Securities Lending as Wholesale Funding: Evidence from the U.S. Life Insurance Industry*

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Abstract

The existing literature assumes that securities lenders primarily respond to demand from securities borrowers and reinvest their cash collateral in short-term markets. We offer compelling evidence for a supply channel, using new data matching U.S. life insurers' individual bond lending and reinvestment decisions to the universe of securities lending transactions. We show that an insurer's decision to lend a bond is positively correlated with liquidity transformation in its lending program, even after controlling for demand for that bond. We discuss how using securities lending cash collateral as a source of wholesale funding might impair securities markets in times of stress.

JEL Codes: G11, G22, G23

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Introduction

Securities lending is widely understood to play an important role in the functioning of securities markets. By agreeing to purchase an asset and return it at a later date, securities borrowers—typically dealers acting for themselves or on behalf of clients such as hedge funds—temporarily gain economic ownership of the asset in exchange for collateral, which is usually cash in the U.S. In addition to managing inventory, financial institutions borrow securities to facilitate short positions, to avoid delivery fails and to use the borrowed security as collateral in other transactions. In the absence of securities lending, a large volume of securities would be tied up in institutions that hold big asset portfolios—pension funds, mutual funds, and life insurance companies—for asset-liability management or regulatory reasons.

In this paper, we study the securities lending market from the lenders' perspective. To understand the decision processes that we analyze, it is helpful to consider the stylized map of shadow banking depicted in Figure 1. The cloud represents the general functioning of securities markets, illustrated with the example of hedge funds taking long and short positions. Securities market participants typically borrow both cash funding and securities using broker-dealers as intermediaries. Broker-dealers obtain cash from several sources, for example, money market mutual funds (MMFs) through short-term funding markets. Securities lenders decide whether to lend assets from their portfolio and whether to invest the cash collateral they receive back into short-term markets or into long-term markets.[1] In the latter case, they may invest, for example, in relatively longer-term corporate bonds or asset-backed securities.

The existing literature implicitly or explicitly assumes that securities lending is primarily driven by demand from borrowers and that lenders reinvest their cash collateral through short-term markets.[2] Some examples include Duffie, Gârleanu & Pedersen (2002), who study the effect of search and bargaining in the securities lending market on pricing in the securities market, abstracting from the reinvestment decisions of securities lenders (Figure 2a). Brunnermeier & Pedersen (2009) and Gorton & Metrick (2012) consider securities market transactions funded through margin accounts and bilateral repurchase agreements (repo), abstracting from the source of securities (Figure 2b). And Krishnamurthy, Nagel & Orlov (2014) focus on the cash provided to broker-dealers from MMFs and securities lenders through short-term funding markets, taking as given the lending and reinvestment decisions of securities lenders (Figure 2c).[3]

[1] Although agent lenders are often involved in the securities lending process, as we describe in Section 1, their role is incidental to our analysis.

[2] Lenders may reinvest in short-term markets directly through tri-party repo or indirectly through MMFs.

[3] In addition, the securities lending market has been studied empirically to better understand the connections between the securities lending market and pricing in the securities market (including, for example, D'avolio (2002), Nashikkar & Pedersen (2007), Saffi & Sigurdsson (2011), Asquith, Au, Covert & Pathak (2013), Kaplan, Moskowitz & Sensoy (2013), and Kolasinski, Reed & Ringgenberg (2013)), and has been exploited to study equity

We offer compelling evidence for an alternative, supply-driven, motive for securities lending. This supply channel arises because the short-term cash collateral available in exchange for lending securities represents a potential source of wholesale funding for lenders. By lending securities at relatively short duration to create and maintain a pool of cash collateral, lenders can finance a portfolio of longer-duration, higher-yielding assets. The liquidity and maturity transformations associated with this strategy allow lenders to increase the return on their asset portfolio. To be sure, our empirical analysis does not attempt to test the demand channel against the supply channel to establish the dominant motive for securities lending. Rather, our analysis seeks to provide the first empirical evidence for a supply channel that shapes the decision to lend securities conditional on the demand channel already established by the literature.

To establish a supply channel in the market for securities lending, we analyze a new dataset that combines data on U.S. life insurers lending programs with the market for securities lending. Specifically, we match every U.S. life insurer's bond portfolio, as well as their lending and reinvestment decisions, to the universe of securities lending transactions. We collect new annual regulatory data made available from 2011, which specify the bonds in an insurer's portfolio that are on loan at the time of filing as well as the composition of the insurer's cash collateral reinvestment portfolio. We combine this information with microdata on loan transactions from the most comprehensive source on the securities lending market, including the amount of each bond borrowed and the terms of the loans. By matching these data at the security level, we can assess how life insurers' decisions to lend individual bonds are related to lending market conditions. To our knowledge, our study is the first to focus on the securities lending market for bonds, where life insurers play a major role.

We use these data to investigate the relationship between the decision to lend securities and the degree of liquidity transformation in the cash collateral reinvestment portfolio. The main empirical challenge is to obtain variation in the decision to lend securities that is independent of demand factors. First, the demand for securities may vary with observable and unobservable time- and security-specific characteristics. Second, including equilibrium market variables as a control for demand may not be appropriate. The concern is that, when specifying the factors that determine the lending decision, omitting any variable that jointly determines the equilibrium market variables will likely invalidate all the coefficient estimates. We demonstrate the severity of the empirical challenge by showing that the cost of borrowing a bond is a function of the distribution of holdings in that bond. Intuitively, this new finding suggests that lenders of hard-to-find bonds can get a better deal on their transaction—as in Duffie (1996)—and the terms of

voting preferences (Aggarwal, Saffi & Sturgess (2015)). These studies do not consider how securities lenders may reinvest the cash collateral they receive from lending their securities.

the transaction may affect their decision to lend particular bonds.

We address this challenge by exploiting the ability to observe in our dataset the same bonds at the same time across different life insurers' portfolios. Our specification includes bond–time fixed effects to control for potentially confounding factors in a reduced form that encompasses the cost of cash borrowing as well as the availability and distribution of holdings associated with each bond. Our proxy for the degree of liquidity transformation is the fraction of assets in an insurer's cash reinvestment portfolio that have a residual maturity of more than one year. Under a demand-driven securities lending strategy, this proxy would be uncorrelated with the decision to lend after controlling for demand. By contrast, we find that an insurer's decision to lend a particular bond is positively correlated with the degree of liquidity transformation in their reinvestment strategy, even after controlling for demand for that bond.

We develop our analysis to address a further concern: Our proxy for the degree of liquidity transformation may not be independent of unobservable time-varying demand that is common across insurers' bonds. For example, life insurers may have bundles of securities that are collectively in demand during some years and this common demand will not be absorbed by either individual insurer or security–time fixed effects. We adopt an instrumental variable (IV) approach. We exploit the institutional feature that securities lending managers take their asset portfolios as given when deciding which assets to lend. Our instrument for the degree of liquidity transformation by an insurer is the annual change in unrealized gains/losses as a fraction of that insurer's total assets. Intuitively, a securities lender can compensate for unrealized losses on its asset portfolio by increasing the return on its cash reinvestment portfolio. Unrealized losses on the entire portfolio of holdings are plausibly unrelated to the unobserved demand that is the source of the endogeneity concern.

Our findings consistently reject the hypothesis that securities lenders' reinvestment strategies are solely demand-driven. Our baseline IV specification suggests that a one standard deviation (28 percent) increase in the fraction of the cash reinvestment portfolio that has a residual maturity of more than one year, on average, is associated with a 0.7 standard deviation (11 percentage points) greater likelihood that a lender will lend a security. Importantly, this finding is based on data available since 2011, indicating that liquidity transformation in securities lending programs was not eliminated by the regulatory responses to the 2008-09 financial crisis.

Our evidence of the use of securities lending cash collateral as a source of wholesale funding suggests important new channels through which securities market functioning could be impaired during a time of overall financial stress. As is widely known, liquidity and maturity transformation are associated with vulnerabilities to runs (Diamond & Dybvig 1983, Goldstein

& Pauzner 2005) and roll-over risk (He & Xiong 2012).[4] The vulnerability of securities lending to runs has the potential to affect securities markets in two ways. First, as securities borrowers return the securities and demand the return of their cash collateral, securities lenders would likely withdraw their reinvestment of cash collateral from short-term markets, which would reduce funding liquidity and adversely affect securities market liquidity (Brunnermeier & Pedersen 2009). Second, the return of borrowed securities reduces market making activity, which could also impair the functioning of securities markets.

The collapse during the 2008-09 financial crisis of tri-party repo funding provided by securities lenders illustrates how liquidity transformation in, and runs on, securities lending programs may have been a root cause of the collapse in short-term funding supporting the functioning of securities markets.[5] Figure 3a shows the total cash collateral held by securities lenders (red dashed line) compared to the total assets held by MMFs (blue solid line). Amid widespread concerns about the liquidity and credit quality of cash reinvestment portfolios, securities borrowers ran on securities lenders by calling their cash collateral.[6] By the first quarter of 2009, cash collateral from securities lending had fallen almost $1 trillion while MMF assets had only begun to decline from pre-crisis levels. Contagion to the broader financial system occurred when, to meet the demand to return cash, securities lenders drew first on the portion of cash collateral that was reinvested in short-term funding markets. The effect of the run on securities lenders' cash collateral on market funding liquidity can be seen in Figure 3b, showing the tri-party repo funding provided by securities lenders (red dashed line) and MMFs (blue solid line).[7] By the first quarter of 2009, repo funding from securities lenders had collapsed by almost $300 billion while MMF funding remained relatively more available.

The remainder of the paper proceeds as follows. In Section 1, we provide an overview of the market for lending securities. Section 2 presents our data and summary statistics. Section 3 presents our empirical results on the supply channel of securities lending, including our IV estimates and robustness tests. We discuss some implications of our findings and conclude in

[4] At an institutional level, these vulnerabilities were manifest at AIG's $80 billion securities lending program in 2008, which had retained only about 20 percent of its cash collateral in short-term assets, while 65 percent was reinvested in longer-term RMBS and other ABS (Peirce 2014, McDonald & Paulson 2015). Increasing concerns among investors about the value of this reinvestment portfolio drove demands for greater collateral reductions. The cumulative and consequential losses ultimately required AIG to request a series of government interventions.

[5] Unfortunately, the new regulatory data on insurer's securities lending programs do not cover the crisis period.

[6] The experience of securities lenders was repeated throughout the financial system, with runs on repo markets (Gorton & Metrick 2010*a*,*b*, 2012), asset-backed commercial paper (Covitz, Liang & Suarez 2013, Schroth, Suarez & Taylor 2014), MMFs (Schmidt, Timmermann & Wermers 2016), and life insurance companies (Foley-Fisher, Narajabad & Verani 2015).

[7] Figures 3a and 3b reflect only part of the sylized map in Figure 1. Figure 3a shows the total cash collateral that flowed from broker-dealer to securities lenders. However, the red dashed line in Figure 3b shows only the part of cash collateral that was reinvested directly into repo; it does not include cash collateral that was reinvested by securities lenders in MMFs.

Sections 4 and 5.

1 Securities lending and life insurance companies

In this section, we first briefly outline the typical structure of a securities lending transaction, together with the motivations of each party to the deal. Then we provide an overview of the securities lending market and the specific role of U.S. life insurers. And, finally, we discuss the distinction between the demand and supply channels of securities lending.

1.1 Securities lending transactions

In a prototypical loan, the security lender transfers full legal and economic ownership of the security to the borrower.[8] In exchange, the borrower gives the lender collateral in the form of cash or another security. The term of the loan is usually open-ended, with either party able to terminate the deal at any time by returning the security/collateral.[9] The securities lender is free to reinvest the cash and, in some cases, rehypothecate the securities used as collateral. In the case of non-cash collateral, the securities lender earns a fee from the borrower. In the case of cash collateral, the securities lender pays a percentage of the reinvestment income to the securities borrower, called the "*rebate*." Both the rebate and fee are equilibrium prices negotiated at the outset of the deal that may reflect the scarcity of the security on loan: A hard-to-find "*special*" security may command a high fee and a low or negative rebate. 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. In addition to the loss of collateral, the security borrower is dissuaded from defaulting on the loan by reputational effects: lender–borrower relationships are formed through repeated transactions, and are often governed by a single master agreement. Overall, the structure of cash-collateralized securities lending is closely related to a sale and repo transaction, in which the securities borrower is entering a reverse-repo arrangement (Duffie 1996, Garbade 2006).

A securities lending transaction usually involves three or four parties. The ultimate owner of the security is typically an institutional investor such as a pension fund, insurance company, mutual fund, or sovereign wealth fund. Owners of large portfolios will often conduct their own

[8] Although they are transferred by default, the parties may agree that the securities borrower will return any dividend/interest payments and/or voting rights.

[9] Flexibility is often preserved, even in term loans, by allowing either party to break the terms early in exchange for a fee.

lending programs, while smaller owners execute their programs through agent lenders, such as custodian banks or asset managers, that act as large warehouses for securities made available for lending. The end users of the borrowed securities are typically dealers and hedge funds. These security market participants generally use large financial institutions, for example, broker-dealers and investment banks, as intermediaries that regularly search for securities and have established relationships with lenders.

The ultimate owners decide which securities in their portfolios will be made available to lend and how the cash collateral proceeds of their lending programs will be reinvested. When they choose to employ agent lenders, the owners typically provide guidelines or specific instructions for the type of lending transactions (for example, minimum fee criteria or hard-to-find securities only) and for the reinvestment of cash collateral. In some cases, these reinvestment strategies are subject to regulatory limits.

If agent lenders are involved, they execute owners' instructions to lend particular securities and reinvest cash collateral. Because agent lenders often have access to the same securities from many ultimate owners, they typically allocate borrowing requests to securities using an algorithm that ensures no owner receives preferential treatment. The agents earn a share of the profits associated with lending securities, including fees and/or reinvestment income after rebate. In exchange, agents will customarily provide indemnification against the risk that the non-cash collateral is insufficient to replace the lent securities if the borrower defaults. To be clear, this indemnification does not protect the owner against the risk of losses associated with reinvesting cash collateral.

The borrowing intermediary generally performs three functions as it matches end-user requests for securities with lenders' availability. First, the intermediary helps to assuage securities lenders' potential concerns about the credit quality of end users, which may be small and weakly regulated. Second, by establishing relationships with lenders and borrowers, they can lower search costs. In the case of broker-dealers, their securities lending intermediation is often combined with prime brokerage to lower costs further. Third, the intermediary may assume some liquidity risk by establishing open-ended loans with lenders, giving them the freedom to recall the securities as needed, and extending term loans to end users so they can be sure their short positions are covered. In exchange for these services, the borrowing intermediary receives a payment from the end user.[10]

The end users have a variety of reasons for borrowing a particular security. The most common motivations are to manage inventory (Faulkner 2008); to take a short position or to cover a naked

[10] Huh & Infante (2016) show how securities lending allows broker-dealers to separate their own portfolio positions from their ability to fulfill client orders.

short position (Duffie 1996, Keane 2013); to avoid a settlement/delivery failure (Musto, Nini & Schwarz 2011), possibly as part of market making activity; to combine one security with other securities as part of an arbitrage trading strategy; to obtain collateral for use in other transactions (Dive, Hodge, Jones & Purchase 2011); and to take advantage of tax or regulatory arbitrage (Faulkner 2006). The details of these trading strategies are often complex and we refer the reader to the reference list for further explanation.

1.2 The securities lending market

Securities lending is a global market totaling more than one trillion U.S. dollars in outstanding contracts, with U.S. loans accounting for about half of the worldwide market. Figure 6 shows U.S. entities' securities lending broken down by the type of lender. Retirement and pension funds account for more than 60 percent of securities lending by U.S. institutions, followed by mutual and investment funds, which together cover about 30 percent of the market. Insurance companies are the third largest group of U.S. securities lenders. Because life insurers typically invest in fixed income securities rather than equities, their lending is heavily biased towards bonds, in particular the corporate bond market. Indeed, U.S. life insurers were the principal lenders of corporate bonds in the pre-crisis period and remain key participants in the market even though their programs shrank during the 2008-09 financial crisis (Figure 7).

The majority of securities lent in the U.S. are against cash collateral. Although lending against non-cash collateral increased in the aftermath of the 2008-09 financial crisis, lending against cash collateral still accounts for the lion's share of the U.S. securities lending market (Keane 2013, Baklanova, Copeland & McCaughrin 2015). Because most of the securities lending, particularly by life insurers, is against cash collateral, the reinvestment of cash collateral is an essential component of the strategies adopted by securities lenders.

1.3 The supply channel of securities lending

In this paper, we emphasize the distinction between the demand and supply channels affecting the decision to lend securities. The former may be represented by a financial institution with a large portfolio of assets that responds to borrowing demand and reinvests the short-term cash collateral received in safe assets of short duration.[11] The absence of maturity and liquidity transformation allows this securities lender to scale up or down the size of its lending program in response to demand without any attendant run risk.

[11] This characterization of lending institutions is typical in studies of securities lending, for example, Krishnamurthy et al. (2014).

In the supply channel, by contrast, the financial institution aims to supply its securities so as to create and maintain a pool of cash collateral that it uses 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 is not without cost. In particular, this lender creates and bears run risk associated with liquidity and maturity transformation. The correlation between the lending decision and the creation of liquidity transformation that underpins the supply channel of securities lending is the empirical evidence we will look for in our data.

To be sure, we are not ruling out the possibility that a lender may respond to borrowing demand and reinvest the cash collateral in illiquid, longer-term assets. Nor are we excluding the possibility that a lender may aim to create a pool of cash collateral with the intention of reinvesting in safe, short-term assets. We also acknowledge that demand-driven and supply-driven strategies are not mutually exclusive. That is, a securities lender aiming to create a pool of cash collateral may take demand conditions into account when deciding which securities to lend and/or may reinvest a portion of its pool of cash collateral in short-term assets. Moreover, we do not seek to test the demand channel against the supply channel to establish the dominant motive for securities lending.

For these reasons, it is important to state clearly that the goal of our paper is to provide the first empirical evidence of an alternative to the prevailing view on securities lending. The frontier literature only considers the demand channel, portraying securities lenders as solely responding to borrowing demand and reinvesting the cash collateral in safe, short-term assets, for example Duffie et al. (2002) and Krishnamurthy et al. (2014). Our intention is to implement an empirical strategy that carefully controls for the demand channel to establish convincingly that there is a supply channel in the securities lending market.

To better understand the supply channel of securities lending requires detailed data on individual loans and cash reinvestment decisions. For this reason, the 2010 adoption by state insurance regulators of the NAIC guidelines for enhanced reporting on securities lending programs presents a golden opportunity to observe new and detailed information about all aspects of securities lending and cash reinvestment activities by U.S. life insurers. We can observe for the first time the individual bonds that are lent by life insurers, the maturity of the collateral they received, and their cash reinvestment portfolios. When combined with security-level data on the broader securities lending market, we can deepen our understanding of the strategic use of securities lending by U.S. life insurers to raise the return on their portfolio of assets.

2 Data

We combine several data sources to obtain the dataset we use in our analysis. The data on insurance company holdings and securities lending activity come from the NAIC Quarterly and Annual Statutory Filings.[12] Within these filings, Schedule D contains reports of all life insurers' individual fixed income holdings at year-end, together with cross-sectional information about each security, including the CUSIP indentifier and whether the bond was on loan as part of the insurer's securities lending program. We drew information about the total size and performance of the life insurer's investment portfolio from the summary balance sheet. We focus on all insurance companies that had a securities lending program at any point during our sample period. Our baseline dataset includes information on 107 life insurers, with holdings data on over half a million bonds. The first four columns of Table 1 report descriptive statistics for the baseline sample. The average bond holding is about \$9 million with a standard deviation of \$27.6 million. The dummy variable for securities lending indicates that about 3 percent of US life insurers' bond holdings were on loan during the period.

We merge life insurers' holdings data with Mergent FISD using the CUSIP identifier. FISD provides a wide range of security-level information for fixed income securities, including corporate, agency, and government bonds, with a geographical focus on the U.S. While approximately one-half of all Schedule D holdings by insurers in our sample appear in FISD, 95 percent of the lent securities in our data are matched. Our interpretation is that almost all securities lent in our sample are non-privately placed fixed income bonds issued by U.S. entities. Excluding the bond holdings that do not appear in FISD reduces the size our data sample to about 250,000 individual bond holdings across the same set of 107 life insurers. Columns 5 through 8 of Table 1 report the additional descriptive statistics, including amount issued, offering yield, credit rating, and residual maturity. In this merged subsample, the average offering amount of the bonds held is \$10 million (with a standard deviation of \$22.8 million), with a yield at origination of about 6 percent. The average residual maturity across all year-end bond holdings is 11.2 years (with a standard deviation of 9.6 years). Our numerical rating measure indicates that the average is about 20, equivalent to a Standard & Poor's bond rating of BBB.[13] Lastly, the average total amount outstanding across all bonds held by life insurers is \$900 million.

The NAIC Quarterly and Annual Statutory Filings also contain the Schedule DL, a relatively

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

[13] We collect data on ratings from Moody's, Fitch, and Standard & Poor's and combine them into a single rating using the lowest rating when only two are available and the median rating when all three are available. To average the ratings, we set AAA, or equivalent = 28, AA+ = 26, AA = 25, AA- = 24 ... CCC- = 9, CC = 7, and C = 4.

new report of individual investments made by life insurers using cash collateral received from securities lending, both on- and off-balance sheets. The Schedule DL was introduced in 2010 as one of many changes to the reporting and statutory accounting of securities lending transactions adopted as a response to the 2008-09 financial crisis.[14] Figure 4 shows an extract from one life insurer's filing in 2012 showing a sample of the individual investments made using cash collateral received in exchange for lending securities. In general, the new data allow us to better track the securities lending transactions entered into by an insurer and to observe detailed information about the life insurers' use of the collateral received. For example, from 2010, if the collateral received from securities lending could "be sold or pledged by custom or contract by the reporting entity or its agent," then the reinvested collateral should be recorded on the balance sheet.[15] We hand-coded data about the maturity of the collateral received in the securities lending transactions from the regulatory Note 5(e) to the Financial Statements. Figure 5 shows the relevant notes for the same 2012 sample regulatory filing. Because we rely on the detailed information collected as part of the new reporting requirements, our sample by necessity begins in 2011. Figure 9 shows that the total amount of securities lending by U.S. life insurers reached over $55 billion at the end of 2013.

It is difficult to compare the bonds lent by life insurers (Schedule D) to the securities in which they reinvested the cash collateral they received (Schedule DL). The sample reinvestment portfolio reported in Figure 4 indicates that a large proportion of CUSIP identifiers contain "#" and "@" symbols representing privately placed securities.[16] Indeed, if we attempt to merge FISD by CUSIP on the reinvestment portfolios, we can match only 30 percent of individual securities even when excluding cash and cash-like reinvestments.[17] Recall, by comparison, that we can match over 95 percent of bonds being lent with FISD. This contrast in match rates hints at the liquidity transformation created by securities lending programs.

Thus, to better proxy for the degree of liquidity transformation, we compute the fraction of assets in an insurer's cash reinvestment portfolio that have a residual maturity of more than

[14] The new guidelines stem from a review of the securities lending practices at AIG that contributed to its collapse during the 2008-09 financial crisis. In particular, the guidelines specify that borrowers should post cash in the amount of at least 102 percent of domestic securities borrowed (and at least 105 percent if the securities are foreign), that individual loans should not be more than 5 percent of admitted assets, that cash reinvestment should be "prudent," and that all cash reinvestment securities (on- and off-balance sheet) are reported in the NAIC Quarterly and Annual Statutory Filing Schedule DL. In addition, each asset financed with cash collateral recorded in the NAIC Quarterly and Annual Statutory Filing Schedule D attracts a risk-based capital charge consistent with its NAIC designation code.
`http://www.dfs.ny.gov/insurance/circltr/2010/cl2010_16.htm`
`http://www.naic.org/capital_markets_archive/110708.htm`

[15] Amendments to SSAP No. 91–R, Accounting for Transfers and Servicing of Financial Assets and Extinguishments of Liabilities.

[16] `https://www.cusip.com/pdf/CUSIP_Intro_03.14.11.pdf`

[17] We identify cash and cash-like reinvestments by selecting descriptions that contain variations of the words "cash", "money market", "MMF", "prime money", and "MMKT".

one year minus the fraction of cash collateral that is received by the life insurer for a duration of more than one year. The one-year threshold is not crucial for the results in the paper. Rather, we choose it so that our variable represents the investment by life insurers in assets that MMFs cannot purchase for regulatory reasons.[18] It follows that these assets are likely to offer a higher return than cash instruments. Figure 10 shows that there is considerable variation in the calculated fraction across life insurers and over time.

Lastly, we add information on the market for securities lending using Markit Securities Finance. This dataset covers about 85 percent of the global market and more than 90 percent of the U.S. market. The daily transaction level data include identifiers for individual lent securities, such as CUSIP and ISIN, as well as the value, quantity, duration, lending fee, rebate rate, and collateral of the loan. For each lent security, the total value and quantity of the inventory available to lend is also reported. We cannot observe counterparties to individual loans, nor information on lenders' reinvestment of cash collateral. We construct weighted averages of the available variables, for each security, across all transactions conducted during the 14 days around year-end and merge with our other data using the CUSIP identifier. Roughly three-quarters of all bond holdings that appear in both regulatory filings and FISD can be matched to Markit. Moreover, consistent with the high coverage of the securities lending market, more than 95 percent of the securities that insurers report as being on loan are observed in Markit. The high proportion of bond holdings covered by Markit Securities Finance hints at the enormous potential for securities lending by U.S. life insurers.

Our final three–way merged dataset of 107 life insurers contains information on over 190,000 bond holdings, of which more than 13,000 are recorded as being on loan. Columns 9 through 12 of Table 1 report the descriptive statistics for this final dataset. The information from the securities lending market suggests that the weighted average rebate on the bonds is about zero. On average, life insurers hold about 3 percent of each security's total lendable amount (with a standard deviation of 16 percent), and a concentration of holdings index (HHI) value equal to 0.37. Lastly, our measure of each security's market tightness, defined as the ratio of the total amount lent to the total amount that is lendable, indicates that, on average, about 14 percent of the available amount of each security is actually lent. The remaining entries in these columns show that the other observable characteristics of the bond holdings do not vary significantly between the baseline and merged datasets.

[18] Amendments to regulation Rule 2a-7, adopted by the SEC in July 2014, imposes a set of constraints on MMF investment portfolio, including that every security in the portfolio must have a maturity not exceeding 397 days, and that the dollar-weighted maturity of the entire portfolio cannot exceed 60 days. Thus, our one year threshold is six times the regulatory limit on the overall maturity of a mutual fund's cash reinvestment portfolio. `https://www.sec.gov/rules/final/2014/33-9616.pdf`

Simple tabulations show that, conditional on the portfolios they hold, life insurers did not disproportionately lend bonds issued by particular industries. Of the bonds lent by life insurers, roughly 62 percent were issued by industrial companies, 23 percent by financial companies, 10 percent by utilities, 5 percent by government and agencies, and less than half a percent by other institutions. The distribution of insurers' bond lending across types of issuers is almost the same as the distribution of their bond holdings.[19] Table 2 offers more detail on the types of bonds used in lending transactions compared with those bonds that are not lent. In general, the bonds that life insurers tend to lend have a slightly larger par value and have a longer residual maturity in comparison with the rest of their portfolio. Life insurers also tend to lend bonds with a lower rebate (higher fee) and in which there is a greater concentration of holding and market tightness. Of course, these pairwise comparisons of characteristics are only indicative.

3 Identifying the supply channel of securities lending

3.1 Bond-specific endogeneity

To formalize our empirical test of the supply channel for securities lending, we denote by $Loan_{ijt}$ the binary lending decision that takes a value of 1 if insurer j is loaning bond i at year t, and 0 otherwise. As evidence for the presence of a supply channel of securities lending, our goal is to establish a correlation between the lending decision and the creation of liquidity transformation ($Transformation_{jt}$). Recall that our proxy for the degree of liquidity transformation is the fraction of assets in an insurer's cash reinvestment portfolio that have a residual maturity of more than one year minus the fraction of cash collateral that is received by the life insurer for a duration of more than one year.

The main empirical challenge is to obtain variation in the decision to lend securities that is independent of demand factors. Estimates of the correlation between $Loan_{ijt}$ and $Transformation_{jt}$ will be biased if there is unobservable variation in bond-specific demand and insurer-specific heterogeneity. In a linear regression setting, one way to control for unobservable variation in individual bond-specific demand and insurer-specific heterogeneity is to include a set of fixed effects (α) to absorb heterogeneity across securities, life insurers, and report dates:

$$Loan_{ijt} = \alpha_i^1 + \alpha_j^2 + \alpha_t^3 + \beta\, Transformation_{jt} + \boldsymbol{Z}_{it}\boldsymbol{\gamma} + \epsilon_{ijt} \ . \tag{1}$$

[19] About 60 percent of their bond holdings were issued by industrial companies, 23 percent by financial companies, 12 percent by utilities, 4 percent by government and agencies, and half a percent by other institutions. As before, each bond holding is counted as a separate observation, because we do not know how much of each security is actually lent.

That said, the coefficient on $Transformation_{jt}$ when estimating Equation 1 may still be biased if the unobservable bond-specific demand and insurer-specific heterogeneity are time varying.

Including bond-specific equilibrium lending market variables as time-varying proxies for demand will likely produce inconsistent estimates of the partial correlation between the lending decision and liquidity transformation. Intuitively, either quantities traded or prices could proxy for demand if the lender is sufficiently small relative to the overall market. However, life insurers that have the potential to affect these equilibrium market variables and factors that affect the lending decision may also affect these demand proxies. To see this endogeneity problem more formally, consider the previous regression specification representing the loan decision in conjunction with a specification that represents the equilibrium rebate:

$$\begin{aligned} Loan_{ijt} &= \alpha_i^1 + \alpha_j^2 + \alpha_t^3 + \beta\, Transformation_{jt} + \delta Rebate_{it} + \boldsymbol{Z}_{it}\boldsymbol{\gamma} + \epsilon_{ijt} \\ Rebate_{it} &= \tilde{\alpha}_i^1 + \tilde{\alpha}_t^3 + \tilde{\boldsymbol{Z}}_{it}\tilde{\boldsymbol{\gamma}} + \tilde{\epsilon}_{ijt}\ . \end{aligned} \tag{2}$$

If any common variable in $\tilde{\boldsymbol{Z}}_{it}$ and $\boldsymbol{Z}_{it}$ is omitted from the loan decision specification, the estimate of the β coefficient will be inconsistent (Greene 2012).

While it is difficult to accurately gauge the severity of this endogeneity problem, the regression results in Table 3 suggest it is significant. As an example of equation 2, Column 1 shows the results from a regression of our main dependent variable ($Loan_{ijt}$) on insurer j's market share ($Market\ share_{ijt}$) in bond i controlling for the bond rebate rate as well as insurer, year, and bond issuer fixed effects. $Market\ share_{ijt}$ is the year-t holding by insurer j in bond i as a share of the total amount of the bond that is made available to securities borrowers by all lenders. The association between $Loan_{ijt}$ and $Market\ share_{ijt}$ is positive and statistically significant at less than the 1 percent level.[20] Column 2 shows that this association is robust to controlling for bond characteristics, loan market tightness, and concentration for individual securities in the life insurance industry.[21] Column 3 reports the results from a regression of the bond's rebate on $Market\ share_{ijt}$ controlling for insurer, year, and bond issuer fixed effects. The coefficient on $Market\ share_{ijt}$ is positive and statistically significant at less than the 1 percent level. Column 4 shows that the estimate remains broadly unchanged after controlling for loan

[20] The coefficient on $Market\ share_{ijt}$ suggests that, on average, a one standard deviation (12.9 percent) increase in an insurer's market share in a particular bond is associated with a 0.7 percent increase in the probability that the bond is loaned.

[21] Loan market tightness is defined as the fraction of a bond that is on loan relative to the total amount of that bond that is made available for loan by all lenders. Bond characteristics include the issuer, residual maturity, offering yield, offering amount, amount outstanding, and credit rating. Bond concentration is measured by the Herfindahl–Hirschman Index computed at the bond-year level using only life insurers' market shares in each individual bond. The calculation is limited by our ability to observe only life insurers' holdings in our data–i.e., by necessity, it assumes atomistic holdings by other institutions.

market tightness, holdings concentration, and other bond-level characteristics.[22]

Taken together, Table 3 shows that both $\tilde{\boldsymbol{Z}}_{it}$ and $\boldsymbol{Z}_{it}$ likely contain the market share and concentration of holdings in that bond. Intuitively, lenders of hard-to-find securities can get a better deal on their transaction—as in Duffie (1996)—and this may affect their decision to lend particular securities. Because Table 3 shows that known variables are correlated with a bond's rebate, it is likely that other (potentially unobservable) determinants of the lending decision are also correlated with the bond's rebate. Appendix A explores this association further, providing evidence that life insurers not only may affect the market equilibrium of individual bonds, but may also affect the shadow value of their entire lending program.

3.2 Controlling for unobservable bond-specific demand

To overcome this severe endogeneity problem, we exploit the ability to observe in our data the same bonds at the same time across different life insurers' portfolios. We introduce security–time fixed effects to control for potentially confounding time-varying bond-specific demand factors in a reduced form that encompasses the cost of cash borrowing, as well as the availability and distribution of holdings:

$$Loan_{ijt} = \alpha_i^1 + \alpha_j^2 + \alpha_t^3 + \alpha_i^1 \times \alpha_t^3 + \beta\, Transformation_{jt} + \epsilon_{ijt}\ . \tag{3}$$

Testing whether the partial correlation β is positive is equivalent to testing for the supply channel of securities lending. If securities lending decisions were solely driven by the demand channel, $Transformation_{jt}$ would be uncorrelated with $Lend_{ijt}$.

Recall that, since we seek only a partial correlation between $Loan_{ijt}$ and $Transformation_{jt}$ that is plausibly orthogonal to the demand channel, our strategy relies only on the assumption that the interaction term, $\alpha_i^1 \times \alpha_t^3$, fully absorbs the demand channel of the decision to lend. In particular, we are assuming that the demand channel does not directly affect $Transformation_{jt}$. This assumption holds, for example, when lenders are simply endowed with a portfolio of securities over which they can make lending decisions. In the US life insurance industry, the investment portfolios are determined first and foremost by asset-liability (actuarial) management considerations.[23] After the investment portfolios have been determined, portfolio managers can

[22] Reassuringly, our key variable of interest, $Transformation_{jt}$, is not statistically related to the bond-specific rebate rate ($Rebate_{it}$).

[23] For example, the traditional business of life insurers typically consists of meeting a known liability with unknown timing with a lump sum payment. Life insurers also offer annuities-type contracts that may include life and non-life contingencies. Since the liabilities of life insurers tend to be of longer duration, part of the company's asset-liability management process is to select longer duration and inflation protected assets to match those of the liability.

attempt to enhance returns by lending securities.[24] A standard practice is for insurers to use agent lenders, who are instructed only in the management of the securities lending portfolio and are not responsible for the insurer's asset liability management or broad investment strategy.[25]

Table 4 summarizes our main evidence for a supply channel of securities lending. Columns 1 and 2 of Table 4 report the results of estimating equation 3 with only life insurer fixed effects and then including security–time fixed effects, respectively. Column 3 shows that using errors two-way clustered by insurer and bond as a replacement for the heteroscedasticity-robust Huber-White standard errors has no effect on the statistical significance of the results. The coefficient on $Transformation_{jt}$ suggests that, on average, a one standard deviation (29 percent) increase in the degree of liquidity transformation created by the life insurer's reinvestment strategy is associated with a 3 percent increase in the probability that the bond is loaned. This association is significant at less than the 1 percent level.

3.3 Controlling for unobservable insurer-specific heterogeneity

While the interacted fixed effects ($\alpha_i^1 \times \alpha_t^3$) can control for bond-specific, time-varying unobservable factors, they cannot control for all time-varying insurer heterogeneity that affects its ability to lend bonds. For example, life insurers may have bundles of bonds that facilitate lending only in some years. More formally, the concern is that the residual error term ϵ_{ijt} in equation 3 may contain unobservable insurer-specific time-varying demand factors that are potentially correlated with $Transformation_{jt}$. Since we cannot observe these demand factors, we cannot be sure how they might relate to our explanatory variable, or how they might vary over time, and therefore it is not clear in what direction they potentially bias our estimation of the correlation between $Loan_{ijt}$ and $Transformation_{jt}$. However, if we find a source of variation in the degree of liquidity transformation that is plausibly related only to the supply channel, we can address this concern by adopting an instrumental variable approach.

We propose an instrumental variable to deal with possibly unobservable time-varying insurer heterogeneity. To obtain variation in the degree of liquidity transformation that is plausibly independent of the insurer's time-varying heterogeneity, we introduce, as an instrumental variable, the annual change in the amount of unrealized gains/losses on the life insurer's bond portfolio as a fraction of that insurer's total assets ($\Delta\, Unrealized\ gain_{jt}$). Under statutory accounting rules, an insurance company must report the current market value of the securities in its portfolios. Life insurers calculate the unrealized gain/loss as the difference between the

[24] `http://www.naic.org/capital_markets_archive/110708.htm`

[25] See, for example, this Nov. 2, 2009 press release by J.P. Morgan announcing that it would provide securities lending services for Jackson National `http://investor.shareholder.com/jpmorganchase/releasedetail.cfm?ReleaseID=420779`.

cost of its portfolio and the current liquidation value. The unrealized gain/loss on a portfolio is incorporated into ratings agencies' evaluations of the financial strength of an insurer, because they can predict actual economic losses (Standard and Poor's 2009).

Our identification strategy is predicated on the idea that a securities lender will attempt to compensate for the change in unrealized losses on its underlying portfolio by increasing the return on its cash reinvestment portfolio. As described before, portfolio managers are generally endowed with assets, often purchased years before, and decide which securities to lend. In the face of portfolio losses beyond their control, securities lenders can attempt to mitigate these losses by engaging in greater liquidity transformation in their lending programs, further enhancing the return on their assets. Importantly, unrealized losses on the insurer's entire portfolio of holdings are plausibly unrelated to the unobserved demand that is the source of the endogeneity concern.

Columns 3 and 4 of Table 4 report the first- and second-stage results of a regression of $Loan_{ijt}$ on $Transformation_{jt}$, instrumenting $Transformation_{jt}$ with $\Delta\, Unrealized\ gain_{jt}$. As with the reduced form in Column 2 of Table 4, the IV regression includes bond, bond–year, and insurer fixed effects. Column 3 of Table 4 shows that there is a positive first-stage association between $Transformation_{jt}$ and $\Delta\, Unrealized\ gain_{jt}$. The coefficient on $Transformation_{jt}$ in Column 4 of Table 4 suggests that, on average, a one standard deviation (28 percent) increase in the fraction of an insurer's cash reinvestment portfolio invested in assets with maturities greater than 1 year is associated with an 11 percentage point increase in the probability that the bond is loaned. While the estimated IV coefficient is not statistically different from the reduced form estimate, the point estimate is somewhat larger than the estimated OLS coefficient reported in Table 4. Unfortunately, we cannot say whether this is due to unobservable shifts in demand or due to how these demand factors relate to $Transformation_{jt}$.[26]

3.4 Robustness tests

Table 5 summarizes further tests of the robustness of the association between the decision to lend bonds and the degree of liquidity transformation by the life insurer. Each pair of columns in the Table reports the first and second stages, respectively, of a variant to the baseline instrumental variable estimation presented in Table 4. In addition to testing the robustness of our result to alternative standard error specification, we offer some evidence that omitted variables are not confounding our results, we check that the largest life insurers are not driving the result, and we report the findings from a placebo test of our instrument.

Our main analysis specifies standard errors that are two-way clustered by insurer and bond.

[26] One possible explanation is that our empirical approach places greater weight on life insurers that have more variation in active reinvestment over time (Angrist, Graddy & Imbens 2000).

A natural concern is that the error terms may be correlated within insurer-years. Columns 1 and 2 repeats the baseline estimation using errors two-way clustered by insurer-year and bond. Since the alternative clustering assumption only strengthens the statistical result, we continue to report all errors two-way clustered by insurer and bond.

In the context of our empirical model that seeks to identify the supply channel of securities lending while controlling for borrower demand, an important concern is that unobservable demand factors may be correlated with supply factors that affect both the lending decision and the degree of liquidity transformation. Plausible confounding candidates include that borrowers know which insurers to approach when they have a demand for particular securities, for example, because some insurers have large securities lending programs, or because insurers specialize in holding particular securities, or because common shocks to demand may differentially affect insurers depending on the amount of each security that they hold. Columns 3 and 4 report the instrumental variable results including as a control the size of the insurer's securities lending program ($\mathit{SL\ program\ size}_{jt}$), showing that, while the program size is important for the lending decision, it is not significantly correlated with the degree of liquidity transformation. Columns 5 and 6 report the results including bond–insurer fixed effects, which absorb the time-invariant association of insurers with particular bonds. Columns 7 and 8 include the ratio of insurer j's holding of bond i to all insurers' total holdings of bond i interacted with year dummies. While the overall share of an insurer's holding is positively correlated with the lending decision, the share of holding is not correlated with the degree of liquidity transformation. In all cases, we obtain estimated correlations between the decision to lend bonds and the degree of liquidity transformation that are broadly similar to our baseline result.

A further concern relating to the size of individual life insurers, beyond the potential confounding demand factors, is that the result is being driven solely by the largest insurers. To address this concern we excluded in columns 9 and 10 the six largest securities lenders in our sample of life insurers (MetLife, Midland National Life, Aegon, Wellpoint, Lifetime Healthcare and Primerica). Although the sample drops by about one-third, the association between the probability that a bond is loaned and the degree of liquidity transformation on a life insurer's securities lending program remains the same.

Finally, our instrumental variable may be picking up persistence in borrower demand, instead of actual variation in the degree of liquidity transformation. As a placebo test of the validity of our instrument, in Columns 11 and 12 we replace $\Delta \mathit{Unrealized\ gain}_{jt}$ with its lagged value ($\Delta \mathit{Unrealized\ gain}_{jt-1}$). Neither the first- nor second-stage results are significant, reassuring us of the relevance of our instrumental variable.

4 Discussion

As mentioned in the introduction, securities lenders that engage in liquidity transformation create a vulnerability for securities markets. In response to concerns about the liquidity and credit quality of cash reinvestment portfolios, securities borrowers may run on securities lenders by calling their cash collateral. Such a run could affect securities markets in two ways. First, to meet the demand to return cash, securities lenders will likely draw on their short-term investments, that is, the portion of cash collateral that was reinvested in short-term funding markets. Following the theory of Brunnermeier & Pedersen (2009), the associated collapse in funding liquidity would adversely affect the functioning of the securities market. Second, the same concern about securities lenders' cash reinvestment portfolios may lead securities borrowers—e.g. broker–dealers—to return the borrowed securities, thus reducing their market making activity. In both cases, the underlying vulnerability to runs stems from liquidity transformation of securities lending programs.

Our findings highlight the importance of fully understanding the mechanisms through which vulnerabilities in certain locations within the financial system may impact the broader system when, for example, designing financial regulatory policy. To be sure, securities lending may play an important and efficient role within the financial system. But, as the 2008-09 financial crisis amply demonstrated, it behooves regulators to be fully aware of any vulnerabilities associated with financial market activity. Our evidence is based on data from the period after the implementation of sweeping macro- and microprudential reforms that followed the 2008-09 financial crisis, yet nonetheless demonstrates the vulnerabilities posed by securities lenders to securities market functioning.

One possible reason that life insurers continue to engage in liquidity transformation is the persistent low interest rate environment. Low returns to institutional investors' portfolios deriving from a long period of low interest rates increase their incentive to raise the return on assets by levering up and investing in higher yielding asset through their securities lending program.[27] This incentive extends to pension funds, where only limited data on securities lending are available. Although some funds report aggregate level information on their portfolio holdings and lending programs, crucial data are missing on their individual security loan decisions and their cash reinvestment strategies.

In light of these vulnerabilities, measures such as the degree of liquidity transformation in

[27] Regulatory arbitrage as a source of reach for yield has already been documented in the U.S. life insurance industry through the deliberate portfolio selection of more risky corporate bonds within a rating class (Becker & Ivashina 2015), the use of captive reinsurers to lower regulatory capital charges (Koijen & Yogo 2016), and the issuance of institutional funding agreements (Foley-Fisher et al. 2015).

securities lending programs and the extent to which securities lenders provide tri-party repo funding are important financial stability metrics. Careful monitoring of securities lenders' programs is especially important for the functioning of corporate bond markets, where financial stability concerns are greatest. Although these measures are available to some extent in the regulatory filings of U.S. life insurers, they are not widely available for all securities lenders.[28]

Finally, the parameter estimates reported in Section 3.3 suggest there would be only a small reduction in securities lending if something akin to the current regulatory limits on MMF cash reinvestment were also placed on the securities lending programs of U.S. life insurance companies. Table 1 shows that life insurers in our post-crisis sample have on average about 17 percent of their cash collateral portfolio reinvested in assets with a residual maturity of at least one year. A regulation similar to the one faced by MMFs (Rule 2a-7) would remove these assets entirely from the reinvestment portfolio.[29] Using the coefficient estimate from Table 4 of the effect of $Transformation_{jt}$ on the probability of lending (0.4), elimination of the active lending channel would reduce lending by 0.4×0.17, which is about 7 percent. Figure 9 shows that life insurers' lending against cash collateral amounts to about \$55 billion, indicating a potential decline in the market of $0.07 \times$\$55 billion, or less than \$4 billion. This crude calculation suggests that regulation equivalent to Rule 2a-7 on cash collateral reinvestment by life insurers could enhance financial stability with only minor consequences for bond market functioning.

5 Conclusion

This paper brings together new micro-level data on all aspects of the life insurers' securities lending programs and offers the first empirical evidence that certain financial institutions use securities lending as a source of wholesale funding. That is, some firms raise and maintain a level of cash collateral by lending bonds and investing the proceeds in longer-term higher-yielding securities. The evidence of a supply channel of securities lending stands in contrast to the widespread prevailing perception in the literature that securities lenders passively respond to borrower demands and reinvest their cash collateral in short-term funding markets. While our data do not cover the 2008-09 financial crisis, our evidence of the use of securities lending cash collateral as a source of wholesale funding offer a plausible explanation for the collapse in short-term funding in 2008-2009.

[28] Measures of maturity mismatch and repo funding associated with securities lending programs would augment the data collection proposed by Adrian, Begalle, Copeland & Martin (2012). Koijen & Yogo (2015) note that life insurers' statutory filings lack details on the international dimensions of life insurers' securities lending programs.

[29] In addition to restricting the weighted average maturity of the reinvestment portfolio to less than 60 days, Rule 2a-7 specifies that mutual funds can only invest in non-MMF eligible securities with an exception from the SEC. MMF eligible securities must have a residual maturity of less than 397 days.

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6 Tables

Table 1: Summary statistics. Columns 1 through 4 report the number of observations, mean, median, and standard deviation of variables used in our analysis from the annual Statutory filings of insurance companies. Securities lending programs are scaled by the size of the general account. Liquidity transformation is the fraction of the cash reinvestment portfolio that has a residual maturity of at least one year minus the fraction of cash collateral that has a residual maturity of more than one year. The change in unrealized gains/losses are scaled by the size of the general account. Columns 5 through 8 show statistics after merging the Statutory filings with Mergent FISD, adding information on bond characteristics. We numerically translate and average credit ratings across the three main agencies, setting AAA, or equivalent = 28, AA+ = 26, AA = 25, AA- = 24 ... CCC- = 9, CC = 7, and C = 4. Columns 9 through 12 provide statistics after subsequently merging with Markit Securities Finance data on the securities lending market. Weighted averages are calculated using the value of the loan.

	NAIC Annual Statements				Merge with FISD				Merge with Markit			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Obs.	Mean	Med.	St. Dv.	Obs.	Mean	Med.	St. Dv.	Obs.	Mean	Med.	St. Dv.
Life insurance companies	107	.	.	.	107	.	.	.	107	.	.	.
General account value ($bn)	311	22.31	4.96	43.75	311	22.31	4.96	43.75	311	22.31	4.96	43.75
Securities lending ($SL\ program\ size_{jt}$)	299	.02	.01	.03	299	.02	.01	.03	299	.02	.01	.03
Liquidity transformation ($Tranformation_{jt}$)	237	.17	0	.28	237	.17	0	.28	237	.17	0	.28
Δ unrealized gains/loss (bps) ($\Delta Unrealized\ gain_{jt}$)	311	-.04	0	.45	311	-.04	0	.45	311	-.04	0	.45
Par value of bond holding ($m)	549,693	9.36	4	27.58	249,483	10.03	5	22.76	192,272	10.28	5	25.22
Dummy variable for lent security ($Loan_{ijt}$)	549,693	.03	0	.16	249,483	.05	0	.23	192,272	.07	0	.25
Offering amount ($bn)	.	.	.	.	249,483	.94	1	4.6	186,852	1.14	1	2.81
Offering yield (percent)	.	.	.	.	204,568	5.79	6	2.38	152,168	5.59	6	2.48
Residual maturity (yrs)	.	.	.	.	248,284	11.19	8	9.59	185,988	11.3	8	9.34
Amount outstanding ($bn)	.	.	.	.	131,144	.93	1	3.02	95,419	1.19	1	3.43
Credit rating	.	.	.	.	239,673	19.87	20	3.04	180,086	19.8	20	3.08
Weighted avg rebate ($Rebate_{it}$)	.	.	.	.	.	.	.	.	192,272	0	0	.07
% total lendable held ($Market\ share_{ijt}$)	.	.	.	.	.	.	.	.	192,272	.03	0	.16
HHI of life insurers' holdings (HHI_{it})	.	.	.	.	.	.	.	.	192,272	.37	0	7.85
Total lent/total lendable ($Market\ tightness_{it}$)	.	.	.	.	.	.	.	.	192,272	.14	0	.43

Table 2: Summary statistics of lent and non-lent bonds. Using the final merged dataset, the two panels compare characteristics of bonds lent by insurance companies with those that are not lent.

	Non-lent securities: $Loan_{ijt} = 0$				Lent securities: $Loan_{ijt} = 1$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Obs.	Mean	Median	Std. Dev.	Obs.	Mean	Median	Std. Dev.
Par value of bond holding ($m)	179,152	10.06	5.01	24.42	13,120	13.45	5.73	34.2
Offering amount ($m)	173,952	1,061.5	600	2,663.5	12,900	1,482.6	744.3	3,994.9
Offering yield (percent)	141,992	5.58	5.67	2.45	10,176	5.55	5.6	2.61
Residual maturity (yrs)	173,214	11.25	8	9.32	12,774	12.04	8	9.62
Amount outstanding ($m)	89,022	1,129.9	600	3,229.4	6,397	1,575.5	687.5	5,276.4
Credit rating	167,607	19.82	20	3.04	12,479	19.61	20	3.55
Avg weighted rebate ($Rebate_{it}$)	179,152	.01	0	.08	13,120	-.02	0	.12
% total lendable held ($Market\ share_{ijt}$)	179,152	.09	.04	.14	13,120	.09	.05	.13
HHI of total lendable held (HHI_{it})	179,152	.47	.15	7.79	13,120	.48	.12	8.52
Market tightness ($Market\ tightness_{it}$)	179,152	.24	.13	.36	13,120	.3	.21	.39

Table 3: Endogeneity challenge stemming from unobservable bond demand. In columns 1 and 2, the dependent variable ($Loan_{ijt}$) takes a value of 1 if insurer j is lending bond i at time t and 0 otherwise. Column 1 reports a regression of $Loan_{ijt}$ on the transaction-weighted average rebate ($Weighted\ Rebate_{it}$), the insurer's holding as a share of the amount available to borrow ($Market\ share_{ijt}$), and our measure of liquidity transformation in the insurer's securities lending program ($Transformation_{jt}$). Column 2 adds controls for the concentration of life insurers' holdings (HHI_{it}), the amount available to borrow relative to the amount outstanding ($Market\ tightness_{it}$), residual maturity, amount outstanding, rating, offering yield, and amount issued. Column 3 reports a regression of $Weighted\ Rebate_{it}$ on $Market\ share_{ijt}$ and $Transformation_{jt}$. Column 4 adds the same set of controls as in Column 2. All the regressions include fixed effects for insurer, year, and bond issuer; and specify Huber-White standard errors. *** p<0.01; ** p<0.05; * p<0.1.

	(1)	(2)	(3)	(4)
Dependent variable:	$Loan_{ijt}$	$Loan_{ijt}$	$Weighted\ Rebate_{it}$	$Weighted\ Rebate_{it}$
$Transformation_{jt}$	0.204***	0.175***	-0.00224	-0.00189
	(0.0126)	(0.0204)	(0.00219)	(0.00324)
$Market\ share_{ijt}$	0.0563***	0.0689***	-0.0222***	-0.00722**
	(0.00609)	(0.0104)	(0.00201)	(0.00308)
$Weighted\ Rebate_{it}$	-0.275***	-0.272***		
	(0.0167)	(0.0283)		
HHI_{it}		-0.0160***		-0.00744***
		(0.00415)		(0.00106)
$Market\ tightness_{it}$		0.0398***		0.00386***
		(0.00434)		(0.000816)
$Residual\ maturity_{it}$		0.000801***		0.000262***
		(0.000152)		(2.82e-05)
$Amount\ outstanding_{it}$		0.0143***		0.00569***
		(0.00419)		(0.00122)
$Rating_{it}$		-0.00543**		0.00482***
		(0.00231)		(0.000701)
$Offering\ yield_i$		-0.00301***		0.000752***
		(0.00106)		(0.000189)
$Offering\ amount_i$		-0.00816*		-0.00251**
		(0.00450)		(0.00122)
Fixed effects:				
Insurer, year, issuer	Y	Y	Y	Y
Observations	154,612	58,122	150,621	56,655
R-squared	0.149	0.163	0.532	0.587

Table 4: The supply channel of securities lending. The dependent variable ($Loan_{ijt}$) takes a value of 1 if insurer j is lending bond i at time t and 0 otherwise. The main explanatory variable ($Transformation_{jt}$) is the fraction of cash collateral reinvestment that has a residual maturity of more than one year minus the fraction of cash collateral that has a residual maturity of more than one year. Columns 1, 2 and 3 report reduced form correlations including insurer, bond, year, and bond–year fixed effects. Columns 4 and 5 contain the first and second stages, respectively, of a two-stage least squares estimation. The instrumental variable ($\Delta\, Unrealized\ gain_{jt}$) is the unrealized gain/loss made by insurer j on its bond portfolio. Columns 1 and 2 report Huber-White heteroskedasticity consistent standard errors. Columns 3, 4 and 5 report errors two-way clustered by insurer and bond (87 insurer clusters and 31,382 bond clusters). The sources for the data used in the analysis are described in Section 2 of the main text. *** p<0.01; ** p<0.05; * p<0.1.

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	Reduced	Reduced	Reduced	Instrum.	variable
$Loan_{ijt}$	form	form	form	Stage 1	Stage 2
$Transformation_{jt}$	0.071***	0.121***	0.121***		0.400***
	(0.004)	(0.007)	(0.046)		(0.148)
$\Delta\, Unrealized\ gain_{jt}$				-0.033**	
				(0.015)	
Fixed effects:					
Insurer	Y	Y	Y	Y	Y
Bond	N	Y	Y	Y	Y
Year	N	Y	Y	Y	Y
Bond× Year	N	Y	Y	Y	Y
Observations	462,433	343,465	343,465	343,465	343,465
R-squared	0.036	0.287	0.287	0.963	0.281

Table 5: Robustness tests. The dependent and main explanatory variables are the same as in Table 4. Each pair of columns reports the first and second stages, respectively, of a variation to the baseline 2SLS IV presented in Table 4. All columns except columns 1 and 2 report errors two-way clustered by insurer and bond; in the first two columns the errors are two-way clustered by insurer-year and bond. Columns 3 and 4 include the size of the insurer's securities lending program. Columns 5 and 6 include CUSIP–Insurer fixed effects. Columns 7 and 8 include the ratio of an insurer's bond i holding to insurers' total i holdings interacted with year dummies. Columns 9 and 10 exclude the top six securities lenders (MetLife, Midland National Life, Aegon, Wellpoint, Lifetime Healthcare and Primerica). And columns 11 and 12 replace the instrumental variable with its lagged value. The sources for the data are described in Section 2 of the main text. *** p<0.01; ** p<0.05; * p<0.1.

Dependent variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$Loan_{ijt}$	Stage 1	Stage 2	Stage 1	Stage 2	Stage 1	Stage 2	Stage 1	Stage 2	Stage 1	Stage 2	Stage 1	Stage 2
$Transformation_{jt}$		0.400***		0.596**		0.394**		0.403***		0.359***		-0.184
		(0.122)		(0.247)		(0.175)		(0.149)		(0.124)		(1.060)
$\Delta\,Unrealized\ gain_{jt}$	-0.0329***		-0.0321*		-0.0313**		-0.0326**		-0.0447**			
	(0.0112)		(0.0165)		(0.0151)		(0.0153)		(0.0183)			
$Share\ of\ holdings_{ijt}$							-0.0197	0.0277**				
							(0.0178)	(0.0123)				
$2012\ share\ of\ holdings_{ijt}$							0.0103	-0.0165				
							(0.0230)	(0.0178)				
$2013\ share\ of\ holdings_{ijt}$							0.0444	-0.0143				
							(0.0358)	(0.0167)				
$\Delta SL\ program\ size_{jt}$			-0.232	1.929***								
			(0.648)	(0.543)								
$\Delta\,Unrealized\ gain_{jt-1}$											0.00195	
											(0.00351)	
Observations	343,465	343,465	343,465	343,465	293,944	293,944	343,274	343,274	290,114	290,114	343,465	343,465
R-squared	0.963	0.281	0.963	0.272	0.962	0.626	0.963	0.281	0.909	0.296	0.962	0.280
Fixed effects:												
Insurer, year, bond	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
bond× *Year*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
bond× *Insurer*	N	N	N	N	Y	Y	N	N	N	N	N	N

7 Figures

Figure 1: A stylized map of securities lenders' role in the shadow banking system. Broker-dealers obtain cash from money market mutual funds and securities lenders through short-term funding markets. The dealers provide the cash to securities market participants. The cloud represents the general functioning of securities markets, illustrated with the example of hedge funds taking long and short positions. Securities market participants borrow both cash funding and securities. Securities lenders decide whether to lend assets from their portfolios in exchange for collateral in the form of either cash or other securities, from broker-dealers. When they receive cash collateral, securities lenders decide whether to invest back into short-term markets or into long-term markets. In the latter case, they may invest, for example, in long-term corporate bonds or asset-backed securities.

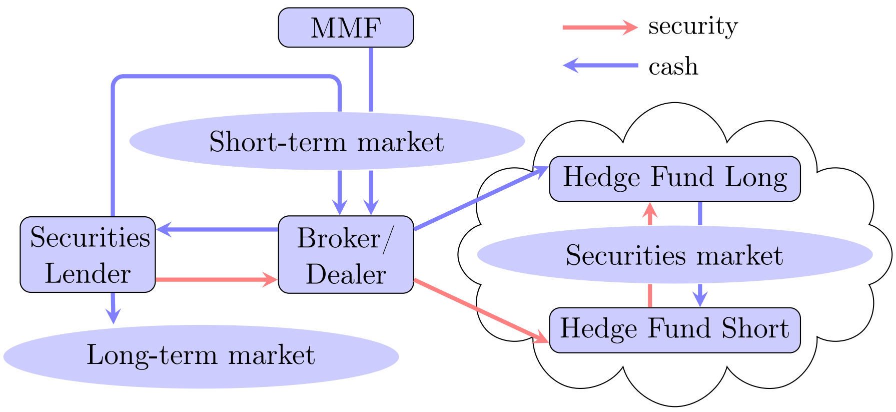
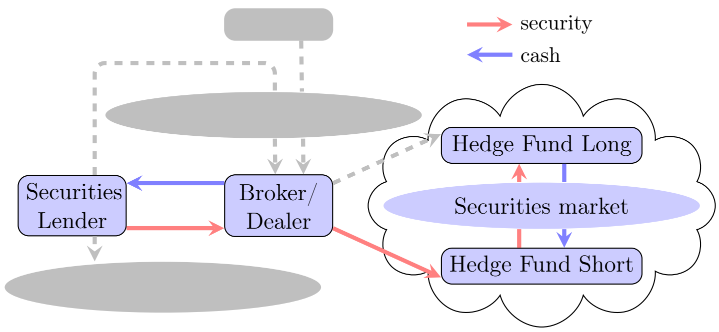
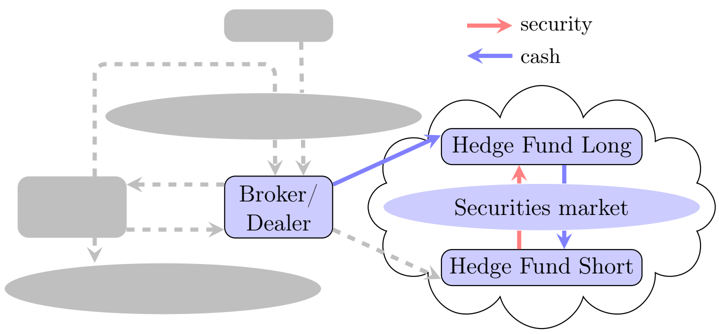


Figure 2: Coverage of the stylized map of securities lending by the existing literature. Duffie et al. (2002) (Panel (a)) study the effect of interactions between securities lenders and broker-dealers on pricing in the securities market. Brunnermeier & Pedersen (2009) and Gorton & Metrick (2012) (Panel (b)) consider the effect of haircuts on cash funding and the functioning of securities markets. Krishnamurthy et al. (2014) (Panel (c)) describe how securities lenders and MMFs participate in short-term funding markets. The overall map is described in the notes to Figure 1.

(a) Duffie, Gârleanu & Pedersen (2002)



(b) Brunnermeier & Pedersen (2009), Gorton & Metrick (2012)



(c) Krishnamurthy, Nagel & Orlov (2014)

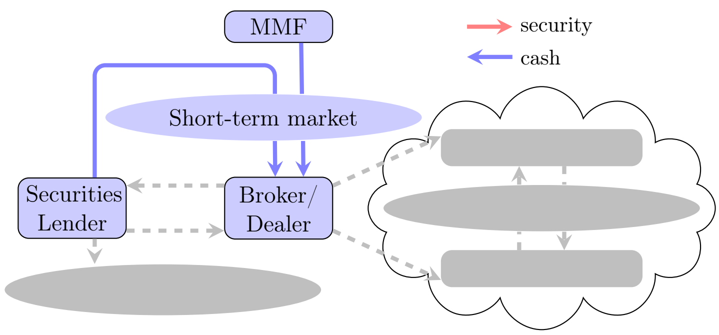
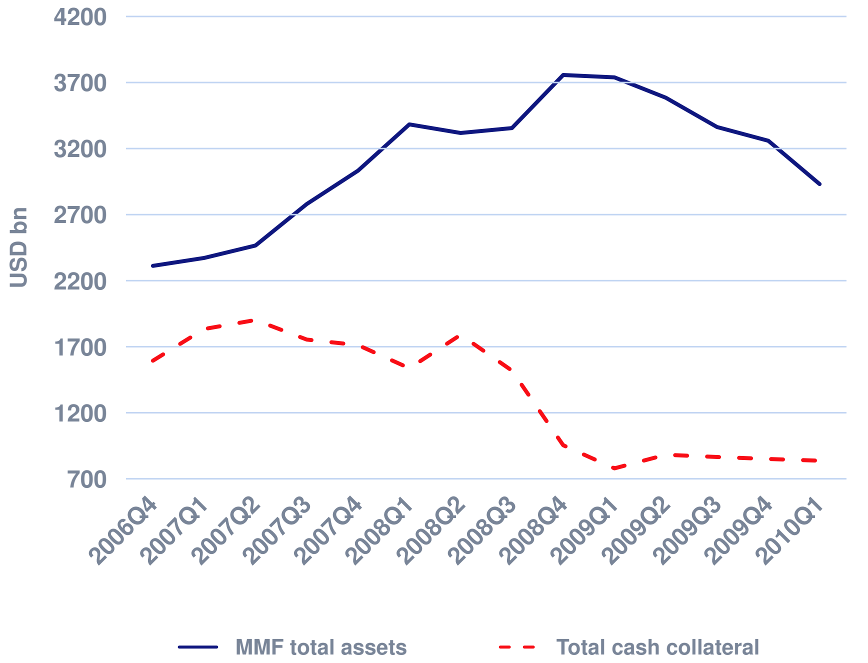


Figure 3: Securities lenders' and MMFs' tri-party repo market funding. Panel (a) shows the total resources potentially available to securities lenders and MMFs for lending. Panel (b) shows the amount of funding that securities lenders and MMFs provided through the tri-party repo market. Source: Krishnamurthy, Nagel & Orlov (2014), based on data from Risk Management Associates.

(a) Total resources available to lend



(b) Tri-party repo funding

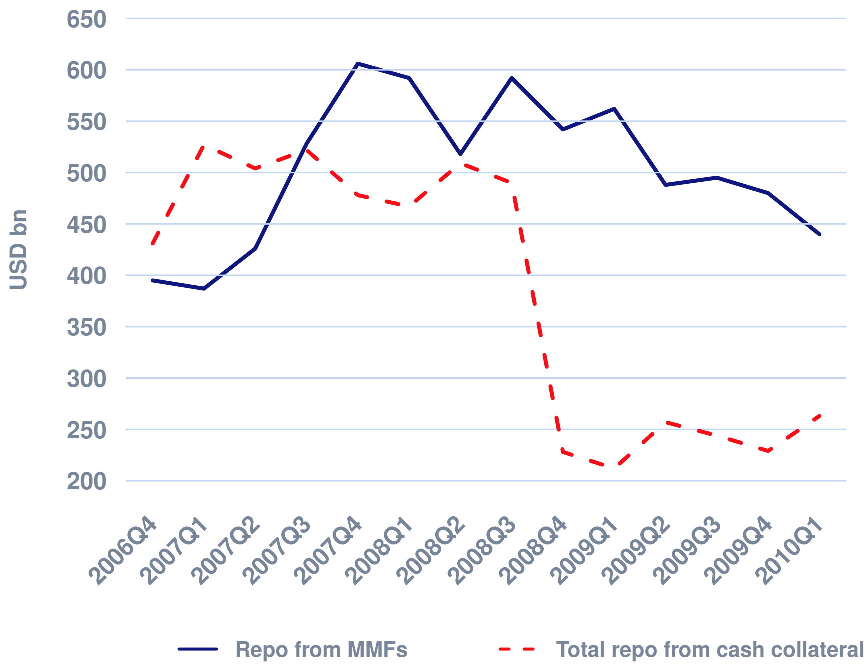


Figure 4: Extract from Schedule DL. The exhibit below is an extract from the 2012 regulatory filing by the Metropolitan Life Insurance Company, showing a sample of the individual security-level investments made using cash collateral received from securities lending.

Annual Statement for the year 2012 of the **METROPOLITAN LIFE INSURANCE COMPANY**

SCHEDULE DL - PART 2
SECURITIES LENDING COLLATERAL ASSETS

Reinvested Collateral Assets Owned December 31 Current Year

1 CUSIP Identification	2 Description	3 Code	4 NAIC Designation /Market Indicator	5 Fair Value	6 Book/Adjusted Carrying Value	7 Maturity Dates
980888 AC 5	WOOLWORTHS LIMITED 2.55% 9/22/2015		1FE	3,116,130	2,998,032	09/22/2015
983024 AE 0	WYETH 5.5% 2/1/14		1FE	1,539,161	1,484,005	02/01/2014
98372P AF 5	XL CAPITAL LTD 5.25% 9/15/2014 5 1/4% DU		2FE	9,051,140	8,988,388	09/15/2014
98389B AK 6	XCEL ENERGY INC 5.613% 04/01/2017		2FE	9,360,160	7,991,468	04/01/2017
984121 BP 7	XEROX CORPORATION 6.4% 3/15/2016		2FE	8,451,525	7,576,334	03/15/2016
984121 BV 4	XEROX CORPORATION 5.65% 5/15/2013		2FE	22,947,696	22,899,734	05/15/2013
984121 CE 1	XEROX CORPORATION 0% 9/13/2013		2FE	10,065,600	10,000,000	09/13/2013
98417E AD 2	XSTRATA CANADA FIN CORP 2.85% 11/10/2014		2FE	35,924,000	34,979,296	11/10/2014
98417E AG 5	XSTRATA CANADA FIN CORP 3.6% 1/15/2017		2FE	18,695,862	18,406,346	01/15/2017
98419M AA 8	XYLEM INC 3.55% 9/20/2016		2FE	11,718,630	11,495,002	09/20/2016
C5341@ AA 0	MAPLE LEAF SPORTS		2FE	11,458,047	11,215,347	06/30/2013
D5472# AD 2	MOLKEREI ALOIS MULLER GMBH AND CO KG 2.7		2	21,029,925	20,500,000	07/17/2017
F5849@ AA 4	PICARD B1/LION POLARIS S.A.S.		5*	980,514	975,148	09/14/2017
F5849@ AB 2	PICARD B2/LION POLARIS S.A.S.		5*	4,579,008	4,553,740	09/14/2017
F9731# AB 3	VICAT SA 10 YR SR NT		2	8,630,815	8,599,539	08/05/2013
F9731# AC 1	VICAT SA 5.660% 08/05/15		2	5,369,300	5,180,112	08/05/2015
G0369@ AR 7	ANGLIAN WATER SERVICES FINANCING PLC 4.1		2Z	27,069,665	25,856,973	10/10/2017
G1696# AJ 5	BUNZL PLC 4.620% 04/17/13		2	40,312,400	40,000,000	04/17/2013
G3970* AB 9	GOLDMAN SACHS VINTAGE FUND IV LP BL 2.51		1Z	12,782,470	12,782,470	12/15/2014
G4133# AA 9	GROSVENOR GROUP HOLDINGS LTD 8.375% 02/1		1	46,733,529	45,720,815	02/15/2019
G4803# AA 8	INFORMA GROUP HOLDINGS LTD 3.430% 12/15/		2	48,725,370	47,000,000	12/15/2015
G5350# AA 2	LAIRD GROUP PLC 5.590% 10/29/14		2	12,776,760	12,122,084	10/29/2014
G6164# AA 6	MITIE TREASURY MANAGEMENT LTD 3.390% 12/		2	10,555,500	10,000,000	12/16/2017
G7815@ AA 9	SAP IRELAND US FINANCIAL SERVICES LTD CB		1	20,425,000	20,000,000	10/14/2015
G7866# AB 3	SAGE GROUP PLC 4.390% 03/11/15		2	52,821,500	50,000,000	03/11/2015
G8038# AD 0	SERCO GROUP PLC 3.620% 05/09/16		2	15,814,350	15,457,678	05/09/2016
G8252@ AJ 8	SMURFIT KAPPA TL B4A (2016)		3	127,342	127,107	06/30/2016
G8252@ AK 5	SMURFIT KAPPA TL B4B (2016)		3	280,762	280,245	06/30/2016
G8252@ AL 3	SMURFIT KAPPA TL B4C (2016)		3	2,737,796	2,732,751	06/30/2016
G8252@ AM 1	SMURFIT KAPPA TL C4A (2017)		3	127,823	127,594	03/31/2017
G8252@ AN 9	SMURFIT KAPPA TL C4B (2017)		3	281,553	281,047	03/31/2017
G8252@ AP 4	SMURFIT KAPPA TL C4C (2017)		3	2,715,091	2,710,222	03/31/2017
G9284# AV 9	VITOL FINANCE LTD 4.210% 07/28/16		2	16,398,535	15,500,000	07/28/2016
K7260# AD 6	ISS HOLDING/FS FUNDING (2013) GBP TRANCH		4	9,417,570	9,536,780	04/30/2015
N7334# AA 1	WERELDHAVE NV 4.210% 03/22/16		2	23,297,780	22,000,000	03/22/2016
N7660# AK 3	SHV NETHERLANDS NV 3.330% 03/28/17		2FE	52,536,000	50,000,000	03/28/2017
Q0455# AG 3	APT PIPELINES LIMITED 7.380% 05/15/17		2	24,853,471	22,519,341	05/15/2017
Q0455# AJ 7	APT PIPELINES LIMITED 7.400% 05/15/19		2	10,745,876	9,651,146	05/15/2019
Q2594# AE 6	COCA-COLA AMATIL LTD FRN 07/28/15		1	20,507,060	20,764,120	07/28/2015
Q2594# AK 2	COCA-COLA AMATIL LTD FRN 06/27/16		1	26,823,825	27,299,658	06/27/2016
Q5516* AA 6	LEIGHTON FINANCE (USA) PTY. LTD 4.510% 0		2	21,276,800	20,000,000	07/21/2015
Q9103# AA 3	TOLL HOLDINGS LTD 2.950% 12/07/15		2	10,161,000	10,000,000	12/07/2015
999999 99 8	Summary Adjustment		2Z	(71,182)	(71,182)	12/01/2015
3299999. Industrial & Miscellaneous (Unaffiliated) - Issuer Obligations				5,198,602,781	5,086,818,777	XXX
Industrial & Miscellaneous (Unaffiliated) - Residential Mortgage-Backed Securities						
02150E AW 3	CWALT 2007-5CB 1A21		5FM	15,142,700	22,719,730	04/25/2037
02151E AC 6	CWALT 2007-23CB A3		1FM	11,867,514	11,867,514	09/25/2037
02151H AF 2	CWALT 2007-17CB 1A6		4FM	22,299,384	29,152,832	08/25/2037
03072S GQ 2	AMSI 2003-6 M2		1FM	882,937	929,133	05/25/2033
040104 RV 5	ARSI 2006-W2 A2B		3FM	3,772,029	5,881,667	03/25/2036
041239 CD 4	ARKLE 2010-2A 1A1		1FE	16,855,506	16,774,554	05/17/2060
041239 CP 7	ARKLE 2012-1A 2A1		1FE	75,147,000	74,000,000	05/17/2060
04542B LY 6	ABFC 2005-WF1 M1		1FM	9,273,214	12,547,139	11/25/2034
05948K 4E 6	BOAA 2006-3 2CB1		4FM	20,346,847	21,441,436	04/25/2036
12637H AP 3	CSMC 2006-4 2A1		4FM	27,031,345	27,031,345	05/25/2036
12637H AZ 1	CSMC 2006-4 10A1		5FM	9,130,157	12,397,944	05/25/2036
126671 XU 5	CWL 2003-1 M2		1FM	239,914	239,914	02/25/2033
126671 YD 2	CWL 2003-BC2 M2		1FM	67,523	0	02/25/2033
12668B SQ 7	CWALT 2006-6CB 2A10		5FM	40,625,653	49,048,020	05/25/2036
126694 D2 1	CWHL 2006-HYB2 2A1B		4FM	22,874,356	31,283,608	04/20/2036
161546 JP 2	CFAB 2004-2 2M1		1FM	759,371	1,231,703	02/25/2035
16163E AJ 7	CHASE 2007-S2 1A9		4FM	45,223,661	46,570,086	03/25/2037
199990 AA 0	COMMUNITY PRESERVATION CORP		1	20,812	20,812	04/01/2027
225470 DV 2	CSFB 2005-10 2A1		1FM	9,753,979	9,419,133	11/25/2020
225470 EA 7	CSFB 2005-10 4A1		5FM	9,272,462	12,345,087	11/25/2035
251510 DF 7	DBALT 2005-1 1A3		2FM	34,740,454	41,826,237	02/25/2035
32051G J7 1	FHASI 2005-AR6 3A1		3FM	5,232,711	5,465,545	01/25/2036
32052K AB 1	FHASI 2006-AR2 2A1		3FM	10,597,518	12,564,681	07/25/2036
32052U AG 8	FHASI 2006-4 1A7		3FM	5,981,272	6,084,462	02/25/2037
34988W AF 1	FOSSM 2011-1A A2		1FE	27,404,886	27,051,078	10/18/2054
34988W AL 8	FOSSM 2012-1A 2A2		1FE	7,152,600	7,001,697	10/18/2054
34988W AQ 7	FOSSM 2012-1A 3A1		1FE	51,765,000	50,000,000	10/18/2054
36157R HU 2	GECMS 1998-HE2 A6		2FM	1,310,053	1,272,094	09/25/2028
36242D NU 3	GSAMP 2004-OPT M1		2FM	1,695,640	2,000,000	11/25/2034
36242D QX 4	GSR 2004-15F 2A1		2FM	12,489,578	11,852,281	12/25/2034
404225 AD 6	HSART 2012-T2 A1		1FE	4,266,150	4,249,793	10/15/2043
404225 AE 4	HSART 2012-T2 A2		1FE	10,143,800	9,999,535	10/15/2045
404225 AF 1	HSART 2012-T2 B1		1FE	3,513,300	3,499,900	10/15/2043

Figure 5: Extract from Note 5(e) to the Financial Statements. The exhibit below is an extract from the 2012 regulatory filing by the Metropolitan Life Insurance Company, showing a breakdown by maturity of the cash collateral received from securities lending.

NOTES TO THE FINANCIAL STATEMENTS

(5) The Company performs a regular evaluation, on a security-by-security basis, of its securities holdings in accordance with its OTTI policy in order to evaluate whether such investments are other-than temporarily impaired. Management considers a wide range of factors about the security issuer and uses its best judgment in evaluating the cause of the decline in the estimated fair value of the security and in assessing the prospects for near-term recovery. Factors considered include fundamentals of the industry and geographic area in which the security issuer operates, as well as overall macroeconomic conditions. Projected future cash flows are estimated using assumptions derived from management's best estimates of likely scenario-based outcomes after giving consideration to a variety of variables including, but are not limited to: (i) general payment terms of the security; (ii) the likelihood that the issuer can service the scheduled interest and principal payments; (iii) the quality and amount of any credit enhancements; (iv) the security's position within the capital structure of the issuer; (v) possible corporate restructurings or asset sales by the issuer; and (vi) changes to the rating of the security or the issuer by rating agencies. Additional considerations are made when assessing the unique features that apply to certain loan-backed and structured securities including, but are not limited to: (i) the quality of underlying collateral; (ii) expected prepayment speeds; (iii) current and forecasted loss severity; (iv) consideration of the payment terms of the underlying assets backing the security; and (v) the payment priority within the tranche structure of the security. For loan-backed or structured securities in an unrealized loss position as summarized in the immediately preceding table, the Company does not have the intent to sell the securities, believes it has the intent and ability to retain the security for a period of time sufficient to recover the carrying value of the security and, based on the cash flow modeling and other considerations as described above, believes these securities are not other than temporarily impaired.

E. Repurchase Agreements and/or Securities Lending Transactions

(1) For repurchase agreements, the Company requires a minimum of 100 percent of the fair value of securities purchased under repurchase agreements to be maintained as collateral. Cash collateral received is invested in short-term investments with an offsetting liability for collateral to be returned to the counterparty.

The Company participates in a securities lending program whereby blocks of securities, which are included in invested assets, are loaned to third parties, primarily major brokerage firms and commercial banks. Generally, the Company accepts collateral of 102 percent of the fair value of the loaned securities to be separately maintained as collateral for the loans. The Company is liable for the return of the cash collateral under its control to its counterparties.

(2) The Company pledged its assets at book/adjusted carrying value of $13,475 million as collateral as of December 31, 2012.

(3) Collateral received

The Company participates in a securities lending program as discussed in Note 17.

a. The aggregate amount of collateral received as of December 31, 2012, was as follows (in millions):

1. The Company did not have any cash collateral received from repurchase agreements.

2.

Securities Lending		Fair Value
Open[1]	$	3,638
30 days or less		10,291
31 to 60 days		3,116
61 to 90 days		1,396
Greater than 90 days		-
Sub-Total	$	18,441
Securities received		45
Total collateral received	$	18,486

[1] The related loaned security could be returned to the Company on the next business day requiring the Company to immediately return the cash collateral.

3. The Company did not have any cash collateral received from dollar repurchase agreements.

Securities with a cost or amortized cost of $15,652 million and an estimated fair value of $17,982 million were on loan under the Company's securities lending program at December 31, 2012.

b. As of December 31, 2012, the aggregate fair value of all securities acquired from the sale, trade or use of the accepted collateral (reinvested collateral) was (in millions): $ 18,496

c. The estimated fair value of the securities related to the cash collateral on open terms was $3,544 million at December 31, 2012, of which $3,417 million were U.S. Treasury and agency securities which, if put to the Company, can be sold to satisfy the cash requirements. The remainder of the securities on loan, related to the cash collateral aged les than thirty days to ninety days or greater, were primarily U.S. Treasury and agency securities and liquid RMBS. The reinvestment portfolio acquired with the cash collateral consisted principally of fixed maturity securities (including RMBS, ABS, U.S. corporate and foreign corporate securities).

Figure 6: Securities lending against cash collateral in the United States. These daily data aggregate the fair value of all securities lent against cash collateral in the United States, including equity, Treasuries, agency securities, and corporate bonds. The category of other lenders includes corporations, endowments, foundations, and government bodies. Source: authors' calculations based on data from Markit Securities Finance.

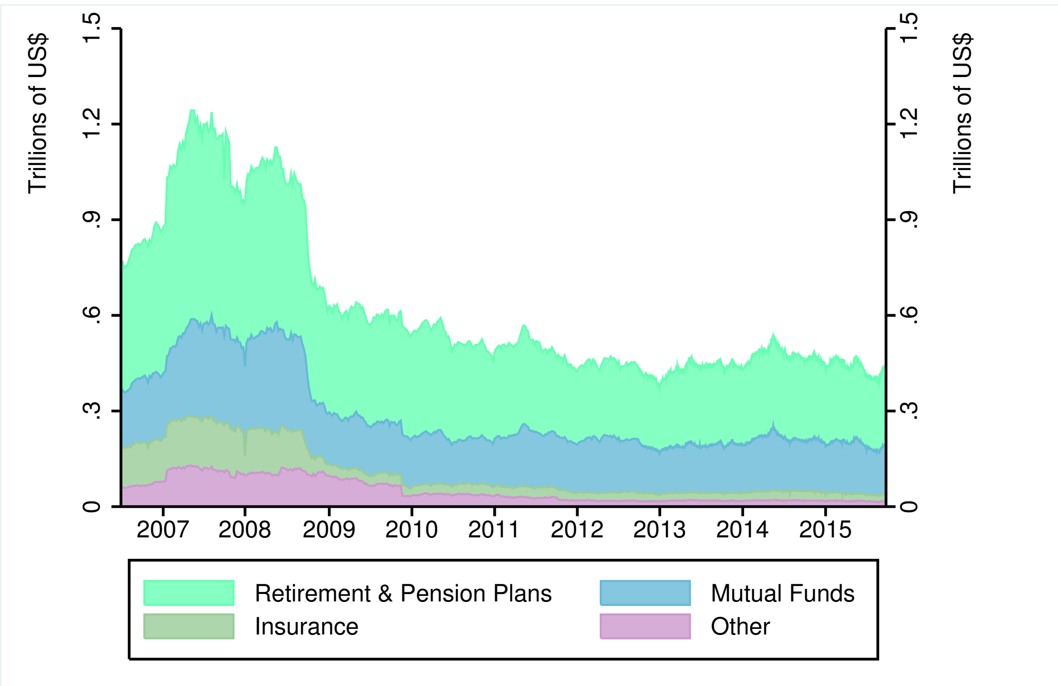


Figure 7: Corporate bond lending against cash collateral in the United States. These daily data aggregate the fair value of all corporate bonds lent against cash collateral in the United States. The category of other lenders includes corporations, endowments, foundations, and government bodies. Source: authors' calculations based on data from Markit Securities Finance.

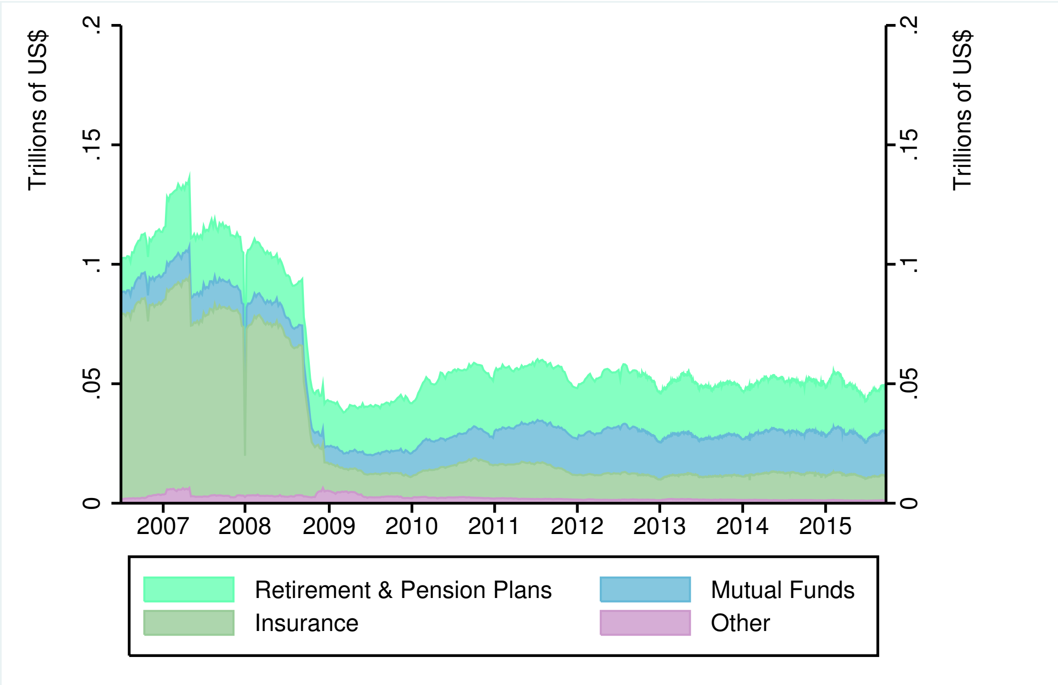


Figure 8: Securities lending cash collateral reinvestment. The blue shaded region shows the quarterly total amount of cash collateral received by securities lenders. The black and yellow lines, respectively, show the mean and median weighted average maturity of the reinvestment portfolio. Source: authors' calculations based on data from Risk Management Associates, from a survey of about 14 agent lenders.

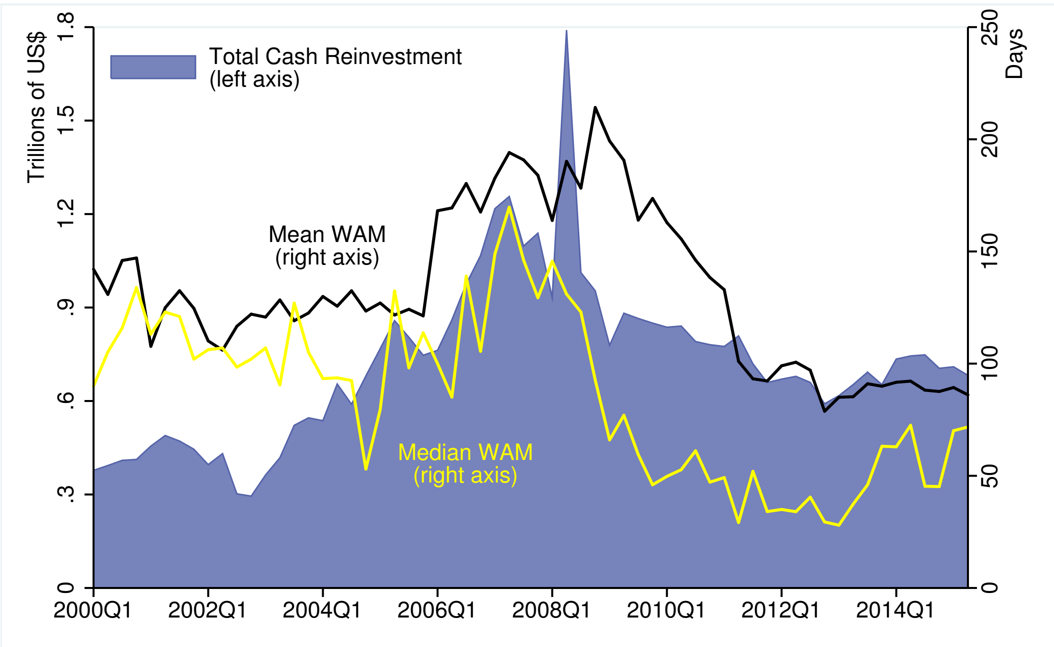


Figure 9: Securities lending by U.S. life insurers. The line shows the quarterly amount of cash collateral received by U.S. life insurers through their securities lending programs. Source: authors' calculations based on data from NAIC Quarterly Statutory Filings.

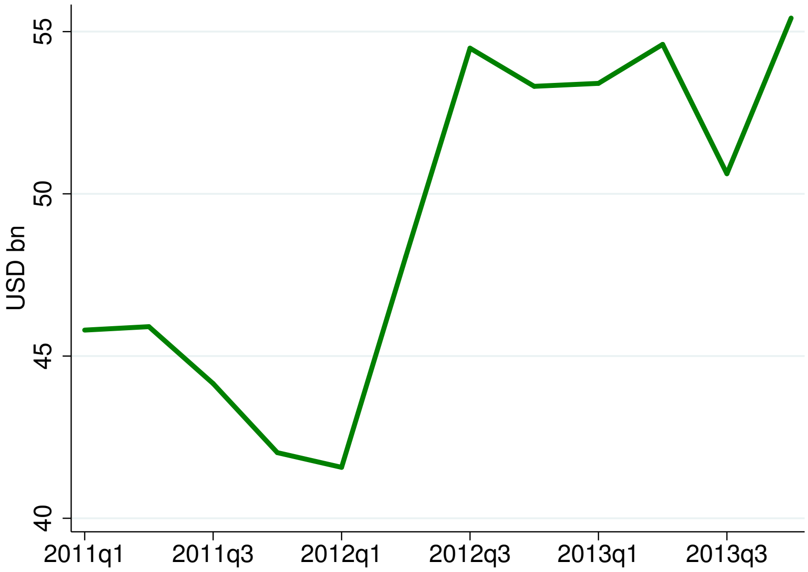
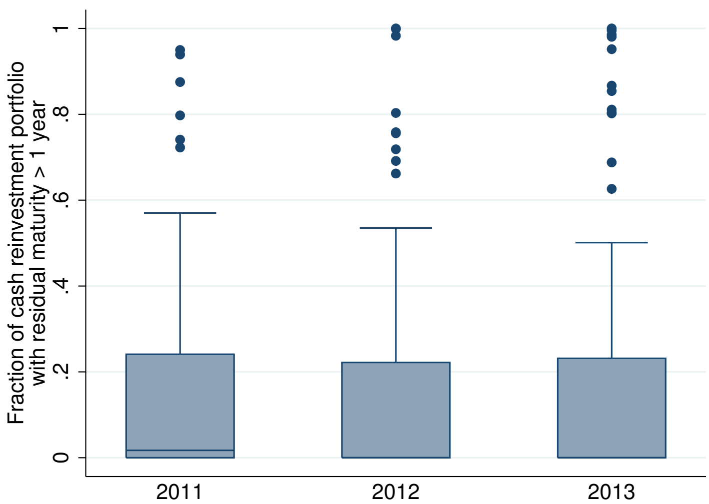


Figure 10: Variation in life insurers' liquidity transformation. We proxy for liquidity transformation using the fraction of each life insurer's cash reinvestment portfolio that has a residual maturity of more than one year minus the fraction of the cash collateral the insurer received that has a duration of more than one year. Each box-and-whisker plot shows the distribution of the 100 available U.S. life insurance companies, with the solid area covering the 25-th to 75-th percentiles and the line within the solid area showing the median of the distribution. The whiskers reflect the remaining observations, up to 1.5 times the interquartile range, and the dots are outliers. There is a considerable variation in the degree of liquidity transformation across life insurers, in some instances reinvesting almost all their cash collateral into securities with a residual maturity of more than one year. Source: authors' calculations based on NAIC Annual Statutory Filings.



A Appendix

A.1 Determinants of an insurer's overall cost of cash collateral

In this appendix, we analyze the determinants of life insurers' overall cost of funding and show that life insurers' can potentially affect their overall cost of obtaining cash collateral by lending bonds. Section 3.1 provided some evidence that using market equilibrium variables as a proxy for demand might result in inconsistent coefficient estimates because these variables could be correlated with potentially unobserved determinants of the lending decision. However, it could be that life insurers have the ability to affect the market equilibrium only for a small fraction of the bonds in their portfolio. For example, although an insurer might be able to influence the rebate rate on some of the bonds it holds, its ability to influence the rebate rate on other bonds could be more limited.

As a first step to assessing the ability of life insurers to affect their cost of raising cash collateral by lending their bonds, we need to aggregate and summarize the content of each insurer's bond portfolio. Aggregating to the level of the entire portfolio will result in few observations and low testing power. Instead, we rank each life insurer's bond portfolio according to the rebate of each bond and divide the portfolios according to rebate quantiles, which yields equal-sized groups of bonds that differ by the average rebate of the bonds in each group. Then, for each bond group within a quantile, we compute weighted-average analogues of the variables used to estimate Equation 2 in the main text. Throughout the analysis, each bond observation is weighted by its fair value divided by the total fair value of all bonds in the quantile. The unit of observation for this analysis is thus a rebate quantile q for bonds held by a life insurer j at the end of year t. With variables defined as before, the regression specification is:

$$Loan_{qjt} = \alpha_q^1 + \alpha_j^2 + \alpha_t^3 + \beta\, Transformation_{jt} + \delta Market\ share_{qjt} + \boldsymbol{Z}_{qjt}\boldsymbol{\gamma} + \epsilon_{qjt}\ . \quad (4)$$

Columns 1 and 4 of Table 6 summarize the regression results for 32 and 64 rebate groups, respectively. These specifications control for weighted average bond characteristics in each group, as well as insurer and year fixed effects. The coefficient estimates suggest there is a positive and robust association between the fraction of bonds on loan and the weighted average market share in those bonds, conditional on the weighted average rebate and concentration. Columns 2 and 3 perform the same test on the subsets of 32 rebate groups above and below the median rebate, respectively. The coefficient on $\textit{Market share}_{qjt}$ is broadly similar, with marginally weaker significance for rebate groups below the median rebate. Columns 5 and 6 repeat this test on the subsets of 64 rebate groups above and below the median rebate, respectively. Here, the coefficient on $\textit{Market share}_{qjt}$ is only significant for the sample of groups above the median, suggesting that the positive association between the loan and market share is likely to be more pronounced in the portion of the portfolio that has a higher average rebate. However, since a higher rebate tends to be associated with a higher probability of loaning a bond, increasing the number of quantiles mechanically reduces the fraction of loaned bonds in the lower group. As a result, any correlation between average loan and market share is likely to be weaker.

Taken together, these results suggest that the association between the fraction of bonds loaned and the weighted average market share is significant in a large portion of life insurers' bond portfolios–at least half of the bonds–and especially so in the portion of the portfolio above the median rebate rate. We interpret this result as suggesting that life insurers are likely to be able to influence their overall cost of funding via securities lending. This finding invalidates the potential strategy of aggregating market equilibrium variables over life insurers' portfolios to use as a exogenous proxy for the cost of raising cash collateral via securities lending.

Table 6: Relationship between fraction lent and weighted average market share in the portfolio. We divide life insurers' portfolios into groups according to rebate quantile. The dependent variable $Loan_{qjt}$ is the fraction of bonds in group q lent by insurer j at time t. The main explanatory variable ($Market\ share_{qjt}$) is the fair-value-weighted average holding of bonds in group q by insurer j relative to the total amount of the bonds made available to securities borrowers by all lenders. Columns 1 and 4 divide the porfolios into 32 and 64 groups, respectively, and include controls for various bond and market characteristics as well as insurer and year fixed effects. Columns 2 and 3 and Columns 5 and 6 divide the groups into those that are above and below the median, respectively. The sources for the data used in the analysis are described in Section 2. Huber–White robust standard errors are reported in parentheses. *** p<0.01; ** p<0.05; * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	All	32 parts	32 parts	All	64 parts	64 parts
$Loan_{qjt}$	perc.	> 50 perc.	≤ 50 perc.	perc.	> 50 perc.	≤ 50 perc.
$Transformation_{jt}$	0.0535**	0.0692*	0.0382	0.0527**	0.0663**	0.0388
	(0.0254)	(0.0363)	(0.0323)	(0.0214)	(0.0314)	(0.0269)
$Market\ share_{qjt}$	0.0836**	0.116*	0.0896	0.0585**	0.112**	0.0497
	(0.0411)	(0.0604)	(0.0580)	(0.0286)	(0.0450)	(0.0380)
$Rebate_{qt}$	-0.322***	-0.496***	-0.336***	-0.326***	-0.646***	-0.352***
	(0.0360)	(0.185)	(0.0406)	(0.0307)	(0.130)	(0.0336)
HHI_{qt}	-0.0622***	-0.0676***	-0.0537***	-0.0453***	-0.0375**	-0.0430***
	(0.0144)	(0.0232)	(0.0188)	(0.00968)	(0.0169)	(0.0114)
$Amt\ outst_{qt}$	0.00127	0.00270*	-0.00677	0.00253	0.00367**	-0.00245
	(0.00167)	(0.00164)	(0.00516)	(0.00156)	(0.00161)	(0.00416)
$Rating_{qt}$	0.0678	0.0574	0.0722	0.0362	0.0156	0.0349
	(0.0816)	(0.123)	(0.111)	(0.0613)	(0.0875)	(0.0849)
$Offering\ amt_{qt}$	0.006***	0.004***	0.016***	0.006***	0.005***	0.014***
	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)	(0.003)
$Offering\ yield_{qt}$	-0.261*	-0.00232	-0.449**	-0.335***	-0.184	-0.432***
	(0.149)	(0.229)	(0.195)	(0.0982)	(0.176)	(0.119)
$Residual\ mat_{qt}$	-0.198	0.103	-0.427	-0.0295	0.372*	-0.367**
	(0.191)	(0.266)	(0.270)	(0.132)	(0.199)	(0.171)
Fixed effects:						
Insurer, year	Y	Y	Y	Y	Y	Y
Observations	8,280	4,109	4,171	14,094	6,934	7,160
R-squared	0.318	0.352	0.338	0.269	0.296	0.287