day-trade size-trade direction fixed effects substantially reduce our sample, the coefficient of the interaction term remains positive and highly significant. The result suggests that for trades in the same bond, on the same day, and with the same trade direction and similar trade size, a one-standard-deviation reduction in a dealer's $Variation\ in\ Insurance\ Funding_j$ measure is associated with an additional 9 basis point reduction in transaction costs. In Columns III and IV of Table 7, we show qualitatively similar results when we replace our proxy of funding stability with the Knox and Sørensen (2021) proxy that solely accounts for variation in insurer's underwriting profitability.

If, as hypothesized, insurers with more stable funding are better able to facilitate dealer liquidity provision during the crisis, we should expect to find a more direct impact of variation in insurance funding on transaction costs for dealer purchases than for dealer sales, as more stable funded insurers may eventually be able to take on the acquired dealer inventories. Our results, reported in Table 8, support this hypothesis. As shown in Table 8, Columns I and II, already during the pre-crisis period, we find a positive and highly significant relationship between variation in insurance funding and transaction costs that is a considerably more pronounced for dealer buys than for dealer sells. This is consistent with the idea that stable funded investors matter more when dealers need to offload acquired inventories. More importantly, during the crisis period, the transaction costs of a dealer's purchases became markedly more sensitive to variation in insurance funding—roughly twice the magnitude in terms of the regression coefficients—than the transaction of dealer sales. This result suggests that, as the market sell-off began, dealers that could rely on a network of stable-funded insurers were able to charge considerably lower transaction costs than dealers with a network of less stable funded insurers. Again, as shown in Columns III and IV, the results are qualitatively similar when we use variation in insurer's underwriting profitability.

6.2 Controlling for Dealer Characteristics

One could argue that dealer characteristics, rather than their connection with stable funded insurers, explain the differences in transaction costs. To address this concern, we expand Model (8) to account for various dealer characteristics. First, we include each dealer's market share, $Dealer\ Market\ Share_j$, which represents the fraction of the customer-dealer trading volume that was executed by dealer j between 2017 and 2019 relative to the total market trading volume over the same period. Second, to capture the special role played by underwriter in secondary market trading, we include a dummy, $Underwriter_{j,b}$, for whether dealer j is the lead underwriter for bond *b*. As shown in Table 9, Column I, consistent with the notion that underwriters are implicitly committed to stabilize secondary market trading, transaction costs decrease for trades executed by lead underwriters. Meanwhile, dealer market share does not appear to affect transaction costs. Most importantly, however, with the inclusion of these control variables the coefficient on the $Crisis_t \times Variation\ in\ Insurance\ Funding_j$ interaction term is little changed in magnitude compared to Table 7, Column II, and remains positive and highly significant.

To mitigate concerns that our results might be driven by other dealer characteristics, we include dealers' financial statement data from SEC's FOCUS Reports. In particular, in Table 9, Column II, we include three additional variables in Model (8): dealer size, dealer leverage, and dealer profitability. $Dealer\ Size_j$ is the logarithm of a dealer's total assets. $Dealer\ Leverage_j$ is one minus the ratio of equity to total assets. $Dealer\ ROA_j$ refers to a dealer's net income divided by total assets. We find that dealer size has a negative impact on transaction costs, while dealer profitability is strongly positively associated with higher trading costs. Dealer leverage does not appear to significantly affect transaction costs. With the inclusion of the three additional dealer controls, the magnitude of the coefficient on the $Crisis_t \times Variation\ in\ Insurance\ Funding_j$

interaction term increases slightly, while it remains highly significant. Thus, our result that the funding stability of dealers' relationship insurers improves bond liquidity is robust to the inclusion of relevant dealer financial statement variables.

Lastly, we allow each dealer characteristic to have a differentiated effect on the dependent variable, $Cost_k$, during the pre-crisis and crisis period. That is, we re-estimate Model (8) by interacting the dealer control variables with the $Crisis_t$ indicator variable. Table 9, Column III, shows that some dealer characteristics indeed have a differentiated effect on transaction costs. While dealer leverage did not appear to have a significant impact on transaction costs before, in Column III it is highly significantly and positively associated with transaction costs in the crisis period. Dealer profitability, on the other hand, no longer has a significant effect in the crisis period. Most importantly, interacting the dealer controls with the crisis dummy nearly doubles the still highly significant coefficient on $Crisis_t \times Variation\ in\ Insurance\ Funding_j$. That is, our main effect remains robust when we account for the period-specific impact of dealer variables. Overall, we find strong empirical evidence that the funding stability of dealers' relationship insurers lowers the transaction costs that a dealer charges investors, in particular during times of stress.

6.3 Insurer Funding Stability and Mutual Fund Bond Ownership

Our results in Subsection 3.2 show that insurers' purchases during the crisis were strongly concentrated in bonds with larger mutual funds holdings, suggesting that insurance companies stepped in as buyers when bond prices came under pressure from mutual fund fire sales. If insurers stepped in strategically to profit from the temporary price dislocations caused by mutual fund selling pressure, we should find that dealers with stable-funded relationship insurers were in a position to complete trades at lower transaction costs, knowing that they would eventually be able to offset some of their trades with their relationship insurers.

To test this empirically, we introduce mutual fund bond holdings to Model (8). Specifically, we interact a bond's mutual fund holdings, $MF\ Holdings_{b,t}$, with the two-way interaction $Crisis_t \times Variation\ in\ Insurance\ Funding_j$ to form a three-way interaction term and estimate the following model:

$$
\begin{aligned}
Cost_k = \beta_1 Crisis_t &+ \beta_2\, Variation\ in\ Insurance\ Funding_j + \beta_3\, MF\ Holdings_{b,t} \\
&+ \beta_4\, Crisis_t \times Variation\ in\ Insurance\ Funding_j \\
&+ \beta_5\, Variation\ in\ Insurance\ Funding_j \times MF\ Holdings_{b,t} \\
&+ \beta_6\, Crisis_t \times Variation\ in\ Insurance\ Funding_j \times MF\ Holdings_{b,t} \\
&+ Controls_{j,t}^T\, \boldsymbol{\gamma} + \mu_{b,t,s,d} + \varepsilon_k, \qquad (9)
\end{aligned}
$$

where, as before, $Variation\ in\ Insurance\ Funding_j$ captures the average variation in insurance funding of dealer j's relationship insurers, weighted by the total trading volume of an insurer with the dealer over the period from 2017 to 2019. $Crisis_t$ takes the value of one for the crisis period. And, the vector $Controls_{j,t}^T$ contains the dealer characteristics $Dealer\ Market\ Share_j$ and the $Underwriter_{j,b}$, dummy variable. Moreover, we include a composite bond-day-trade size-trade direction fixed effect, $\mu_{b,t,s,d}$. Standard errors are double clustered at the day and bond-dealer levels.

If our hypothesis holds, we should expect the triple interaction term, $Crisis_t \times Variation\ in\ Insurance\ Funding_j \times\ MF\ Holdings_{b,t}$, to have a positive and significant effect on transaction costs. A positive triple interaction term would still suggest lower transaction costs for dealers with stable-funded relationship insurers (i.e., low variation in insurance funding) trading bonds in which mutual fund holdings were high at the end of 2019. Table 10, Column I, confirms our hypothesis as we find a positive, economically meaningful, and strongly significant coefficient at the 5% significance level on the triple interaction term. This suggests that in bonds with presumably high mutual fund selling pressure dealers with relationships to stable funded insurance companies were able to charge lower transaction costs. We find qualitatively similar results when we use variation in insurer's underwriting profitability as an insurance funding proxy.

To mitigate concerns about dealer-level time-variation as we enter the crisis period, we further include dealer-day fixed effects and re-estimate Model (9). As shown in Table 10, Column II, the triple interaction is little changed and remains strongly significant. Again, our results also hold when we use variation in insurers' underwriting profitability as a proxy for funding stability. Together, these results provide strong support to our hypothesis that dealers with stable-funded relationship insurers were able to complete trades at lower transaction costs when bond prices came under pressure from mutual fund fire sales.

7. Conclusion

The COVID-19 financial crisis revealed yet again that dealer liquidity provision in OTC markets is fragile during times of stress. We learned once more that dealers are to be understood primarily as buyers of "first resort", acting to smooth short-term order flow imbalances, with neither the capital nor the inclination to stop outright market meltdowns. The buyers of "last resort" are value investors, whose long investment horizons allow them to step in and buy when illiquidity and temporary price dislocations present investment opportunities. Insurance companies fit this characterization: Typically, their stable funding structures give them the ability to step in and profit from transitory market fluctuations. During times of heavy selling pressure, this ability makes them particularly valuable counterparties for dealers, and for the bond market in general.

Using regulatory bond transaction data, we investigate how insurers' funding structures shaped their trading behavior during the COVID-19 bond sell-off. We document that insurance companies were leaning against the wind and increasing their positions in corporate bonds when most institutional investors were under heavy selling pressure. In doing so, insurance companies contributed to stabilizing the disruptions in the corporate bond market. We show that insurers with more stable funding were more likely to buy on net during the crisis, emphasizing the importance of funding stability relative to investment horizons. Moreover, we find strong evidence of relationship trading: Insurers bought more from (and sold less to) dealers with whom they had prior trading relationships, tilting their trading in a way that helped their relationship dealers to offset inventory imbalances. This type of liquidity support by insurers carries important implications for bond market liquidity in times of stress, as it highlights that the insurance companies can ameliorate poor liquidity conditions. In fact, we find that dealers charged lower transaction costs when their relationship insurers had more stable insurance funding. This impact of insurer funding stability on transaction costs is particularly pronounced for bonds facing selling pressure from mutual funds.

Our results carry important policy implications. Regulatory reforms introduced after the global financial crisis have limited both the ability and willingness of bank-affiliated dealers to intermediate corporate bond trading, raising the concern that liquidity has become more fragile and a potential risk to financial stability. Adding to this concern is the rapid growth of open-end mutual funds, whose fragile funding structures have been shown to amplify market stress and exacerbate liquidity conditions. Our study highlights the important role of long-term, stable-funded value investors in mitigating financial fragility concerns in bond markets. While other investors with similarly stable funding structures could also play a stabilizing role, their overall impact relative to insurance companies is likely to be small due to their limited presence in U.S. corporate bond markets.

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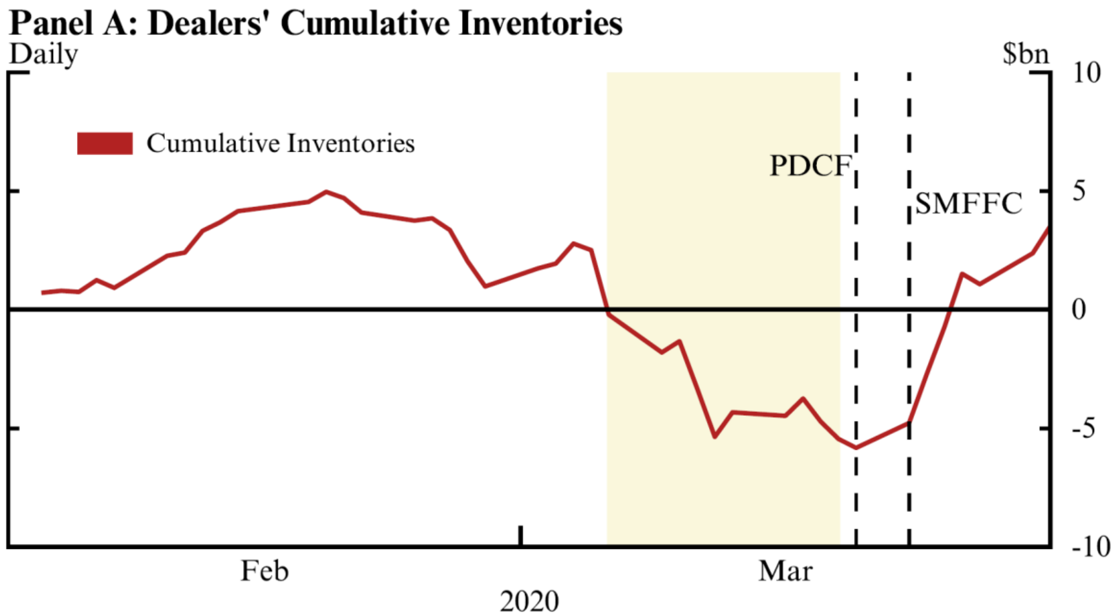
Figure 1. Dealers' cumulative inventory changes and insurers' cumulative net purchases in secondary bond markets

Panel A presents dealers' cumulative inventory changes since 2/1/2020. Dealer cumulative inventory changes are defined as cumulative dealer buys less cumulative dealer sells in secondary bond markets. They are calculated using the TRACE data. Panel B covers the same period and presents insurance companies' cumulative net purchases in secondary bond markets. Insurers' cumulative net purchases are defined as cumulative insurer buys less cumulative insurer sells. They are calculated using the NAIC data. The shaded areas mark the crisis period from 3/6/2020 to 3/19/2020. *PDCF* refers to the Primary Dealer Credit Facility, and *SMFFC* refers to the Secondary Market Corporate Credit Facility.



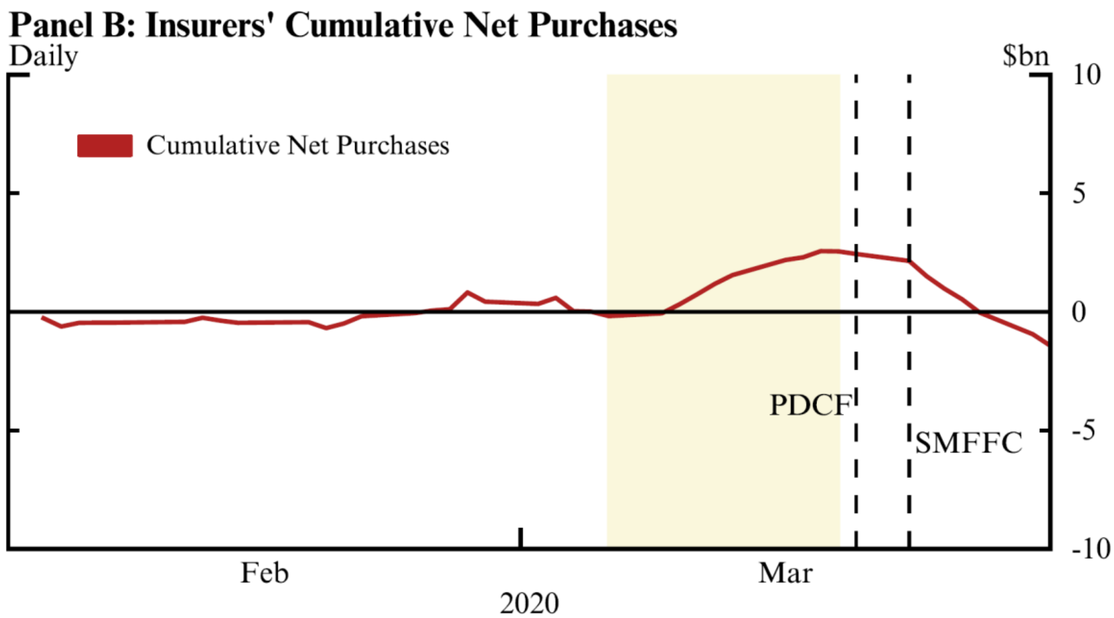


Figure 2. Insurers' net purchases during the crisis and mutual funds' bond ownership

This figure shows insurers' net purchases in secondary bond markets during the two-week crisis period, ranging from 3/6/2020 to 3/19/2020. Insurers' net purchases are separated across three groups of bonds, formed on bonds' mutual fund holdings at the end of 2019. Insurers' net purchases are calculated using the NAIC data. Mutual funds' holdings are calculated using the eMaxx data.

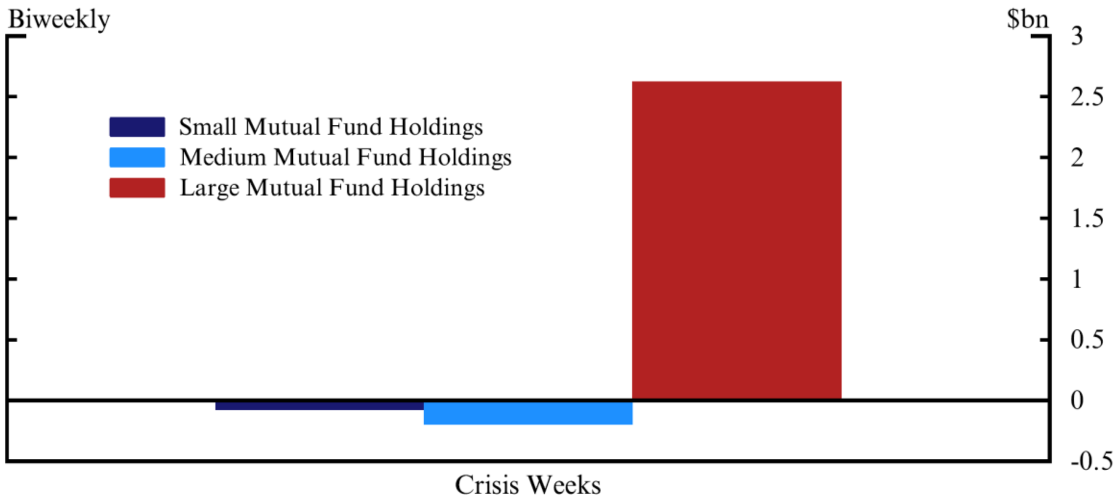


Table 1. Insurer Financial Conditions around COVID-19 Crisis

This table reports how financial conditions changes around the COVID-19 crisis for the insurance companies in our sample. We obtain quarterly balance sheet data from S&P Global Market Intelligence up to 2019:Q4 for the insurers in our NAIC sample. The column *All Insurers* gives summary statistics across both types, while *Life* and *Property & Casualty*, respectively, hold type-specific summary statistics. Insurers are compared across the following metrics: *Total Assets*, reported in $ millions. *Surplus*, reported in $ millions. *Total Liabilities*, reported in $ millions. *Leverage* is one minus the ratio of equity to total assets and reported in %. *Cash-to-Assets* is an insurer's cash holdings over total assets and reported in %. *Bond Portfolio Rating* is an insurer's weighted average NAIC bond portfolio rating (1 through 6). All balance sheet variables and financial ratios are winsorized at the 0.5th and 99.5th percentile. We further require insurers to be active over the last five years and have at least $10 million in net total assets as well as an RBC ratio above 200.

	All Insurers		**Life Insurers**		**Property & Casualty**	
	Q4:2019	*Q1:2020*	*Q4:2019*	*Q1:2020*	*Q4:2019*	*Q1:2020*
No. of Firms	1,744	1,740	481	478	1,263	1,262
Total Assets	5,041	4,973	15,024	14,850	1,239	1,232
Surplus	596	591	952	984	460	442
Total Liabilities	4,427	4,359	14,033	13,816	768	777
Leverage	59.1	59.8	77.9	78.4	52.0	52.8
Cash-to-Assets	2.4	2.7	1.7	1.9	2.7	2.9
Bond Portfolio Rating	1.3	1.3	1.4	1.4	1.2	1.2

Table 2. Insurer Trading, Dealer Inventory Changes, and Mutual Fund Ownership

The sample is constructed at the bond-day level, spanning the period from 2/ 21/2020 to 3/19/2020. The dependent variables *Insurer Trades*, *Insurer Buys*, and *Insurer Sells* refer to the logarithm of 1 plus the par amount of bonds traded, bought, or sold, respectively, by insurance companies in a given bond on a given day. These variables are calculated using the NAIC data. *Dealer Trades* refers to the logarithm of 1 plus the par amount of bonds traded by dealers in a given bond on a given day, and it is calculated using the TRACE data. *MF Holdings* is the logarithm of 1 plus the total par amount held by mutual funds as of the end of 2019, which is calculated using the eMaxx data. *Crisis* is a dummy that takes the value of one for trades executed on or after 3/6/2020. *Time to Maturity* and *Age* refer to the logarithm of the number of years to maturity and the number of years since issuance, respectively. *Outstanding Amount* refers to the logarithm of a bond's total par amount outstanding. *Credit rating fixed effects* are based on each bond's composite rating. Standard errors are clustered at the bond and the day levels. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	I	II	III	IV	V	VI
	Insurer Trades	Insurer Trades	Insurer Buys	Insurer Sells	Insurer Buys	Insurer Sells
Dealer Trades	0.199***					
	(15.54)					
Crisis * Dealer Trades	0.033**					
	(2.28)					
MF Holding		0.004	-0.001	0.005	-0.003	0.005
		(0.96)	(-0.48)	(1.24)	(-0.97)	(1.45)
Crisis * MF Holding		0.010*	0.009**	0.001	0.012**	-0.000
		(1.88)	(2.75)	(0.31)	(2.81)	(-0.07)
Time to Maturity	0.019*	0.033***	0.042***	-0.007	0.040***	-0.013
	(1.91)	(3.13)	(7.71)	(-0.66)	(5.55)	(-1.12)
Age	-0.004	-0.089***	-0.067***	-0.026**	-0.072***	-0.024
	(-0.39)	(-8.36)	(-9.86)	(-2.48)	(-8.83)	(-1.62)
Outstanding Amount	-0.041***	0.172***	0.112***	0.071***	0.104***	0.071***
	(-3.49)	(11.63)	(12.35)	(7.22)	(9.12)	(8.07)
Rating Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Day Fixed Effects	Yes	Yes	Yes	Yes	No	No
Issuer-Day Fixed Effects	No	No	No	No	Yes	Yes
Nobs	93,547	90,850	90,850	90,850	84,031	84,031
Rsq	0.08	0.02	0.02	0.01	0.17	0.16

Table 3. Insurer Characteristics before the COVID-19 crisis

This table reports summary statistics for the insurance companies in our sample. We obtain quarterly balance sheet data from S&P Global Market Intelligence up to 2019:Q4 for the insurers in our NAIC sample. The column *All Insurers* gives summary statistics across both types, while *Life* and *Property & Casualty*, respectively, hold type-specific summary statistics. Insurers are compared across the following metrics: *Total Assets*, reported in $ millions. *Asset Growth* is the five-year compound annual growth rate of total assets and reported in %. *Risk-based Capital (RBC) Ratio* represents the ACL risk-based capital ratio, reported in %. *Leverage* is one minus the ratio of equity to total assets and reported in %. *Cash-to-Assets* is an insurer's cash holdings over total assets and reported in %. *Bond Portfolio Rating* is an insurer's weighted average NAIC bond portfolio rating (1 through 6). *Variation in Underwriting Profitability* and *Variation in Insurance Funding* are the standard deviations of an insurer's underwriting profitability and funding, respectively, over the last five years. *Pre-crisis (Crisis) Net Buyer* is the share of net buyers among insurers in the pre-crisis (crisis) period and reported in %. All balance sheet variables and financial ratios are winsorized at the 0.5th and 99.5th percentile. We further require insurers to be active over the last five years and have at least $10 million in net total assets as well as an RBC ratio above 200.

	All Insurers (n=1,744)					**Life Insurers (n=481)**					**Property & Casualty (n=1,263)**				
	Mean	*Std. Dev.*	*Q1*	*Median*	*Q3*	*Mean*	*Std. Dev.*	*Q1*	*Median*	*Q3*	*Mean*	*Std. Dev.*	*Q1*	*Median*	*Q3*
Total Assets	5,041	24,384	76	274	1,172	15,024	44,517	173	887	7,112	1,239	3,872	63	177	627
Asset Growth	4.2	10.7	0.2	3.9	7.8	4.2	11.4	-0.6	3.3	7.1	4.2	10.5	0.5	4.1	8.0
RBC Ratio	3,039	7,418	585	918	1,554	1,344	1,634	711	918	1,255	3,684	8,572	526	918	1,780
Leverage	59.1	24.5	44.7	61.8	75.6	77.9	22.7	69.7	88.1	93.4	52.0	21.2	40.1	56.4	68.1
Cash-to-Assets	2.4	6.1	0.0	0.6	3.0	1.7	5.0	0.0	0.3	1.5	2.7	6.5	0.0	0.8	3.6
Bond Portfolio Rating	1.3	0.2	1.1	1.2	1.4	1.4	0.2	1.3	1.4	1.5	1.2	0.2	1.1	1.2	1.3
Variation in Insurance Funding	0.14	0.36	0.02	0.04	0.10	0.05	0.07	0.01	0.02	0.06	0.17	0.42	0.03	0.05	0.12
Variation in Underwriting Profitability	0.07	0.13	0.01	0.03	0.07	0.03	0.05	0.00	0.01	0.04	0.08	0.15	0.02	0.04	0.09
Pre-Crisis Net Buyers (%)	31	46	0	0	100	45	50	0	0	100	26	44	0	0	100
Crisis Net Buyers (%)	41	49	0	0	100	53	50	0	100	100	37	48	0	0	100

Table 4. Variation in insurer funding and insurer trading during the crisis

The sample is constructed at the insurer-period level, aggregating an insurer's net trading in the *Pre-Crisis* period (2/21/2020 to 3/6/2020) and *Crisis* period (3/6/2020 to 3/19/2020), respectively. The dependent variable *Net Buyer* is a dummy variable that is equal to one if an insurer's aggregate net trading volume per period is positive. The variable is calculated using the NAIC data. The independent variables are based on quarterly balance sheet data from S&P Global Market Intelligence up to 2019:Q4. *Variation in Underwriting Profitability* and *Variation in Insurance Funding* are the standard deviations of an insurer's underwriting profitability and funding, respectively, over the last five years. *Log(Total Assets)* is the logarithm of an insurer's total assets. *Asset Growth* is the five-year compound annual growth rate of total assets. *Log(RBC Ratio)* is the logarithm of the ACL risk-based capital ratio. *Leverage* is one minus the ratio of equity to total assets. *Cash-to-Assets* is an insurer's cash holdings over total assets. *Bond Portfolio Rating* is an insurer's weighted average NAIC bond portfolio rating. *Insurer Type fixed effects* differentiate Life and P&C insurers. Standard errors are clustered at the insurer type and the day levels. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	I	II	III	IV
	Net Buyer *(Pre-Crisis)*	Net Buyer *(Crisis)*	Net Buyer *(Pre-Crisis)*	Net Buyer *(Crisis)*
Variation in Insurance Funding	-0.0331	-0.0895***		
	(-1.51)	(-3.64)		
Variation in Underwriting Profitability			-0.0837**	-0.258***
			(-2.00)	(-4.95)
Log(Total Assets)	0.0714***	0.0634***	0.0711***	0.0625***
	(11.44)	(9.48)	(11.41)	(9.36)
Asset Growth (5-year)	0.164	0.0696	0.166*	0.0758
	(1.64)	(0.66)	(1.67)	(0.72)
Log(ACL RBC Ratio)	-0.0183*	-0.0226*	-0.0193*	-0.0248**
	(-1.65)	(-1.80)	(-1.76)	(-2.00)
Leverage	-0.0807	-0.0913	-0.0723	-0.0706
	(-1.17)	(-1.25)	(-1.09)	(-0.99)
Cash-to-Assets Ratio	0.158	-0.0279	0.162	-0.0151
	(1.01)	(-0.16)	(1.03)	(-0.09)
Weighted Avg. Bond Rating	0.0272	0.120*	0.0228	0.108*
	(0.51)	(1.94)	(0.43)	(1.76)
Insurer Type Fixed Effects	Yes	Yes	Yes	Yes
Nobs	1,744	1,744	1,744	1,744
Rsq	0.129	0.105	0.129	0.107

Table 5. Variation in insurer funding and insurer trading during the crisis – additional analysis

The sample is constructed at the insurer-period level, aggregating an insurer's net trading in the *Pre-Crisis* period (2/21/2020 to 3/6/2020) and *Crisis* period (3/6/2020 to 3/19/2020), respectively. The table contains results for *Life* and *P&C* insurers separatelty. The dependent variable *Net Buyer* is a dummy variable that is equal to one if an insurer's aggregate net trading volume per period is positive. The variable is calculated using the NAIC data. The independent variables are based on quarterly balance sheet data from S&P Global Market Intelligence up to 2019:Q4. *Variation in Insurance Funding* is the standard deviations of an insurer's funding over the last five years. *Log(Total Assets)* is the logarithm of an insurer's total assets. *Asset Growth* is the five-year compound annual growth rate of total assets. *Log(RBC Ratio)* is the logarithm of the ACL risk-based capital ratio. *Leverage* is one minus the ratio of equity to total assets. *Cash-to-Assets* is an insurer's cash holdings over total assets. *Bond Portfolio Rating* is an insurer's weighted average NAIC bond portfolio rating. Standard errors are clustered at the insurer type and the day levels. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	Life		**P&C**	
	I	II	III	IV
	Net Buyer	Net Buyer	Net Buyer	Net Buyer
	(Pre-Crisis)	*(Crisis)*	*(Pre-Crisis)*	*(Crisis)*
Variation in Insurance Funding	-0.0910	-0.766**	-0.0381*	-0.0969***
	(-0.24)	(-2.08)	(-1.65)	(-3.81)
Log(Total Assets)	0.0661***	0.0444***	0.0719***	0.0701***
	(6.59)	(4.31)	(8.65)	(7.87)
Asset Growth (5-year)	-0.00503	0.0651	0.267**	0.111
	(-0.03)	(0.33)	(2.26)	(0.90)
Log(ACL RBC Ratio)	-0.00413	-0.0329	-0.0295**	-0.0366***
	(-0.11)	(-0.86)	(-2.54)	(-2.71)
Leverage	0.0785	0.101	-0.197**	-0.266***
	(0.55)	(0.69)	(-2.42)	(-3.02)
Cash-to-Assets	0.176	-0.129	0.167	0.0566
	(0.36)	(-0.33)	(1.03)	(0.30)
Weighted Avg. Bond Rating	0.0275	0.0128	0.0106	0.123*
	(0.23)	(0.10)	(0.18)	(1.70)
Nobs	481	481	1,263	1,263
Rsq	0.124	0.111	0.090	0.085

Table 6. Dealer-insurer relationships and trading activities during crisis

The sample is constructed at the insurer-dealer-day level, spanning the period from 2/21/2020 to 3/19/2020. All insurer-dealer pairs trading between 2017 and 2019 are considered as possible pairings for trade and included in the sample. *Insurer i's buys from (sells to) dealer j* refers to the logarithm of 1 plus the total par amount of bonds that insurer i bought from (sold to) dealer j on a given day, and it is calculated using the NAIC data. *Past Trading* is the logarithm of 1 plus the average monthly trade volume between insurer i and dealer j between 2017 and 2019, and it is also calculated using the NAIC data. *Log(Total Assets)* is the logarithm of an insurer's total assets. *Asset Growth* is the five-year compound annual growth rate of total assets. *Log(RBC Ratio)* is the logarithm of the ACL risk-based capital ratio. *Leverage* is one minus the ratio of equity to total assets. *Cash-to-Assets* is an insurer's cash holdings over total assets. *Bond Portfolio Rating* is an insurer's weighted average NAIC bond rating. *Crisis* is a dummy that takes the value of one on or after 3/6/2020. Standard errors are clustered at the day and the insurer-dealer levels. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

(Table 6 continued)

	I	II	III	IV	V	VI	VII	VIII
	Insurer *i*'s buys from dealer *j*	Insurer *i*'s sells to dealer *j*	Insurer *i*'s buys from dealer *j*	Insurer *i*'s sells to dealer *j*	Insurer *i*'s buys from dealer *j*	Insurer *i*'s sells to dealer *j*	Insurer *i*'s buys from dealer *j*	Insurer *i*'s sells to dealer *j*
Crisis	-0.001*	0.000	-0.003***	-0.000				
	(-1.89)	(0.17)	(-5.08)	(-0.36)				
Past Trading	0.278***	0.200***	0.301***	0.197***	0.300***	0.191***	0.175***	0.140***
	(14.55)	(12.49)	(16.99)	(13.44)	(15.99)	(12.47)	(12.88)	(10.57)
Crisis * Past Trading	0.081***	-0.025*	0.074***	-0.039***	0.062***	-0.034**	0.038**	-0.032**
	(3.96)	(-1.86)	(3.97)	(-3.15)	(2.66)	(-1.96)	(2.05)	(-1.97)
Log (Total Assets)	0.001***	0.000						
	(6.05)	(1.01)						
Asset Growth	0.005***	0.002***						
	(4.86)	(3.53)						
Log (RBC Ratio)	0.000***	0.000***						
	(2.66)	(2.65)						
Leverage	-0.005***	-0.002***						
	(-5.69)	(-3.18)						
Cash-to-Assets	0.010***	0.005***						
	(7.68)	(5.08)						
Bond Portfolio Rating	0.001	0.003***						
	(1.03)	(4.32)						
Insurer Fixed Effects	No	No	Yes	Yes	No	No	No	No
Dealer Fixed Effects	Yes	Yes	Yes	Yes	No	No	No	No
Day Fixed Effects	No	No	Yes	Yes	No	No	No	No
Insurer-Day Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Dealer-Day Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Nobs	713193	713193	891,578	891,578	882,424	882,424	871,266	871,266
Rsq	0.02	0.01	0.06	0.06	0.10	0.10	0.09	0.10

Table 7. Insurer funding stability and bond liquidity around the crisis

The sample is constructed at the trade level, spanning the period from 2/21/2020 to 3/19/2020. *Cost* refers to the transaction cost for a customer-dealer trade, estimated using Eq. (7). Here, *Variation in Underwriting Profitability* and *Variation in Insurance Funding* refer to the average variation in underwriting profitability and average variation in insurance funding, respectively, of a dealer's connected insurers, weighted by their total trade volume with the dealer over the period from 2017 to 2019. *Crisis* is a dummy that takes the value of one on or after 3/6/2020. *Age* and *Time to Maturity* refer to the logarithm of the number of years since issuance and the number of years to maturity, respectively. *Amount Outstanding* refers to the logarithm of a bond's total par amount outstanding. *Credit rating fixed effects* are based on each bond's composite rating. *Trade size fixed effects* are based on four size categories formed on the par amount traded: micro ($1 to $100,000), odd-lot ($100,000 to $1,000,000), round-lot ($1,000,000 to $5,000,000), and block (above $5,000,000). *Trade direction fixed effects* differentiate dealer purchases and dealer sales. Standard errors are clustered at the day and the insurer-dealer levels. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

(Table 7 continued)

	I	II	III	IV
	Cost *(All Trades)*	Cost *(All Trades)*	Cost *(All Trades)*	Cost *(All Trades)*
Crisis	26.175***		25.187***	
	(9.27)		(8.73)	
Variation in Insurance Funding	0.125***	0.120***		
	(7.92)	(7.82)		
Crisis * Variation in Insurance Funding	0.238***	0.152***		
	(6.60)	(5.29)		
Variation in Underwriting Profitability			0.242***	0.234***
			(7.48)	(7.46)
Crisis * Variation in Underwriting Profitability			0.470***	0.291***
			(6.64)	(5.09)
Time to Maturity	20.952***		21.021***	
	(16.55)		(16.59)	
Age	1.399		1.380	
	(1.55)		(1.52)	
Outstanding Amount	-3.394**		-3.464**	
	(-2.66)		(-2.73)	
Rating Fixed Effects	Yes	No	Yes	No
Trade Size Fixed Effects	Yes	No	Yes	No
Trade Direction Fixed Effects	Yes	No	Yes	No
Bond-Day-Trade Size-Trade Direction Fixed Effects	No	Yes	No	Yes
Nobs	191694	102063	191694	102063
Rsq	0.17	0.65	0.17	0.65

Table 8. Insurer funding stability and bond liquidity around the crisis – additional analysis

The sample is constructed at the trade level, spanning the period from 2/21/2020 to 3/19/2020. *Cost* refers to the transaction cost for a customer-dealer trade, estimated using Eq. (7). The table separates estimates for *Dealer Buys* and *Dealer Sells*. Here, *Variation in Underwriting Profitability* and *Variation in Insurance Funding* refer to the average variation in underwriting profitability and average variation in insurance funding, respectively, of a dealer's connected insurers, weighted by their total trade volume with the dealer over the period from 2017 to 2019. *Crisis* is a dummy that takes the value of one on or after 3/6/2020. Trade size categories in the *Bond-Day-Trade Size fixed effects* are based on four size categories formed on the par amount traded: micro ($1 to $100,000), odd-lot ($100,000 to $1,000,000), round-lot ($1,000,000 to $5,000,000), and block (above $5,000,000). Standard errors are clustered at the day and the insurer-dealer levels. Standard errors are clustered at the day and the insurer-dealer levels. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	I	II	III	IV
	Cost	Cost	Cost	Cost
	(Dealer Buy)	*(Dealer Sell)*	*(Dealer Buy)*	*(Dealer Sell)*
Variation in Insurance Funding	0.069***	0.173***		
	(4.49)	(10.24)		
Crisis * Variation in Insurance Funding	0.206***	0.093***		
	(4.87)	(3.20)		
Variation in Underwriting Profitability			0.130***	0.346***
			(4.11)	(10.00)
Crisis * Variation in Underwriting Profitability			0.397***	0.175***
			(4.61)	(2.97)
Bond-Day-Trade Size Fixed Effects	Yes	Yes	Yes	Yes
Nobs	57100	44963	57100	44963
Rsq	0.63	0.68	0.63	0.68

Table 9. Insurer funding stability and bond liquidity around crisis with dealer controls

The sample is constructed at the trade level, spanning the period from 2/21/2020 to 3/19/2020. *Cost* refers to the transaction cost for a customer-dealer trade, estimated using Eq. (7). Here, *Variation in Underwriting Profitability* and *Variation in Insurance Funding* refer to the average variation in underwriting profitability and average variation in insurance funding, respectively, of a dealer's connected insurers, weighted by their total trade volume with the dealer over the period from 2017 to 2019. *Crisis* is a dummy that takes the value of one on or after 3/6/2020. *Dealer Market Share* refers to the share of a dealer's trading volume relative to total market trading volume between 2017 and 2019, and it is calculated using the TRACE data. *Underwriter* is a dummy that takes the value of one if a dealer is also a lead underwriter for the traded bond. *Dealer Size* is the logarithm of a dealer's total assets. *Dealer Leverage* is one minus the ratio of equity to total assets. *Dealer ROA* refers to a dealer's net income divided by total assets. Trade size categories in the *Bond-Day-Trade Size-Trade Direction fixed effects* are based on four size categories formed on the par amount traded: micro ($1 to $100,000), odd-lot ($100,000 to $1,000,000), round-lot ($1,000,000 to $5,000,000), and block (above $5,000,000). Within the *Bond-Day-Trade Size-Trade Direction fixed effects* trade direction differentiates dealer purchase and dealer sales. Standard errors are clustered at the day and the insurer-dealer levels. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

(Table 9 continued)

	I	II	III	IV	V	VI
	Cost	Cost	Cost	Cost	Cost	Cost
Variation in Insurance Funding	0.165***	0.162***	0.083***			
	(5.49)	(4.93)	(3.55)			
Crisis * Variation in Insurance Funding	0.151***	0.190***	0.341***			
	(5.27)	(5.12)	(6.48)			
Variation in Underwriting Profitability				0.293***	0.237***	0.122**
				(5.16)	(4.06)	(2.80)
Crisis * Variation in Underwriting Profitability				0.290***	0.375***	0.567***
				(5.05)	(5.18)	(5.99)
Dealer Market Share	-0.758	-0.341	-0.567***	-0.439	0.145	-0.373***
	(-1.23)	(-1.00)	(-4.45)	(-0.74)	(0.40)	(-3.69)
Underwriter	-5.659***	-4.700***	-3.029**	-5.248***	-4.713***	-2.971**
	(-4.69)	(-4.36)	(-2.74)	(-4.30)	(-4.32)	(-2.74)
Dealer Size		-4.406**	-1.123		-3.323**	-0.593
		(-2.84)	(-1.15)		(-2.20)	(-0.68)
Dealer Leverage		30.069	-47.121***		15.017	-53.901***
		(1.27)	(-5.15)		(0.69)	(-6.22)
Dealer Return		45.074***	43.869***		56.152***	47.491***
		(5.89)	(6.81)		(7.12)	(6.91)
Dealer Market Share * Crisis			0.589			1.244
			(0.75)			(1.61)
Underwriter * Crisis			-4.027**			-4.200**
			(-2.29)			(-2.38)
Dealer Size * Crisis			-6.418**			-4.994*
			(-2.53)			(-1.92)
Dealer Leverage * Crisis			167.690***			147.817***
			(6.54)			(5.87)
Dealer Return * Crisis			11.985			28.351*
			(0.77)			(1.86)
Bond-Day-Trade Size-Trade Direction Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Nobs	102063	66268	66268	102063	66268	66268
Rsq	0.65	0.69	0.70	0.65	0.69	0.70

Table 10. Insurer funding stability, mutual fund ownership, and bond liquidity around crisis

The sample is constructed at the trade level, spanning the period from 2/21/2020 to 3/19/2020. *Cost* refers to the transaction cost for a customer-dealer trade, estimated using Eq. (7). Here, *Variation in Underwriting Profitability* and *Variation in Insurance Funding* refer to the average variation in underwriting profitability and average variation in insurance funding, respectively, of a dealer's connected insurers, weighted by their total trade volume with the dealer over the period from 2017 to 2019. *Share by MMF* is the percentage of a bond's outstanding amount that is held by mutual funds. *Crisis* is a dummy that takes the value of one on or after 3/6/2020. *Dealer Market Share* refers to the share of a dealer's trading volume relative to total market trading volume between 2017 and 2019, and it is calculated using the TRACE data. *Underwriter* is a dummy that takes the value of one if a dealer is also a lead underwriter for the traded bond. Trade size categories in the *Bond-Day-Trade Size-Trade Direction fixed effects* are based on four size categories formed on the par amount traded: micro ($1 to $100,000), odd-lot ($100,000 to $1,000,000), round-lot ($1,000,000 to $5,000,000), and block (above $5,000,000). Within the *Bond-Day-Trade Size-Trade Direction fixed effects* trade direction differentiates dealer purchase and dealer sales. Standard errors are clustered at the day and the insurer-dealer levels. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	I	II	III	IV
	Cost	Cost	Cost	Cost
Variation in Insurance Funding	0.150***			
	(5.22)			
Crisis * Variation in Insurance Funding	0.115***			
	(3.25)			
Variation in Insurance Funding * Share by MMF	0.069**	0.058***		
	(2.46)	(2.98)		
Crisis * Variation in Insurance Funding * Share by MMF	0.153**	0.131**		
	(2.54)	(2.10)		
Variation in Underwriting Profitability			0.262***	
			(4.92)	
Crisis * Variation in Underwriting Profitability			0.199***	
			(2.91)	
Variation in Underwriting Profitability * Share by MMF			0.135**	0.114***
			(2.44)	(2.92)
Crisis * Variation in Underwriting Profitability * Share by MMF			0.388***	0.320**
			(3.29)	(2.50)
Dealer Market Share	-0.800		-0.483	
	(-1.30)		(-0.81)	
Underwriter Dummy	-5.517***	-1.349*	-5.078***	-1.320*
	(-4.58)	(-1.84)	(-4.18)	(-1.81)
Bond-Day-Trade Size-Trade Direction Fixed Effects	Yes	Yes	Yes	Yes
Dealer-Day Fixed Effects	No	Yes	No	Yes
Nobs	102063	101889	102063	101889
Rsq	0.65	0.71	0.65	0.71