Over-the-Counter Market Liquidity and Securities Lending*

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Abstract

This paper studies how over-the-counter (OTC) market liquidity was adversely affected by the collapse of securities lending during the 2007-2008 financial crisis. We combine micro-data on corporate bond OTC market trades with securities lending transactions, in which insurance companies are major counterparties. We exploit cross-sectional differences in the corporate bonds held and lent by insurance companies to estimate the causal effect of securities lending on corporate bond market liquidity. We show that the run on insurers' securities lending programs in 2008 caused a long-lasting reduction in corporate bond market liquidity, even after controlling for the interaction between funding liquidity and market liquidity.

JEL Codes: G01, G12, G22, G23

Keywords: over-the-counter markets, corporate bonds, market liquidity, securities lending, insurance companies

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Introduction

The financial crisis of 2007-2008 kindled a wider interest in studies of liquidity in over-the-counter (OTC) markets, in which participants trade without standardized exchanges.[1] A large swathe of the literature argues that natural frictions in OTC markets, such as the need to search for and bargain with counterparties, impede market liquidity, the ability of market participants to transact efficiently (Duffie, Gârleanu & Pedersen 2005, Lagos, Rocheteau & Weill 2011). Intermediaries such as broker-dealers may emerge to help reduce such frictions by matching buyers and sellers and by maintaining an inventory of securities (Hugonnier, Lester & Weill 2014, Chang & Zhang 2015, Neklyudov & Sambalaibat 2015, Wang 2016). Nevertheless, intermediation costs, such as maintaining inventory, preclude the elimination of frictions in OTC markets that may play an important role in determining market liquidity.

One such potential friction can arise in the market for securities lending. Intermediaries can avoid the need to either find a seller or draw on inventory to match a security buyer's trade request by taking temporary ownership of the security. In exchange for paying a fee and posting collateral, intermediaries can borrow the security from other financial institutions with large security portfolios, such as insurance companies, pension funds, and mutual funds. In addition, the ability to lend securities can improve OTC market liquidity, for example, by facilitating other market participants' short positions and certain aribitrage strategies and by avoiding delivery fails. In theory, while the ability to borrow securities can improve market efficiency, i.e. liquidity, the converse is also true: Frictions in the ability to borrow securities can reduce market liquidity.[2] However, identifying and quantifying the importance of securities lending to OTC market liquidity has remained elusive.[3]

In this paper, our objective is to measure the causal effect of securities lending on OTC market liquidity. Specifically, we quantify the adverse effect of the collapse of

[1] For an overview of the structure of OTC markets and some research and policy issues, see Duffie (2012).

[2] Such frictions may arise from lending fees for borrowing securities (Duffie 1996, Krishnamurthy 2002, D'avolio 2002) or search and bargaining in the securities lending market (Duffie, Gârleanu & Pedersen 2002).

[3] A few papers seek to connect securities lending and market liquidity in non-OTC markets, including Saffi & Sigurdsson (2011), and Kolasinski, Reed & Ringgenberg (2013). Existing empirical studies of corporate bond lending describe market details, with a particular focus on borrowing costs, but do not connect lending transactions with corporate bond market liquidity (Nashikkar & Pedersen 2007, Asquith, Au, Covert & Pathak 2013).

corporate bond lending during the 2007-2008 financial crisis on OTC corporate bond market liquidity. Figure 1 illustrates the massive shock to corporate bond lending that occurred during the financial crisis. The figure shows the value of corporate bond lending against cash collateral at a daily frequency from mid 2006 to the end of 2015. In the period before the financial crisis of 2008-09, insurance companies dominated the market for lending corporate bonds, accounting for more than three-quarters of all loans.[4] In late 2008, amid concerns about the quality of cash collateral reinvestment, unrelated to corporate bond market liquidity, securities borrowers demanded the return of their cash and precipitated a collapse of several insurance companies securities lending programs. The case of AIG epitomises this narrative and has been well-documented by, among others, Peirce (2014) and McDonald & Paulson (2015).

To analyze the interaction between corporate bond market liquidity and lending, we construct a new dataset by combining micro-level data on bond purchases and sales with bond lending. We obtain a comprehensive overview by matching, at the individual bond level, the over-the-counter Trade Reporting and Compliance Engine (TRACE) records of corporate bond transactions with Markit Securities Finance, which provides the most extensive coverage of the securities lending market. Lastly, we add information on the bond-level holdings and lending of U.S. insurance companies from their annual statutory filings.

Our empirical analysis follows a difference-in-difference strategy, where the dependent variable is market liquidity, measured as the average realized spread.[5] The first difference in our strategy is between those bonds in which insurers hold a high fraction of the bond amount outstanding and those in which insurers have a low fraction. The second difference is between the period before the shutdown in insurers' lending programs and the period after the shutdown. The interaction of these two differences is our basic idea for identifying the effect of an exogenous reduction in corporate bond lending on market liquidity.[6]

[4] Pursuing a buy and hold strategy, insurance companies are the largest institutional investors in corporate bonds and are natural bond lenders. The income earned from lending securities is a way for institutional investors such as insurance companies to enhance the return on their asset holdings. `http://www.naic.org/capital_markets_archive/140911.htm`

[5] This well-established measure is the gap between the price that a customer pays to a dealer to purchase a bond and the price a dealer pays to a customer for buying a bond

[6] Our identification strategy shares features with other studies that exploit differential effects of shocks originating in the crisis. Examples include the Lehman bankruptcy (Aragon & Strahan 2012, Kovner 2012, Chodorow-Reich 2014) and fiscal stimulus programs (Mian & Sufi 2012).

Our main results suggest that changes in the corporate bond lending market have long-lasting consequences for a bond's market liquidity. A one standard deviation increase in the fraction of a bond held by insurers reduces that bond's liquidity by about one-tenth of a standard deviation in 2008 through 2010. We provide evidence that the change in a bond's lending supply is the main source for this relationship. We observe that bonds held in greater quantities by insurers saw an increase in their borrowing costs, as well as a large decrease in the amount available and the actual amount lent on the securities lending market.

The main empirical challenge to our identification strategy is potentially confounding determinants of market liquidity that also vary as a function of insurers' bond holdings. One specific example is suggested by Brunnermeier & Pedersen (2009), who describe the interaction of market liquidity and funding liquidity. This relationship suggests that, if a bond is tied up on insurers' balance sheets, then funding liquidity shocks that make it more difficult to borrow that bond will have a stronger effect on that bond's market liquidity.

We can exploit our institutional setting to address this identification challenge. In particular, there was a marked difference in the lending programs of the hundred or so U.S. insurance groups in our sample. These differences were especially pronounced at those groups significantly engaged in life insurance, which are the largest lenders of corporate bonds in the pre-crisis period. For example, the actions of securities borrowers precipitated a complete shutdown of AIG's lending program operated by its life subsidiaries, which fell from a peak of over $80 billion to nothing in less than one year.[7] By contrast, MetLife remained a significant corporate bond lender and, while their lending program shrank somewhat during the crisis, it since became the main lender of corporate bonds.

Figure 2 illustrates our identification strategy by focusing on the differences in lending behavior between MetLife and AIG. We calculate and fix the fraction of bonds held by AIG and MetLife at the end of 2006, and scatter-plot the bonds that they exclusively lent through the crisis, as a function of their holdings. In this example, our new difference-in-difference strategy combines the difference between the bonds held by AIG and those held by MetLife, with the difference that AIG exits the lending market entirely in 2008,

[7] Existing studies of corporate bond lenders examine transaction level data for programs smaller than $15 billion (Nashikkar & Pedersen 2007) and (Asquith et al. 2013).

while MetLife remains relatively active.[8] We adapt this approach using the fraction of a bond held and lent by AIG, while controlling for the fraction of the bond's total amount held by the insurance industry.

Our identification strategy relies on several key assumptions. First, that insurance companies, in particular AIG, did not reinvest a large amount of their cash collateral in corporate bonds. Second, that the shutdown of AIG's securities lending programs was not due to concerns about liquidity in the corporate bond market. And, third, that those corporate bonds held and lent by AIG and those bonds held and lent by other insurance companies differ only along observable dimensions, for which we include control variables in the tests. Using information from a variety of sources, we investigate and discuss the validity of these assumptions.

Our paper contributes to several broad research topics in the literature. We provide the first evidence that OTC market liquidity is vulnerable to run risks arising in the securities lending market, particularly corporate bond lending by non-bank financial institutions. The financial crisis of 2007-2008 initiated a surge of interest in the activity of so-called shadow banks and the risks those activities may pose to the broader financial system.[9] While many studies have sought to understand the determinants of market liquidity, few have explored the important contribution of the shadow banking system.[10] Our finding helps to understand the determinants of corporate bond market liquidity and, especially, the connection between market liquidity and the shadow banking system.

In addition, our paper contributes to a growing literature on corporate bond market liquidity during and after the financial crisis. Dick-Nielsen, Feldhütter & Lando (2012) find evidence of short-run illiquidity, potentially as a consequence of (i) distress at lead underwriters (Bear-Sterns, Lehman Brothers), (ii) investor flight towards more highly rated securities, and (iii) information assymetry. Other studies examine long-term corporate bond market liquidity in the aftermath of the financial crisis. In the main, as surveyed by Adrian, Fleming & Vogt (2016), the literature has found little to no evidence

[8] Bond characteristics interacted with time-specific fixed effects absorb the variation in liquidity associated with bond heterogeneity (Friewald, Jankowitsch & Subrahmanyam 2012).

[9] See Gorton & Metrick (2012) for a survey of the literature.

[10] The effects of corporate bond illiquidity on the level and volatility of investor returns have a wide range of potential real and financial consequences, including for corporate structure (Hoshi, Kashyap & Scharfstein 1991), for portfolio management (Amihud & Mendelson 1988, 2006), and for financial stability (Adrian & Shin 2010).

of a long-lasting decline in corporate bond market liquidity.[11] We offer a nuanced view that long-term corporate bond market liquidity did decline for those bonds that were held in large amounts by insurance companies and were made available to market participants through securities lending programs.

The remainder of the paper proceeds as follows. In Section 1 we provide an overview of the market for corporate bond lending and the experience of insurance companies during the financial crisis. Section 2 describes our data and summary statistics. Sections 3 and 4 present our empirical strategy and results. We conclude in Section 5.

1 Institutional background

In this section, we first outline the role of securities lending in OTC corporate bond markets. Then we describe a typical corporate bond lending transaction, including the specific part played by insurance companies. And we provide an overview of the experience of AIG, which in the pre-crisis period operated the largest corporate bond lending program ever maintained by an insurance company.

1.1 OTC corporate bond markets and securities lending

The OTC corporate bond market is yuge. In 2015, U.S. corporations issued almost $1,500 billion of debt, compared with only $256 billion in equity.[12] After their initial offering in the primary market, most of this debt is tradable in an OTC secondary market. In 2015, over 25,000 unique corporate bonds were publicly traded, with most of the trading taking place in investment grade bonds (61 percent). Between 2006 and 2016, there were on average 44,082 daily transactions that amounted to almost $30 billion in daily volume traded. About two-thirds of these transactions are between a client and a dealer and one-third of these transactions are between dealers.[13]

To buy and sell securities in the OTC corporate bond market, participants must search for counterparties (Duffie et al. 2005). The associated costs of search can be reduced by

[11] Exceptions include Bao, O'Hara & Zhou (2016) and Choi & Huh (2016), who find some evidence that regulations, in particular the Volcker Rule, may have reduced market liquidity for some corporate bonds.

[12] `www.sifma.org`. The value of new corporate debt excludes the issuance of convertible debt, asset-backed securities, and non-agency mortgage-backed securities.

[13] `www.finra.org`. All these statistics exclude convertible debt transactions.

some participants acting as intermediaries—such as broker-dealers—that match buyers with sellers.[14] Intermediaries typically facilitate efficient market functioning either by swiftly finding a matching counterparty for a customer elsewhere in the market, or by trading itself with the customer and maintaining its own inventory of securities. Although intermediaries can help to reduce search costs, they cannot fully eliminate such costs because their inventories are naturally limited by the supply of individual bonds and the associated inventory maintenance costs.

The limitations on intermediaries' ability to make markets create an opportunity for institutional investors, as natural large repositories of securities, to smooth the matching process by lending their securities. Among institutional investors in corporate bonds, insurance companies have the largest holdings, giving them a dominant position as potential bond lenders.[15] When a customer wants to buy a bond that a intermediary does not hold in its inventory, the intermediary may borrow the bond elsewhere and deliver it to the buyer. The intermediary can then wait until it can find another customer willing to sell the same bond, which the intermediary can return to the lender.

In addition to aiding intermediaries in their inventory management, corporate bond lending can improve OTC market liquidity by facilitating short positions and certain arbitrage strategies and by avoiding delivery fails.[16] For example, in a capital structure arbitrage trade, a firm's bond is shorted to hedge a long position in the firm equity. Another example is a convertible bond arbitrage trade, in which firm's equity is sold short to hedge a long position in a bond issued by that firm. In this second example, the dealer might also borrow the convertible bond.

1.2 Corporate bond lending transactions

In a prototypical corporate bond loan, full legal and economic ownership of the bond is transfered from the lender (e.g. insurance company) to the borrower. The ownership is essential for borrowers (e.g. dealers) to be able to deliver the bond to other counterparties (customers). To allow the borrower flexibility in the time needed to find another seller

[14] A recent literature has studied the reasons for certain institutions to act as intermediaries (Hugonnier et al. 2014, Chang & Zhang 2015, Neklyudov & Sambalaibat 2015) and the equilibrium number of broker-dealers as an outcome of the cost of inventory and the liquidity of the market (Wang 2016)

[15] Flow of Funds Accounts of the United States, Table L213, `https://www.federalreserve.gov/releases/z1/current/accessible/l213.htm`.

[16] For more details, see Duffie (1996), Faulkner (2006), Nashikkar & Pedersen (2007), Faulkner (2008), Musto, Nini & Schwarz (2011), Keane (2013) and Asquith et al. (2013).

of the same bond, the term of the loan is usually open-ended, but either party is able to terminate the deal at any time by returning the security/collateral.[17]

In exchange, the bond borrower gives the bond lender collateral in the form of cash, which the lender may reinvest according to its own strategy and regulatory limitations.[18] Typically, the loan is marked to market daily and is "*overcollateralized*," with borrowers providing, for example, $102 in cash for every $100 in notional value of a security. The percentage of overcollateralization is called the "*margin*," which serves to insure the securities lender against the cost of replacing the lent security if the borrower defaults. Lastly, the bond lender pays a percentage of the reinvestment income to the bond borrower, called the "*rebate rate*." This equilibrium price is negotiated at the outset of the deal and reflects the scarcity of the bond on loan: A hard-to-find "*special*" bond may command a low or negative rebate.

In addition to the ultimate owner that lends the bond and the borrower, a corporate bond lending transaction may involve one or two other parties. First, owners of large portfolios like AIG and MetLife often conduct their own lending programs with an affiliated agent lender, while smaller owners typically execute their programs through third party agent lenders, such as custodian banks or asset managers, that act as large warehouses for securities made available for lending.[19] Second, the end users of the borrowed securities may be small and weakly regulated. In such cases, they will often borrow through intermediaries who help to assuage lenders' concerns about counterparty risk. Since these smaller end-users interact repeatedly with the same dealers, corporate bond lending may sometimes involve more than one dealer intermediating between the bond lender and the bond borrower.

As discussed in Foley-Fisher, Narajabad & Verani (2016), some insurers aim to supply their securities so as to create and maintain a pool of cash collateral that they use to finance a portfolio of longer-duration, higher-yielding assets. The greater return associated with reinvesting the cash collateral in less liquid and/or longer-term assets

[17] Even in the unusual cases of term lending, parties often have the ability to break the contract early by paying a nominal penalty. More than 90 percent of the corporate bond loans in our data sample are open-ended.

[18] In principle, the contract may allow a borrower to post non-cash collateral against the bond, but this is uncommon in the U.S. In our data on corporate bond loans, more than 90 percent of transactions are against cash collateral.

[19] Agent lenders that warehouse bonds from many ultimate owners typically use an algorithm to determine which owner will be matched with borrowing requests.

is not without cost. In particular, insurers that pursue this strategy create and bear run risk associated with liquidity and maturity transformation. The reinvestment of cash collateral in U.S. mortgage-related securities was one of the root causes for the collapse of AIG in 2008.

1.3 AIG's securities lending program during the 2008-09 financial crisis

Although it has been told in greater detail elsewhere, an overview of AIG is helpful to understand the shock to corporate bond lending that we will exploit in our empirical exercise.[20] Beginning in the 1980s and through the run-up to the 2007-09 financial crisis, AIG increased profits by diversifying its operations into non-traditional insurance activities that, for the large part, occurred beyond regulatory oversight. Many of these activities created direct and indirect exposures to the U.S. housing market. In addition to exposure through its credit default swap (CDS) portfolio and mortgage insurance business, AIG lent vast quantities of bonds from the general accounts of its life insurance subsidiaries in exchange for cash collateral. The insurer reinvested a large fraction of the incoming cash collateral in non-agency residential mortgage backed securities (RMBS) and other illiquid medium-term securities. At its pre-crisis peak in 2007, AIG's consolidated securities lending business was [[$82 billion]]. When the U.S. housing market collapsed, AIG's massive exposures to the housing-related securities and credit derivatives caused a severe liquidity crisis.

From early 2008, AIG's mortgage insurance business began to experience losses due to poorly performing loans. At about the same time, concerns about the credit quality of securities referenced by CDS that AIG had sold led to a combination of losses and collateral calls that began to drain the company's cash and cash-like assets. As AIG's financial condition deteriorated, securities borrowers reduced the amount of cash collateral they were willing to provide to roll over the securities AIG had lent. Throughout the summer of 2008, many securities borrowers returned the securities and demanded their cash collateral. By September 2008, AIG had exhausted all of the cash and cash-like assets in the securities lending pool and began to make calls on their life insurance companies to avoid selling their reinvestment holdings of RMBS at fire sale prices. The combination

[20]For more details about AIG, see Peirce (2014) and McDonald & Paulson (2015).

of actual losses and lack of cash-like assets undermined the market's confidence in AIG and led to rating downgrades, which prevented the parent company from rolling over the repurchase agreements and commercial paper that many AIG subsidiaries relied on for funding. After several attempts to structure a private-sector rescue for AIG failed, the Federal Reserve Board of Governors, the Federal Reserve Bank of New York and the U.S. Treasury conducted a number of interventions beginning in September 2008, which ultimately stabilized AIG (GAO 2011). From about 80 billion at the beginning of 2008, AIG securities lending program was almost completely shut down by the beginning of 2009.

2 Data

We use several data sources to construct the dataset we use in our analysis. This section lays out how we combine data on corporate bond liquidity, securities lending data, and insurers' holdings of corporate bonds, and their lending activity.

We follow the established literature in calculating corporate bond liquidity using data on secondary market over-the-counter trading of corporate bonds from the Trade Reporting and Compliance Engine (TRACE), created by the Financial Regulatory Authority (FINRA). Under regulations introduced in 2002 by FINRA, dealers are required to file detailed reports of their transactions, including trade time, quantity, price, and counterparty.[21] We follow standard procedures for cleaning these data, including deleting all small noise-generating trades below $10,000 and removing duplicate transactions.[22] We first calculate for each bond on each day the volume-weighted average buy and sell prices across customer-dealer trades. We then compute bond market liquidity as the *average realized spread*, which is the difference between the average daily price at which a dealer sells a bond to a customer and the average daily price at which a dealer buys the same bond from a customer. With our daily measure of bond liquidity, we compute the average (mean) over days to obtain a monthly unbalanced panel of bond-specific liquidity.

We merge the TRACE data with Mergent's Fixed Income Securities Database (FISD)

[21] Our sample by necessity begins in 2005 because, although FINRA began collecting data in 2002, the coverage was limited until 2005.

[22] See, for example, Dick-Nielsen (2009) and Bao et al. (2016). We use confidential regulatory data with dealer identifiers, which allows us to match trades by buyer, seller, amount, and trade time when removing duplicates.

by CUSIP identifier to obtain bond characteristics, including offering amount, offering yield, amount outstanding, credit rating, and a range of indicators on the type of each bond. We exclude from our sample all bonds that are convertible, putable, privately placed, asset-backed, or sold as part of a unit deal. We account for reissuance and early retirement when computing the amount outstanding over time and we define rating changes using the date by the first acting rating agency (Ellul, Jotikasthira & Lundblad 2011). Our final dataset consists of 279,404 bond-month observations covering 17,994 unique bonds between 2006 and 2010. The median initial maturity of the corporate bonds in our sample is 9 years, with an median residual maturity across the entire sample of 5 years.

The major data contribution of our study is to combine the information on corporate bond liquidity with data on corporate bond lending. We match by CUSIP identifier the corporate bond liquidity data from TRACE with loan-level transactions recorded in the Markit Securities Finance (MSF) dataset. These data include both equity and fixed income loans and cover about 85 percent of the global market and more than 90 percent of the U.S. securities lending market. Securities lenders report information about each loan they have outstanding on a given day, including the identity of the security on loan, the value of the loan, duration, lending fee, rebate rate, and the type of collateral posted. In addition, securities lenders report on each day the total value of every security that they have available to lend. We first aggregate these transaction-level data to a daily frequency by calculating over the daily stock of loans outstanding on each security, the total value on loan, as well as the median value, fee, and rebate rate. Then, using these daily measures across the stock of loans outstanding, we compute monthly median values for each security. After merging the two datasets, we find that MSF reports data on the amount of a corporate bond available for lending for more than 90 percent of all bond-month observations in TRACE. Information on actual loan transactions are available for almost 80 percent of all bond-month observations. We assume that the available and lending amounts are zero for the minority of TRACE bond-month observations that do not match to MSF.

Lastly, we combine our TRACE-MSF merged data with specific information about insurance company security holdings and lending activity from the NAIC Annual

Statutory Filings.[23] Within these filings, Schedule D reports all insurers' individual fixed income holdings at year-end, together with cross-sectional information about each security, including the CUSIP identifier, first date of purchase, and whether the bond was on loan as part of the insurer's securities lending program.[24] We calculate aggregate holdings by all life, property and casualty, and health insurers including bonds that are held in their separate accounts, as well as aggregate holdings by all insurance companies that have active corporate bond lending programs, identified as those insurance companies that have at least one bond on loan at year-end during the sample period. Unsurprisingly, since insurance companies are one of the largest institutional holders of corporate bonds, we find that about 88 percent of bond-month observations have non-zero holdings by insurance companies, and about 86 percent have non-zero holdings by insurance companies that have active securities lending programs.

We present summary statistics for our final dataset in Table 1. Our main dependent variable on corporate bond market liquidity exhibits substantial variation, both between corporate bonds and within each corporate bond over time (this variation is not shown in the Table). The variables derived from MSF indicate that, on average across the corporate bonds in our sample, securities lenders make roughly one quarter of the amount outstanding available to lend. Nevertheless, only about two percent of the amount outstanding is actually on loan at any given time. The median rebate rate is about 1 percent, while the median lending fee is about 0.1 percent. Finally, data on insurance company holdings at year-end reveal that they hold, on average, about 16 percent of the amount outstanding with a distribution that is positively skewed. Insurance companies with active bond lending programs account for the lion's share of the holdings, which is simply a reflection of the tendency of larger insurance companies to lend their bond holdings.

[23] Historical NAIC Annual Statutory Filings are contained in the NAIC Financial Data Repository, a centralized warehouse of financial data used primarily by state and federal regulators.

[24] Unfortunately, we do not observe more detailed information on the insurers' securities lending programs at this time. Beginning in 2011, after state regulators adopted regulatory guidelines established by the NAIC, insurance companies started to report information about their lending programs (Foley-Fisher, Narajabad & Verani 2016).

3 Corporate bond lending and market liquidity

This section introduces our empirical strategy for studying how the supply of corporate bonds through the securities lending market can affect corporate bond market liquidity.

3.1 Empirical strategy

We exploit the major role played by insurance companies in the corporate bond lending market to estimate the effect of a change in the supply of corporate bonds to the securities lending market on corporate bond market liquidity. Insurance companies are the largest institutional investors in corporate bonds as part of their asset-liability management, and thus naturally occupy a dominant position as large corporate bond lenders. Moreover, insurers select bonds with certain maturities, ratings, and issuers according to their asset-liability management strategy, creating heterogeneity across their bond portfolios. And since many insurance companies make their corporate bond portfolios available to securities borrowers, this heterogeneity has implications for the securities lending market. We use the differences in bond portfolios across insurance companies to estimate how changes in insurers' bond lending affects the liquidity of individual corporate bonds.

To tease out the effect of corporate bond lending on corporate bond market liquidity, we use the large exogenous reduction in insurers' bond lending programs that occurred in 2008. Since corporate bond lending reflects both supply and demand factors, including conditions in the secondary bond market such as liquidity, we require a shock to bond lending supply that is independent of these conditions. In 2008, securities borrowers developed concerns about the quality of cash collateral reinvestment portfolios of a few insurers. These portfolios contained, at least in part, higher yielding, illiquid securities related to the U.S. housing market. A massive decline in lending was inevitable after AIG was forced to shut down its lending program. While other insurers continued to lend, overall corporate bond lending by insurers was greatly diminished.

Our basic identification strategy exploits this large shock to the securities lending market together with differences in corporate bond holding across insurance companies. Adopting a difference-in-differences approach, we test the hypothesis that corporate bonds held in a larger fraction by insurance companies became more illiquid after insurance companies made less corporate bonds available to securities borrowers. In the main

specification, the first difference is between a bond b of which insurers hold a high fraction of the outstanding par value and a bond in which insurers hold a low fraction. Although insurance companies tend to follow a buy-and-hold portfolio strategy, it is plausible that their buying strategy changed in the post crisis period.[25] We address this concern by fixing the fraction of insurers' holdings (InsFrac2006_b) to their level of 2006.[26] The second difference is between the period before the shutdown in insurers' lending programs and the period after the shutdown, measured using a set of dummy variables (Year_t^y) for each year y.

Our main dependent variable is the secondary market liquidity (liquidity_{bt}) of corporate bond b in month t, measured using the average realized spread between the price paid by a dealer to a customer for purchasing bond b and the price at which the dealer sells the same bond to a customer. The coefficients β^y on the interaction terms in the following linear model allow us to trace the difference-in-difference effect of the reduction in the lending supply of corporate bonds that were mostly held by insurers that occured during the financial crisis:

$$\text{liquidity}_{bt} = \alpha_b^1 + \alpha_t^2 + \beta^y \text{InsFrac2006}_b \times \text{Year}_t^y + \mathbf{X}_{bt}\boldsymbol{\gamma} + \epsilon_{bt}. \tag{1}$$

We include bond fixed effects (α_b^1) to control for time-invariant heterogeneity across bonds and we include month fixed effects (α_t^2) to control for time-varying common shocks to bond market liquidity, including shocks to investors' or dealers' bond demand. We also include a vector ($\mathbf{X}_{bt}$) of bond-specific control variables interacted with time fixed effects. The interaction between bond characteristics and time is essential to control, for example, for potential changes in bond demand that occurred during the crisis period (e.g. flight to quality) and the development of the low interest rate environment (e.g. reach for yield). In addition to controlling for unobservable heterogeneity with fixed effects and time-varying bond characteristics, in all the tests reported in this paper we two-way cluster our standard errors by month and bond to alleviate concerns that shocks may be correlated within months or across bonds.[27]

[25] For example, some insurance companies may select into more illiquid bonds to earn a higher yields to maintain profitability in a low interest environments.

[26] To be clear, since we are calculating insurers' holdings at the end of 2006, throughout the analysis we restrict the sample to bonds that were issued in 2006 and before.

[27] Across specifications, our standard errors have roughly 55 month clusters and 13,000 bond clusters. The findings reported are not dependent on the clustering assumption, we obtain statistically significant

3.2 Baseline results

Table 2 summarizes the results from the estimation of equation 1. Column 1 tests the association between corporate bond liquidity and the supply of corporate bonds to securities borrowers, controlling for bond and month fixed effects. Column 2 adds bond characteristic controls interacted with time fixed effects to the specification in column 1.[28] Since controlling for time-varying bond characteristics is essential in this analysis, we use the results in column 2 as our baseline. The coefficient estimate on the interaction terms suggests that those bonds in which insurers hold a greater fraction became less liquid in 2008 relative to their levels in 2006 and 2007.[29] A one standard deviation increase in the fraction of a bond held by insurers leads to an additional increase in illiquidity by one-tenth of a standard deviation in 2008. This effect persists until the end of our sample period, though it decays somewhat.

In the remaining columns of the table, we replace the dependent variable in equation 1 with a set of variables related to the bond lending and secondary markets. Columns 3 though 6 investigate the bond lending market through which insurers' holdings of corporate bonds influence corporate bond market liquidity. In particular, we examine the relationship between the fraction of an individual corporate bond that is held by insurers and its lending availability, actual lending, rebate rate (a proxy for the inverse of the cost of borrowing), and volume traded.[30]

The picture that emerges from the results in columns 3 though 5 reveals the severity of the shock that affected the supply of corporate bonds by insurance companies during the crisis. The interaction terms for 2008 indicate that bonds held by insurers had no decrease in actual lending and only a slightly lower availability. However, at the same time, the cost associated with borrowing bonds held by insurers fell, as indicated by higher rebates. This finding is consistent with the narrative that insurers such as AIG lowered the cost of borrowing in an effort to keep their lending programs active (Peirce

results if we one-way cluster our standard errors by month or bond and if we replace the clustered standard errors with Eicker-White heteroscedasticity robust standard errors. These results are available from the authors on request.

[28] These bond characteristics are credit rating, amount outstanding, issue amount, bond type, residual maturity, time since issuance, and a dummy variable for whether the bond is held by any insurer.

[29] For simplicity, we combine the half-year of data available for 2006 with the data for 2007. We obtain similar results using only 2006 as the base year.

[30] With the exception of the rebate rate, all the variables are scaled by the amount of the bond outstanding.

2014).

In 2009, the interaction terms reveal that those bonds held in greater quantities by insurers became much harder to borrow—a one standard deviation (20 percentage point) increase in the fraction of a bond held by insurers decreased the fraction of that bond's availability by one-quarter of a standard deviation (4 percentage points). Consistent with a negative supply shock to the lending availability of bonds held by insurers, the cost to borrowing those bonds rose significantly (rebate rate fell) and actual lending declined. The coefficients on the interaction terms for 2010 are statistically the same as those for 2009, underscoring the long-lasting nature of the reduction in the supply of corporate bond lending.

Finally, column 6 reports the effect of the shock to insurers' lending programs on the volume of trade on the secondary market. While there was there is greater trading in bonds held in a higher fraction by insurers from 2008 through 2010, we show in the next section that this may be related to demand rather than supply factors.

4 Controlling for omitted variables and insurers' bond sales

This section implements a series of additional tests to address two concerns. The first concern is that our baseline estimates may be confounded by omitted demand-side variables that are potentially correlated with our main explanatory variable. The second concern is that insurance companies' bond sales during the crisis may have had a direct effect on corporate bond market liquidity.

4.1 Controlling for omitted variables: AIG versus other insurers

The difference-in-difference identification strategy described in the previous section assumes that shocks to the demand for borrowing insurers' bonds are not correlated with insurers' bond holdings. To be sure, the tests include time fixed effects and time-clustered standard errors in acknowledgment of time-varying and correlated shocks to bond borrowing demand. But we recognize the possibility that potentially unobserved demand factors are correlated with the amount of a particular bond held by insurers.

One such potentially confounding factor is suggested by Brunnermeier & Pedersen (2009), who describe the relationship between funding liquidity and market liquidity. This relationship might mean that the effect of shocks to funding liquidity on market liquidity may be correlated with insurers' bond holdings. For example, a negative shock to funding liquidity will make it more difficult for intermediaries to borrow any bond. But the harder it is for an intermediary to match buyers and sellers of a particular bond, the stronger will be effect of the greater difficulty to borrow that bond on its market liquidity. By holding and not trading a bond, an insurer reduces the ability of intermediaries to match buyers and sellers of that bond. Thus, the relationship between insurance companies' bond holdings and market liquidity may be confounded by the relationship between funding liquidity and market liquidity.

Ideally, we would address this concern by comparing the market liquidity of two identical bonds that are held and lent by different insurance companies in the aftermath of an exogenous closure of one insurer's lending program. We can approximate this ideal test by contrasting the experience of AIG with that of other insurance companies. As described in Section 1.3, AIG was the largest lender of corporate bonds prior to the crisis that, following a run by securities borrowers, had almost entirely closed its bond lending program by the end of 2008. In contrast to AIG, other insurers remained relatively active bond lenders, as exemplified by the experience of MetLife.

After AIG, MetLife was the second largest insurance company lending corporate bonds in the pre-crisis period, with a securities lending program of around $45 billion at its peak in 2007. And, like AIG, MetLife experienced enormous unrealized losses on its asset portfolio in 2008.[31] As the crisis unfolded, MetLife experienced large withdrawals by investors—including by securities borrowers requesting the return of their cash collateral. MetLife was creative in finding sources of cash and cash-like assets that enabled these withdrawals to be met.[32] Specifically with regards to its securities lending program,

[31]See GAO report 13-583, "Impacts of and Regulatory Response to the 2007-2009 Financial Crisis.". MetLife's losses were second only to those of AIG. The unrealized losses stemmed in part from significant exposures to the U.S. housing market. Both insurance companies funded a material fraction their assets using short-term non-traditional non-insurance liabilities. This included securities lending cash collateral and other debt-like instruments such as Funding Agreement-Backed Securities with embedded put options (Foley-Fisher, Meisenzahl, Narajabad, Perozek & Verani 2016).

[32]At the time, MetLife was a Bank Holding Company, which allowed it to borrow from the Federal Reserve Bank of New York Discount Window and from the Federal Reserve Term Auction Facility (See Bloomberg, "The Fed's Secret Liquidity Lifelines," available at `http://www.bloomberg.com/data-visualization/federal-reserve-emergency-lending/#/MetLife_Inc` and Board of Governors, Term Auction Facility, available at `http://www.federalreserve.gov/newsevents/reform_`

MetLife swapped illiquid securities in its securities lending cash reinvestment portfolio for cash and short-term investments in other investment portfolios to avoid selling the illiquid securities in the reinvestment portfolio at fire sale prices.[33] By the beginning of 2009, not only was MetLife's asset portfolio still available to securities borrowers with about [$20 billion]] on loan, but the company had replaced AIG as the largest lender of corporate bonds in the insurance industry.

The contrast between the experience of AIG and that of other insurers, such as MetLife, is the motivation for a more detailed analysis. We exploit cross-sectional differences in the corporate bonds held and lent by AIG and other insurance companies. Holding fixed the total amount of each bond held by all insurance companies, we compare the liquidity of those bonds held in large amounts by AIG with bonds held by other insurers that were not forced to close their bond lending programs. Intuitively, the disproportionate shock to AIG's lending program in 2008 will asymetrically affect the market liquidity of the bonds held by all insurers.

More formally, we calculate for each bond b in our sample the fraction held by AIG relative to the total amount held by all insurance companies with bond lending programs at the end of 2006 (AIGFrac2006_b). This variable becomes the main dependent variable in a new difference-in-differences specification:

$$\text{liquidity}_{bt} = \alpha_b^1 + \alpha_t^2 + \beta^y \text{AIGFrac2006}_b \times \text{Year}_t^y + \tilde{\mathbf{X}}_{bt}\tilde{\boldsymbol{\gamma}} + \epsilon_{bt}. \tag{2}$$

The dependent variable is the same as in equation 1. However, in addition to the time- and bond-specific fixed effects (α_b^1, α_t^2) and the bond-characteristics interacted with time ($\mathbf{X}_{bt}$) present in equation 1, we now include as a control variable the fraction of insurers'

`taf.htm`). In addition, MetLife's life insurance subsidiaries ramped up borrowing from the Federal Government by issuing funding agreement backed commercial paper to the Federal Reserve's Commercial Paper Funding Facility and by increasing funding agreement backed borrowing from the Federal Home Loan Banks (See Board of Governors, Commercial Paper Funding Facility, available at `http://www.federalreserve.gov/newsevents/reform_cpff.htm` and MetLife's Form 10-K for 2007 and 2008.).

[33] From MetLife's 2009Q2 Form 10-Q: "During the three months ended March 31, 2009, a period of market disruption, internal asset transfers were utilized extensively to preserve economic value for MetLife by transferring assets across business segments instead of selling them to external parties at depressed market prices. Securities with an estimated fair value of $3.7 billion were transferred across business segments in the three months ended March 31, 2009 generating $509 million in net investment losses, principally within Individual and Institutional, with the offset in Corporate & Other's net investment gains (losses). Transfers of securities out of the securities lending portfolio to other investment portfolios in exchange for cash and short-term investments represented the majority of the internal asset transfers during this period."

holdings of the amount outstanding in 2006 (InsFrac2006_b) interacted with time. This new control variable absorbs the potentially confounding effects stemming from unobserved demand factors that are correlated with insurers' bond holdings.

4.2 Controlling for omitted variables: Results

Table 3 presents the results from estimating equation 2. The dependent variable in columns 1 and 2 is the average realized spread. The test reported in column 1 excludes the interaction between the fraction of insurers' holdings of the amount outstanding in 2006 and time. This specification is comparable to column 2 of Table 2, replacing the insurers' fraction held with AIG's fraction held. When compared with our previous results, we observe that in comparison to overall insurers with bond lending programs, the shock to AIG's lending program had a smaller effect in 2008, but a larger impact on liquidity during the following years. This is consistent with the narrative, exemplified by MetLife, that the shock to other insurers' lending programs was more temporary than for AIG.

The test reported in column 2 includes the new control variable that absorbs the potentially confounding effects stemming from unobserved demand factors that are correlated with insurers' bond holdings. The point estimates of the coefficients on the interaction terms are slightly smaller, especially the interaction with 2008, indicating that confounding effects may indeed be present. However, the overall narrative remains essentially the same, with roughly the same magnitude of effect: A one standard deviation increase in the ratio of AIG holdings of a bond to the total amount of the bond held by insurers with bond lending programs (15 percentage points) lowers the liquidity of that bond by about one-tenth of a standard deviation (4 basis points).

As in our baseline analysis, we further investigate the collapse of AIG's bond lending program by replacing the dependent variable in equation 2 with a set of variables related to the bond lending and secondary markets. The interaction of our main explanatory variable with the year dummy for 2008 suggests that, after controlling for the overall fraction held by insurers, the availability of bonds held by AIG did not fall significantly (column 3), lending did not fall significantly (column 4), and AIG was not forced to offer cheaper terms for borrowing its bonds (column 5). However, from 2009 onward, even after controlling for the overall fraction held by insurers interacted with time, the availability

and lending of bonds held by AIG fell, and the cost of borrowing rose, consistent with a sizeable and significant reduction in the supply of bonds through the insurer's lending program. Finally, column 6 reveals that there was a significantly lower volume of trade in the bonds that AIG held in 2006, after the collapse of AIG's bond lending program.[34]

4.3 Controlling for insurers' bond sales: Results

Although insurance companies' liability-management strategy is generally to buy and hold bonds, a reasonable concern is that insurers may have sold some bonds as part of their overall response to the financial crisis. As we discussed in the institutional background, investors withdrawal from AIG, MetLife, and others required the insurers to find sources of cash and cash-like assets. In principle, insurers might have sold bonds to raise cash, and this may have had a direct effect on the market liquidity of these bonds, unrelated to the closure of the insurers' bond lending programs.

To test this hypothesis, we restrict our sample only to those bonds that insurers continued to hold at the end of 2010 and repeat the tests of the previous section. Table 4 presents the results. Broadly speaking, they are the same as Table 3, indicating that bond sales are not a substantial confounding factor.

5 Conclusion

The theoretical literature on over-the-counter (OTC) markets suggests that frictions in the ability to borrow securities may reduce market liquidity. In this paper we empirically identify and measure the effect of a shock to the available supply of bonds on corporate bond market liquidity. During the financial crisis of 2007-2008, AIG's securities lending program was forced to close, for reasons unrelated to corporate bond market liquidity, while other insurance companies' bond lending programs remained active. Differences in these insurers' bond holdings allows allows us to tease out the causal effect of bond lending on bond market liquidity. We find a large statistical and economic decrease in market liquidity of the bonds that AIG held in large quantities relative to other insurance

[34] The collapse in volume traded is noticeably different from the greater volume traded 2008-2010 reported in Table 2. The contrast suggests that confounding demand factors may be playing a greater role. Consistent with this hypothesis, if we exclude the overall fraction held by insurers interacted with time, the effect identified in column 6 disappears.

companies. Our findings highlight the importance of the shadow banking system as a potentially fragile determinant of market efficiency.

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6 Figures

Figure 1: Corporate bond lending against cash collateral in the United States. These daily data aggregate the fair value of all corporate bonds lent against cash collateral in the United States. The category of other lenders includes corporations, endowments, foundations, and government bodies. Source: Markit and **?**.

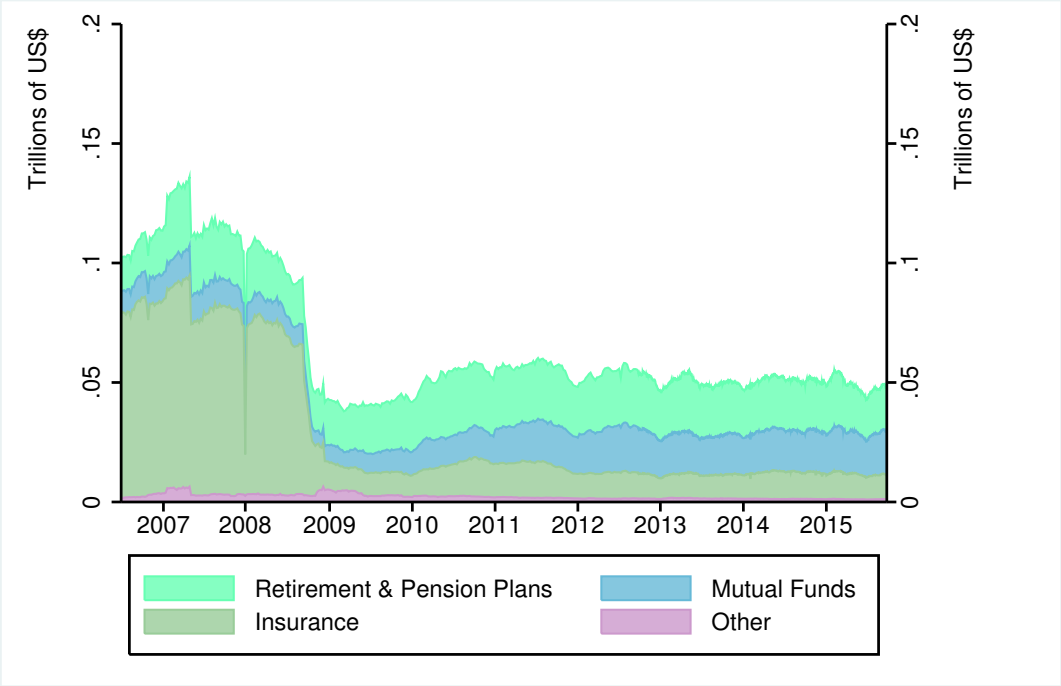
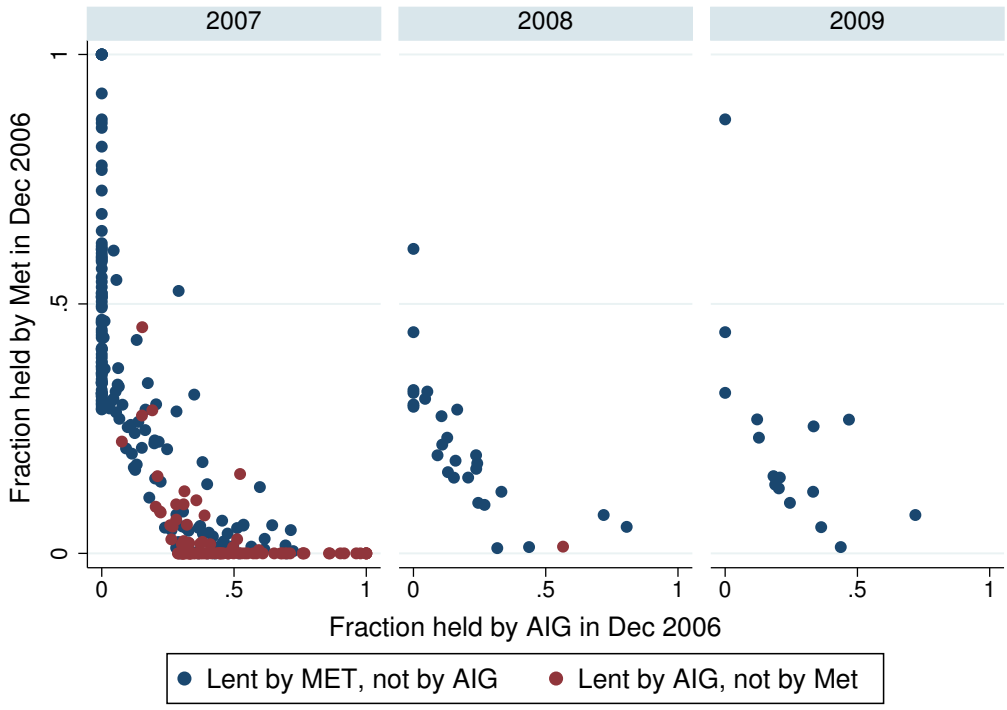


Figure 2: Corporate bond holdings and lending by MetLife and AIG. These data provide a graphical representation of our identification strategy. Each dot represents a single bond in the last month of the year. We first calculate at the end of 2006 the fraction of MetLife and AIG's corporate bond holdings as a share of all holdings by insurance companies with securities lending programs. We restrict our sample only to those bonds in which the combined end-2006 holdings of MetLife and AIG are in the upper quartile of that distribution. Keeping the fraction of holdings fixed at their end-2006 values, we plot for each year 2007 to 2009, the securities that MetLife is lending and AIG is not lending (blue dots) and the securities that MetLife is not lending and AIG is lending (red dots). The time-series indicates the source of our difference-in-difference empirical strategy. The first difference is that each of MetLife and AIG tend to lend bonds in which they individually hold a relatively larger fraction. The second difference is that AIG exits the lending market in 2008, while MetLife remains active. Source: NAIC Statutory Filings and Markit Securities Finance.



7 Tables

Table 1: Summary statistics. Columns 1 through 8 report the number of observations, mean, standard deviation, minimum, maximum, and quartiles of the main variables we calculated from combining corporate bond secondary market transactions reported in TRACE with corporate bond lending activity recorded in MSF. Bond market liquidity is the spread between the average price paid by customers to buy a bond from a dealer and the average price paid by dealers to buy the same bond from customers. All variables are winsorized at the 1 percent level to remove outliers. Additional details on the construction of these variables is available in Section 2.

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
Liquidity (average realized spread in percentage points)	279404	-.41	.61	.9	-2.89	-.08	-.26	-.56
Fraction of bond amount outstanding held by insurers in 2006	279404	.2	.24	0	.89	0	.09	.35
Fraction of bond amount outstanding held by lending insurers in 2006	279404	.14	.18	0	.73	0	.06	.24
Fraction of bond held by lending insurers held by AIG in 2006	279404	.07	.15	0	.8	0	0	.08
Fraction of bond that is available to lend	279,404	.24	.16	0	.7	.11	.23	.35
Fraction of bond that is on loan	279,404	.02	.04	0	.21	0	.01	.03
Median rebate rate (percentage points)	223,331	2.12	2.24	-15.5	18	.12	.95	4.9
Ratio of volume traded to total amount outstanding	279393	.01	.02	0	.11	0	.01	.01
Amount issued (USD bn)	279,404	.65	.61	0	8	.28	.5	.75
Initial maturity (years)	278,510	7.64	8.69	-7.67	99.92	2.67	5.17	8.5
Residual maturity (years)	278,510	7.48	7.69	.08	39.58	2.67	5.17	8.5

Table 2: The effect of corporate bond lending on market liquidity. This table reports tests of the difference-in-difference strategy described in Section 3. In Columns 1 and 2, the dependent variable is the liquidity of bond b in month t, measured using the average realized spread. In Columns 3 and 4, the dependent variables are the fraction of the amount outstanding that is available to lend and the fraction that is actually lent, respectively. The dependent variable in Column 5 is the rebate rate on the cash collateral reinvestment income. And the dependent variable in Column 6 is the ratio of the volume traded to the amount outstanding. The main explanatory variables are the fraction of bond b held in 2006 by insurers with bond lending programs (InsFrac2006_b) interacted with year fixed effects. All tests include month and bond fixed effects, while those of Columns 2—6 also include bond characteristics interacted with time fixed effects. The bond characteristics are credit rating, amount outstanding, issue amount, bond type, residual maturity, time since issuance, and a dummy variable for whether the bond is held by any insurer. Standard errors two-way clustered by bond and month are reported in parentheses. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	Liquidity	Liquidity	Available	Lending	Rebate rate	Volume
$\text{InsFrac2006}_b \times 2008$	-0.448***	-0.243***	-0.0484***	-0.00583	0.229***	0.00477***
	(-8.029)	(-5.067)	(-3.518)	(-0.864)	(3.436)	(4.725)
$\text{InsFrac2006}_b \times 2009$	-0.380***	-0.169***	-0.214***	-0.0579***	-0.282***	0.00541***
	(-7.678)	(-3.800)	(-15.06)	(-11.50)	(-5.840)	(5.441)
$\text{InsFrac2006}_b \times 2010$	-0.220***	-0.0880*	-0.269***	-0.0586***	-0.253***	0.00662***
	(-4.474)	(-1.994)	(-17.22)	(-10.41)	(-5.456)	(6.591)
Observations	153,719	150,452	150,452	150,452	127,364	150,450
R-squared	0.267	0.508	0.963	0.699	0.987	0.602
Date and Bond FE	Y	Y	Y	Y	Y	Y
Bond-time controls	N	Y	Y	Y	Y	Y

Table 3: The effect of AIG's collapse on corporate bond market liquidity. This table reports tests of the difference-in-difference strategy described in Section 4. In Columns 1 and 2, the dependent variable is the liquidity of bond b in month t, measured using the average realized spread. In Columns 3 and 4, the dependent variables are the fraction of the amount outstanding that is available to lend and the fraction that is actually lent, respectively. The dependent variable in Column 5 is the rebate rate on the cash collateral reinvestment income. And the dependent variable in Column 6 is the ratio of the volume traded to the amount outstanding. The main explanatory variables are the fraction of bond b held in 2006 by AIG (AIGFrac2006_b) interacted with year fixed effects. All tests include month and bond fixed effects, as well as bond characteristics interacted with time fixed effects. The bond characteristics are credit rating, amount outstanding, issue amount, bond type, residual maturity, time since issuance, and a dummy variable for whether the bond is held by any insurer. Columns 2—6 also include the fraction of bond b held in 2006 by insurers with bond lending programs (InsFrac2006_b) interacted with month fixed effects. Standard errors are two-way clustered by bond and month. Standard errors two-way clustered by bond and month are reported in parentheses. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	Liquidity	Liquidity	Available	Lending	Rebate rate	Volume
$\text{AIGFrac2006}_b \times 2008$	-0.131***	-0.108***	-0.00324	-0.00908	0.0585	0.000527
	(-4.197)	(-3.423)	(-0.505)	(-1.370)	(1.190)	(0.723)
$\text{AIGFrac2006}_b \times 2009$	-0.227***	-0.212***	-0.0672***	-0.0526***	-0.230***	-0.00231***
	(-5.673)	(-5.263)	(-7.323)	(-11.40)	(-3.439)	(-2.812)
$\text{AIGFrac2006}_b \times 2010$	-0.182***	-0.172***	-0.0453***	-0.0530***	-0.202***	-0.00183*
	(-5.011)	(-4.750)	(-4.120)	(-10.08)	(-3.854)	(-1.965)
Observations	150,452	150,452	150,452	150,452	127,364	150,450
R-squared	0.507	0.509	0.963	0.706	0.987	0.603
Date and Bond FE	Y	Y	Y	Y	Y	Y
Bond-time controls	Y	Y	Y	Y	Y	Y
$\text{InsFrac2006}_b \times$ Date FE	N	Y	Y	Y	Y	Y

Table 4: The effect of AIG's collapse on corporate bond market liquidity. This table reports tests of the difference-in-difference strategy described in Section 4.1. The tests are the same as those reported in Table 3 restricting the sample to those bonds that were held by AIG at the end of 2006 and remained in the portfolio of AIG at the end of 2010. In Column 1, the dependent variable is the liquidity of bond b in month t, measured using the average realized spread. In Columns 3 and 4, the dependent variables are the fraction of the amount outstanding that is available to lend and the fraction that is actually lent, respectively. The dependent variable in Column 5 is the rebate rate on the cash collateral reinvestment income. And the dependent variable in Column 6 is the ratio of the volume traded to the amount outstanding. The main explanatory variables are the fraction of bond b held in 2006 by AIG (AIGFrac2006_b) interacted with year fixed effects. All tests include month and bond fixed effects, bond characteristics interacted with time fixed effects, and the fraction of bond b held in 2006 by insurers with bond lending programs (InsFrac2006_b) interacted with month fixed effects. The bond characteristics are credit rating, amount outstanding, issue amount, bond type, residual maturity, time since issuance, and a dummy variable for whether the bond is held by any insurer. Standard errors two-way clustered by bond and month are reported in parentheses. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	Liquidity	Available	Lending	Rebate rate	Volume
$\text{AIGFrac2006}_b \times 2008$	-0.0407	-0.0108	-0.0151*	0.0947**	-0.000618
	(-0.887)	(-1.236)	(-1.939)	(2.090)	(-0.696)
$\text{AIGFrac2006}_b \times 2009$	-0.137***	-0.0781***	-0.0583***	-0.207**	-0.00210**
	(-2.901)	(-6.356)	(-9.901)	(-2.644)	(-2.247)
$\text{AIGFrac2006}_b \times 2010$	-0.0966**	-0.0608***	-0.0600***	-0.169***	-0.00177*
	(-2.291)	(-4.214)	(-9.279)	(-3.778)	(-1.717)
Observations	83,929	83,929	83,929	75,662	83,929
R-squared	0.517	0.967	0.692	0.990	0.576
Date and Bond FE	Y	Y	Y	Y	Y
Bond-time controls	Y	Y	Y	Y	Y
$\text{InsFrac2006}_b \times$ Date FE	Y	Y	Y	Y	Y