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

Nathan Foley-Fisher Borghan Narajabad Stéphane Verani

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Abstract

The existing literature implicitly or explicitly assumes that securities lenders primarily respond to demand from borrowers and reinvest their cash collateral through short-term markets. Using a new dataset that matches every US life insurers' bond portfolio as well as their lending and reinvestment decisions to the universe of securities lending transactions, we offer compelling evidence for an alternative strategy, in which securities lending programs are used to finance a portfolio of long-dated assets. We discuss how the liquidity and maturity mismatch associated with using securities lending as a source of wholesale funding could potentially impair the functioning of securities market.

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 dealer firms acting for themselves or on behalf of clients such as hedge funds—temporarily gain economic ownership of the asset in exchange for collateral, in the form of either cash or another security. In addition to facilitating short positions (Duffie 1996, Keane 2013), financial institutions borrow securities to avoid delivery fails (Musto, Nini & Schwarz 2011), and use the borrowed security as collateral in other transactions (Dive, Hodge, Jones & Purchase 2011). In the absence of securities lending, a large volume of securities would be tied up in institutions that naturally hold big portfolios of assets—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 perspective of the lenders. To understand the decision processes that we analyze, it is helpful to consider the transactions stylistically represented in Figure 1.[1] The cloud represents the general functioning of securities markets, illustrated with the example of hedge funds taking long and short positions. Securities markets participants typically borrow both cash funding and securities using broker-dealers as intermediaries. Broker-dealers obtain cash from money market mutual funds (MMFs) and securities lenders, for example through short-term funding markets. Securities lenders decide whether or not 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. In the latter case, they may invest, for example, in long-term corporate bonds or asset-backed securities.

The existing literature implicitly or explicitly assumes that securities lenders' strategy is primarily to respond to demand from borrowers and reinvest their cash collateral through short-term markets.[2] We label this lending strategy as '*passive*'. Duffie, Gârleanu & Pedersen (2002) study the effect of search and bargaining in the securities lending market on pricing in the securities market, abstracting from the reinvestment decision of securities lenders (Figure 2a). Brunnermeier & Pedersen (2009) and Gorton & Metrick (2012) consider securities markets transactions funded through margin accounts and bilateral 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).

Using a new dataset that matches every US life insurers' bond portfolio as well as their

[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.

lending and reinvestment decisions to the universe of securities lending transactions, we offer compelling evidence for an alternative '*active*' strategy, in which securities lending programs are akin to using securities lending as wholesale funding. Raising and maintaining a level of cash collateral, lenders finance a portfolio of longer duration, higher yielding assets. The maturity and liquidity transformation associated with this active strategy allows the lender to increase the return on its portfolio of assets. We describe in Section 1 how the degree of passive/active management is likely to be a function of the lender's business model, regulatory environment, and investment opportunities.

Using securities lending as a source of wholesale funding suggests important new channels through which securities markets functioning could be impaired. As is widely known, liquidity and maturity mismatch are associated with vulnerabilities to runs (Diamond & Dybvig 1983, Goldstein & Pauzner 2005) and roll-over risk (He & Xiong 2012).[3] However, it is important to fully understand the mechanisms through which those vulnerabilities may impact the broader financial 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 behoves regulators to be fully aware of any vulnerabilities associated with financial market activity.

The collapse during the 2008-09 financial crisis of tri-party repo funding provided by securities lenders illustrates how securities markets functioning is potentially associated with an active cash reinvestment strategy. Figure 3a shows the total cash collateral held by securities lenders (red dashed line) compared with the total assets held by MMFs (blue solid line). Amid widespread concerns about the quality of cash reinvestment portfolios, securities borrowers ran on lenders' cash collateral.[4] By the first quarter of 2009, cash collateral 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 on their liquid short-term investments, that is, the portion of cash collateral that was reinvested by securities lenders 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). By the first quarter of 2009,

[3] 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 liquid assets, while 65 percent was reinvested in long-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 bailouts.

[4] 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, Timmerman & Wermers forthcoming), and life insurance companies (Foley-Fisher, Narajabad & Verani 2015).

repo funding from securities lenders had collapsed by almost $300 billion while MMF funding remained relatively more available.

To make progress towards identifying the active channel of securities lending, we collect new regulatory data beginning in 2010 on the universe of U.S. life insurers' securities lending programs at the security level. These regulatory data specify which bonds in an insurer's portfolio are on loan at the time of filing as well as the composition of the insurer's cash reinvestment portfolio at the security level. We combine this information with microdata on loan transactions from the most comprehensive source on the securities lending market, which includes information on the amount of individual bonds borrowed and available for loan on any given day, as well as the terms of these transactions. By matching these data at the security-level, we obtain a detailed view of the securities that life insurers lend, given market conditions. Moreover, since life insurers typically pursue a buy-to-hold strategy on their asset holdings over several years, this dataset permits controlling for individual bond characteristics as well as insurer-specific and time-specific variation. The final dataset provides an unprecedented opportunity to study carefully the lending decisions of an important set of securities lenders.

We begin by analyzing the decision to loan bonds as a function of observable security, market, and insurer characteristics. We find a statistically and economically significant positive association between an insurer's decision to lend a particular security and its market share in that security, which is robust to controls for bond, insurer and market characteristics. This finding is consistent with existing empirical literature that studies the passive lending channel (Kolasinski, Reed & Ringgenberg 2013, Kaplan, Moskowitz & Sensoy 2013) and those theories emphasizing search frictions (Duffie et al. 2002, Vayanos & Weill 2008), which imply that the probability of loaning a bond is higher when a potential borrower is matched with an insurer with a high market share in that bond. However, the finding is also consistent with the active lending channel. In such a case, a life insurer would be more likely to lend bonds for which it has a high market share as it facilitates financing a portfolio of long-dated assets, and earning a spread between the cost of cash borrowing and the return on these assets.

This initial result partly illustrates the severe empirical challenge to identifying the active lending channel through the lending decisions of a single lender. The complication is the need to control for *all* the factors affecting the borrowing decision that may be influenced by lenders themselves. For example, life insurers may be able to control their cost of cash borrowing by choosing to lend securities that borrowers cannot easily find. Supporting this view, we show that the cost to borrowing a security is a function of the concentration of holdings in that security. 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. When specifying the lending decision, omitting to control for any variable that is correlated with the borrowing decision will invalidate coefficient estimates because the variable will likely be correlated with equilibrium market variables. While we can and do control for the obvious candidates in our basic analysis, the list of possible confounding factors is practically endless.

Our strategy for identifying the active channel of securities lending is to exploit the ability to observe the same securities at the same time across different life insurers' portfolios. Our specification includes security-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 security. Our proxy for the extent of active management is the fraction of assets in an insurer's cash reinvestment portfolio that has a residual maturity of more than one year. We use this proxy as the main explanatory variable in a specification that includes security-time and insurer fixed effects. Under a passive lending strategy, the variable would be uncorrelated with the decision to lend. By contrast, in the presence of an active lending strategy, the proxy would be associated with a greater likelihood that a security will loaned. This approach approximates a theoretical ideal experiment to establish an active lending channel: testing whether two life insurers with identical bond portfolios would lend differently if one engaged in greater maturity mismatch.

We then develop our analysis beyond the baseline reduced form to address a further concern: Our proxy for active management could be correlated with unobservable time-varying insurer heterogeneity that is potentially determined by the decision to lend securities. For example, life insurers may have bundles of securities that facilitate lending in some years. We adopt an instrumental variable (IV) approach. Our instrument for the degree of active cash reinvestment by an insurer is the annual change in unrealized gains/losses as a fraction of that insurer's total assets. Intuitively, an active securities lender will attempt to compensate for unrealized losses on its underlying portfolio by increasing the return on its cash reinvestment portfolio. The unrealized losses are themselves plausibly beyond the control of the manager of an insurer's securities lending program and, therefore, from the unobserved heterogeneity that is the source of the endogeneity.

Our findings from the reduced form and the IV analyses consistently reject the hypothesis that securities lenders' reinvestment strategies are passive. Our baseline IV specification suggests that a one standard deviation increase in the fraction of the cash reinvestment portfolio that has a residual maturity of more than one year, on average, increases the likelihood that a lender will lend a security by 0.7 standard deviations (11 percentage points). Importantly, this finding is

based on data available since 2010, indicating that the active management of securities lending programs was not eliminated by regulatory responses to the 2008-09 financial crisis.

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. Sections 3, 4 and 5 present our main empirical results, including our IV estimates and robustness tests. We conclude in Section 6 with some remarks on broader implications and further study.

1 Securities lending and life insurance companies

In this section, we outline briefly the typical structure of a securities lending transaction, together with the motivations for each party to the deal. We then provide an overview of the securities lending market and describe the activity of insurance companies within this market. Lastly, we explain how cash collateral reinvestment strategies of different securities lenders depend on their business model and regulatory environment.

1.1 Securities lending transactions

In a prototypical loan, the lender transfers full legal and economic ownership of the security to the borrower.[5] 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.[6] 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 reflect the scarcity of the security on loan: a hard-to-find '*special*' security commands 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 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. Overall, the structure of cash collateralized securities lending is closely

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

[6] Flexibility is often preserved even in term loans, by allowing either party to break out early by incurring a fee.

related to a sale and repurchase (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 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 (e.g. minimum fee criteria or hard-to-find securities only) and for the reinvestment of cash collateral. In some cases, as we will discuss below, these reinvestment strategies are subject to regulatory limits.

If they are involved, agent lenders execute owners' instructions to lend particular securities and reinvest cash collateral. Since agent lenders often receive 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 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. And, 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 that they can be sure their short positions are covered. In exchange for these services, the borrowing

intermediary receives a payment from the end-user.[7]

Lastly, the end-users have a variety of reasons for borrowing a particular security. The most common motivations are to take a short position or to cover a naked short position (Duffie 1996, Keane 2013); to avoid a settlement/delivery failure (Musto et al. 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 et al. 2011); and to take advantage of tax or regulatory arbitrage (Faulkner 2006). The details of these strategies are often complex and we refer the reader to the citations for further explanation.

1.2 The securities lending market

Securities lending is a global market totalling more than one trillion U.S. dollars in outstanding contracts, with U.S. loans accounting for about half of the worldwide market. Figure 4 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. Since life insurers typically invest in fixed income securities, rather than equities, their lending is heavily biased towards 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 5).

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 currently accounts for about 80 percent of the U.S. securities lending market. Importantly, the proportion of lending against cash collateral is greater for life insurance companies than for mutual funds or pension funds. Since most of the securities lending, particularly by life insurers, is against cash collateral, reinvestment of cash collateral is an essential component of the securities lending market. When lending against cash collateral, the main source of income is the return from reinvestment.

1.3 Securities lenders' cash collateral reinvestment strategies

Regardless of their business model and regulatory environment, a financial institution can always choose to pursue a passive cash collateral reinvestment strategy. In such cases, the securities lender responds to borrowing requests and reinvests the cash collateral in safe assets of short

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

duration, e.g. in general collateral repo. The absence of maturity and liquidity mismatch allows these programs to scale up or down with minimal concern for default by either party.

Alternatively, some financial institutions may choose an active cash collateral reinvestment strategy. Such lenders aim to maintain a level of cash from securities borrowers to finance a portfolio of longer-duration, higher-yielding assets, e.g. corporate bonds, mortgages, and mortgage-backed securities. Conditional on the size of their lending program, securities lenders have the opportunity to increase the return from their lending programs by reinvesting the cash collateral in riskier and/or longer-term assets. Since the term of the loan is usually open-ender, this strategy creates a liquidity and/or maturity mismatch between the terms of lending and reinvestment.

The degree to which a lending institution adopts an active reinvestment strategy depends on its business model and regulatory environment. For example, mutual funds have essentially no capital to absorb losses and their liabilities are mostly on-demand. Their business model encourages them to reinvest their cash collateral from securities lending in liquid assets, so that they can return the cash collateral and receive back their lent securities upon demand. Moreover, to protect mutual fund investors, the Securities and Exchange Commission (SEC) subjects mutual funds' reinvestment of cash collateral to the stringent SEC Rule 2a-7. According to this rule, the weighted average maturity of cash reinvestment must be less than 60 days.[8] Enforcement of this rule on mutual funds, together with other regulatory responses to the 2008-09 financial crisis, significantly shortened the maturity of reinvestment of cash collateral (Figure 6).

In contrast to mutual funds, other securities lenders traditionally have longer-term liabilities and are subject to different regulations on the use of securities lending. For example, life insurance companies and pension funds typically hold long-term contingent liabilities, in the form of insurance and pension contracts that are not used by consumers as protection against illiquidity.[9] Under their traditional business model, life insurers and pension funds match the terms of their liabilities to those of safe and liquid assets. This model more easily allows life insurers and pension funds to enhance the return on their asset portfolios because their liabilities are not on-demand. In addition, the regulatory rules on the use of securities lending are generally weaker for life insurers and pension funds. This weaker regulatory environment exists despite the NAIC adopting in 2010 more restrictive guidelines for state regulations pertaining to life insurers' securities lending. The new guidelines stem from a review of securities lending practices at AIG that contributed to its collapse during the 2008-09 financial crisis. In particular, the guidelines

[8] In addition, Rule 2a-7 limits exposure to any counterparty to 5 percent, and requires mutual funds to hold at least 10 percent of their cash reinvestment in daily liquid assets and at least 30 percent in weekly liquid assets.

[9] Health insurance companies and property and casualty life insurers are far less engaged in securities lending because the terms of their liabilities are much shorter than life insurers or pension funds.

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.[10]

The differences in institutional business models and regulatory environments help determine the scope of the cash reinvestment strategies of securities lenders. An institution with less liquid liabilities and less stringent regulation on the use of securities lending may more easily enhance the return on its portfolio by allowing greater maturity mismatch between the tenor of its loans and the reinvestment of the cash collateral it receives.[11] Currently, U.S. life insurers have significantly greater maturity mismatch between their securities lending and their reinvestment of cash collateral than the median securities lender (Figure 8). The mean U.S. life insurer maturity mismatch (not shown) is about 1,000 days, compared with about 100 days for the mean securities lender, shown by the blue line in Figure 6. Indeed, life insurers' reinvestment of cash collateral currently has an average maturity more than 15 times larger than the regulatory maximum of mutual funds' cash reinvestment.

That said, to understand better the securities lending strategies of pension funds and life insurance companies requires detailed data on individual loans and cash reinvestment decisions. In the case of pension funds, these data are not 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.

By contrast, the 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 securities lending and cash reinvestment activities by U.S. life insurers. We can observe the individual securities 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. To be sure, we do not have data on the maturity structure of life insurers' reinvestment of cash collateral before 2010 and, thus, cannot gauge how their reinvestment

[10] 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`

[11] 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 forthcoming), and the issuance of institutional funding agreements (Foley-Fisher et al. 2015).

strategy changed following the 2008-09 financial crisis and in response to the new regulatory environment. Nevertheless, these new data offer the best possible insight into the on-going strategies pursued by institutions whose business models and regulatory environment are similar to life insurers including, for example, pension funds. In the next section, we describe how we put the data together.

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 DL is a relatively new report of individual investments made by life insurers using cash collateral received from securities lending, both on- and off-balance sheet. 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. In general, the new data allow us to track better 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.[13] We hand-coded data about the maturity of the collateral received in the securities lending transactions from the regulatory Notes to the Financial Statements. Figure 7 shows the total amount of securities lending by U.S. life insurers reached over $55 billion at the end of 2013. Since we rely on the detailed information contained in Schedule DL as part of the new reporting requirements, our sample by necessity begins in 2010.

The NAIC Quarterly and Annual Statutory Filings also contain Schedule D, reporting life insurers' individual fixed income holdings at year-end, together with cross-sectional information about each security, including CUSIP indentifier, the NAIC designation code, and whether or not 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 insurers' investment portfolio from the summary balance sheet contained in the NAIC Quarterly and Annual Statutory Filings. 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

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

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 the bond holdings were lent at some point during the period.

We obtain bond characteristics from Mergent FISD and add them to our baseline dataset. FISD provides a wide range of security-level information for mostly U.S. corporate, agency, and government bonds that can be merged with our holdings data using the CUSIP identifier. Our focus on life insurers' holdings and lending of corporate bonds is consistent with their strong bias towards this sector of the securities lending market, as described in section 1. Including this additional information reduces our bond holdings data to about 250,000 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 sample, the average offering amount of the bonds held is $10 million (with a standard deviation of $22.8 million), with a yield 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 an Standard & Poor's bond rating of BBB.[14] Lastly, the average total amount outstanding across all bonds held by life insurers is $900 million.

Finally, Markit Securities Finance provides information on individual securities lending transactions. This dataset offers the most comprehensive view of the securities lending market, covering about 85 percent of the global market and more than 90 percent of the U.S. securities lending market. The daily transaction level data include identifiers of the lent security, such as CUSIP and ISIN; value, quantity and tenure of the loan; the relevant rates, such as securities lending fee and rebate rate; as well as type of collateral (cash or non-cash). 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. Our final dataset contains data for 107 life insurers and over 187,000 bond holdings.[15] Columns 9 through 12 of Table 1 report the descriptive statistics for the dataset following this merge. The information from the securities lending market suggests that the weighted average rebate on the bonds is about zero.

[14] 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.

[15] There are 1,029 out of 14,149 securities reported by life insurers as on-loan, but for which no securities lending information is available in Markit; we exclude these observations from our analysis.

On average, life insurers hold about 3 percent of each security's total lendable amount (with a standard deviation of 16 percent), with 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.

Taken together, these data offer a new lense through which we can obtain a comprehensive and detailed view of all aspects of the life insurers' securities lending programs, from the individual bonds lent, through the collateral received, to the reinvestment portfolios. As a simple analysis of the kinds of bonds that life insurers are lending, Table 2 compares descriptive statistics of securities used in lending transactions compared with the securities not lent.[16] In general, the securities 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 securities 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 mean characteristics are indicative.

In the following three sections, we provide a more careful empirical analysis of securities lending by U.S. life insurers. First, we explore the bond and market characteristics that determine an insurer's decision to lend individual securities. Second, we show how fundamental endogeneity concerns preclude finding compelling evidence for active securities lending within an insurer. And third, we present our methodology for showing that active management of the portfolio plays a significant role in the overall strategy for the lending program.

3 Determinants of securities lending by U.S. life insurers

Our first set of empirical tests investigates the relationship between a life insurer's decision to lend a particular bond and its market share in that bond. We assume that life insurers are endowed with a portfolio of securities over which they can make lending decisions. This assumption is in keeping with industry practice, where the agents who manage the securities lending portfolio are not those who decide the broad investment strategy or specific asset purchases. We denote by $Loan_{ijt}$ a binary variable that takes the value 1 if insurer j is loaning bond i at year t, and 0 otherwise. The main explanatory variable ($Market\ share_{ijt}$) is the year-t holding by insurer j

[16] The table counts each security holding as separate observation, effectively weighting the descriptive statistics by the number of times that a security is lent or not.

in bond i as a share of the total amount of bond i that is made available to securities borrowers by all lenders. We specify a linear model:

$$Loan_{ijt} = \alpha_i^1 + \alpha_j^2 + \alpha_t^3 + \beta Market\ share_{ijt} + \boldsymbol{Z}_{it}\boldsymbol{\gamma} + \epsilon_{ijt} \tag{1}$$

where $\boldsymbol{Z}_{it}$ is a matrix of bond-specific time-varying characteristics. The set of α fixed effects captures unobservable heterogeneity across securities, life insurers, and time.

Table 3 summarizes the results. Column 1 shows the baseline model, controlling for insurer, year, and bond issuer fixed effects. The association between $Loan_{ijt}$ and $Market\ share_{ijt}$ is positive and statistically significant at less than the one percent level. The coefficient on $Market\ share_{ijt}$ suggests that, on average, a one standard deviation (13.4 percent) increase in an insurer's market share in a particular bond is associated with a 0.6 percent increase in the probability that the bond is loaned.

The remaining columns of Table 3 investigate the robustness of this association to additional security- and market-level controls that are likely to be correlated with the demand for individual bonds. Column 2 of Table 3 controls for bond characteristics, including the residual maturity, offering yield, offering amount, amount outstanding, and credit rating. Including these finer controls reduces the original sample by about 60 percent. Nevertheless, the association between the probability that an insurer loans a bond and market share remains largely unchanged. Furthermore, the coefficient estimate on the offering yield and rating are negative, and the coefficient estimates on residual maturity is positive. These findings are broadly consistent with previous empirical studies, for example Asquith, Au, Covert & Pathak (2013).

Column 3 of Table 3 controls for loan market tightness ($Market\ tightness_{it}$), 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, and the bond rebate ($Rebate_{it}$). The inclusion of $Market\ tightness_{it}$ and $Rebate_{it}$ has little effect on the magnitude and significance of the coefficient estimate on $Market\ share_{ijt}$. In addition, consistent with Kolasinski et al. (2013), the estimates suggest that, when controlling for overall market tightness and an insurer's market share in that bond, there is a significant positive association between a more special bond—i.e. a more negative rebate—and the probability that the bond will be on loan. Column 4 of Table 3 adds a measure of concentration for individual securities in the life insurance industry (HHI_{it}) using the Herfindahl-Hirschman Index computed at the bond-year level using only life insurers' market shares in each individual bond.[17]

[17] The calculation is limited by our ability to observe only the holdings in our data i.e. by necessity, it assumes atomistic holdings by other institutions.

This new finding that life insurers are more likely to lend securities in which they have a greater market share is consistent with existing empirical literature that studies the passive lending channel (Kolasinski et al. 2013, Kaplan et al. 2013) and those theories emphasizing search frictions (Miller 1977, Duffie et al. 2002, Vayanos & Weill 2008). Intuitively, the probability of loaning a bond is higher if a securities borrower is matched with a lender with a high market share in that bond. Knowing that they face a greater opportunity cost to looking elsewhere for the bond, the match is more likely to be consummated.

However, the finding is also consistent with the active lending channel. In such a case, a lender would be more likely to lend bonds in which it has a high market share. The lender knows it can more easily finance a portfolio of long-dated assets, and earn a spread between the cost of cash borrowing and the return on these assets.[18]

4 Endogeneity of the cost of cash from securities lending

We build on the analysis of the previous section to understand the major endogeneity challenge to identifying the active lending channel through the lending decisions of a single lender. First, lenders may be able to control factors that affect the borrowing decision, such as the terms of the loan. Second, those factors and/or the lender's ability to control them may be correlated with the lender's strategy. Consider, for example, the previous regression specification representing the loan decision in conjunction with a specification that represents the equilibrium rebate:

$$Loan_{ijt} = \alpha_i^1 + \alpha_j^2 + \alpha_t^3 + \beta Market\ share_{ijt} + \delta Rebate_{it} + \boldsymbol{Z}_{it}\boldsymbol{\gamma} + \epsilon_{ijt} \quad (2)$$

$$Rebate_{it} = \tilde{\alpha}_i^1 + \tilde{\alpha}_t^3 + \tilde{\boldsymbol{Z}}_{it}\tilde{\boldsymbol{\gamma}} + \tilde{\epsilon}_{ijt} \quad (3)$$

As is widely known, if any variable ($\tilde{\boldsymbol{Z}}_{it}$) in equation 3 that determines the equilibrium rebate is omitted from the loan decision specification, all the coefficient estimates from equation 2 will be inconsistent (Greene 2012).

We can demonstrate that confounding factors are likely to be a serious concern by estimating equation 3 including known variables from equation 2. Observing that known variables are correlated with a bond's rebate makes it likely that other (potentially unobservable) determinants of the lending decision are also correlated with the bond's rebate. We show that

[18] The statistically significant negative coefficient on HHI_{it} is also consistent with both an active and passive securities lending strategy. With passive lenders, an increase in bond concentration reduces the probability that a borrower seeking a bond is matched with an insurer holding that bond, which decreases the probability of the loan. With active lenders, an increase in concentration implies that the value of the rebate on that bond rises–i.e. the bond becomes less special–as more of the bond is supplied to securities borrowers. As the bond becomes less scarce, and the rebate increases, the cost of borrowing cash by lending that bond also increases, which reduces the likelihood of loaning the bond.

the rebate is a function of the 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.

We first show that the cost of raising cash by lending a particular security is a function of life insurers' holdings of that security. Adding weight to this likely source of endogeneity, we also show that life insurers may affect the shadow value of their entire lending program. We aggregate the lending decisions over segments of life insurers' bond portfolios and show there is a positive association between the decision to lend bonds within that segment and the holdings distribution of that segment. Taken together, the results suggest that a life insurer may be able to control the cost of cash that it can raise by choosing which bonds to lend, and this confounds the identification of active securities lending. The implication is that we cannot use correlates of the loan decisions within a life insurer to establish the presence of an active securities lending channel.

4.1 Determinants of the rebate on a bond

Table 4 summarizes the results from investigating the relationship between a bond's rebate and the concentration of that bond's holdings across life insurers. As described in section 1, a hard-to-find security attracts a lower and sometimes negative rebate. To be clear, in the latter case, the security borrower pays a premium to the lender in excess of the return from reinvesting the cash collateral. Our specifications are based on equation 3, with the unit of observation being a bond i held by insurer j at the end of year t. We restrict the sample to bonds that have at least three holders in any given year to obtain meaningful variation in the distribution of holdings.

The coefficient on HHI_{it} suggests that those bonds that are the most concentrated among life insurers tend to have a lower rebate (that is, tend to be more special). Column 1 of Table 4 reports the result of a regression of $Rebate_{it}$ on HHI_{it}. This baseline specification includes the loan decision, life insurer, year and bond issuer fixed effects. Column 2 adds market share, market tightness, and other bond-level controls to the specification.[19] Columns 3 and 4 separate the sample into those bonds that are on loan and those that are not loaned by any life insurer, respectively. In all cases, the relationship between $Rebate_{it}$ and HHI_{it} is statistically significant at less than the one percent level. The baseline coefficient estimate suggests that, on average, a one standard deviation increase in a bond concentration is associated with a 0.4 percentage point (1.2 standard deviation) decrease in the rebate rate for that security.[20]

[19] In general, we find results that are qualitatively similar to those of Nashikkar & Pedersen (2007).

[20] The positive association between $Rebate_{it}$ and $Loan_{ijt}$, conditional on HHI_{it}, is consistent with both a passive and active securities lending program. When life insurers are passive, a bond that is more sought after should attract a higher rebate in order to secure the loan, resulting in a positive association between the lending

Taken together, the results reported in Table 4 show the likely endogenity of bond rebate and loan decision. At the same time that a bond's rebate is likely to be a function of the size of life insurers' holdings, life insurers' decisions to lend the bond are likely to be influenced by its specialness. More generally, the findings support a concern that life insurers may be able to use their market power over a large number of bonds to exert significant control over their cost of cash borrowing via securities lending. This means that, unless the regression that specifies the loan decision accounts for all the co-determinants of a bond's rebate, the coefficient estimates from equation 2 will be inconsistent.

4.2 Determinants of an insurer's overall cost of cash collateral

We now study the potential endogeneity of life insurers' overall cost of raising cash collateral via securities lending. The previous section provided some evidence that individual bond specialness is potentially determined by the distribution of bond holdings and by life insurers' decisions to lend. The findings, however, are only suggestive of an insurer's ability to exert control over its overall cost of funding. For example, life insurers may have market power for a small fraction of their portfolio. While an insurer might exert control over the rebate on some bonds, its control over the rebate of other bonds could be more limited.

To assess the determinants of life insurers' overall cost of funding requires summarizing the content of their portfolios. A crude approach is to run the same test as in Table 4 using averages of the previously defined variables defined over each insurer's portfolio. However, aggregating bond-level information to the insurer level is likely to produce a test without much power. We adopt an alternative approach by creating subsets of life insurers' bond portfolios. Specifically, we rank each life insurer's bond portfolio according to the rebate of each bond, and divide the portfolios according to rebate quantiles. Dividing the portfolio according to rebate quantiles yields equal sized group of bond that differ by the average rebate of the bonds in each group. Then, for each equal-sized bond group within two rebate quantiles, we compute weighted average analog of the variables discussed in the previous sections. Throughout the analysis, the weights are the shares of a bond in terms of fair value with respect to the total fair value of bonds in the group. The unit of observation for this analysis is a rebate group q for bonds held by a life insurer j at the end of year t. With variables defined as before, the regression specification is:

$$Loan_{qjt} = \alpha_q^1 + \alpha_j^2 + \alpha_t^3 + \beta Market\ share_{qjt} + \boldsymbol{Z}_{qjt}\boldsymbol{\gamma} + \epsilon_{qjt} \tag{4}$$

decision and the rebate. Conversely, active life insurers may choose to lend a bond for which they receive a better deal—a more negative rebate—to minimize their overall cost of cash borrowing, resulting in the same correlation.

Columns 1 and 4 of Table 5 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 weighted average market share in those bonds, conditional on weighted average rebate and concentration. Columns 2 and 3 perform the same test on the subset of the 32 rebate groups above and below the median rebate, respectively. The coefficient on $Market\ share_{qjt}$ is broadly similar, with marginally weaker significance for rebate groups below the median rebate. Column 5 and 6 repeat this test on the subset of the 64 rebate groups above and below the median rebate, respectively. Here, the coefficient on $Market\ share_{qjt}$ is only significant on 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 that portion of the portfolio that has higher average rebate. However, since a higher rebate tends to be associated with higher probability of loaning a bond, increasing the number of quantile mechanically reduces the fraction of loaned bond 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 bond loaned and the weighted average market share is significant on a large portion of life insurers' bond portfolio–at least half of the bonds–and especially so in that portion of the portfolio that faces above the median rebate rate. We interpret this result as suggesting that life insurers are likely to have significant control over their overall cost of funding via securities lending.

The analysis presented in this section suggests that a within-insurer analysis of loan decisions is unlikely to provide compelling evidence for an active lending channel. We find support for the argument that there are factors affecting the securities borrowing decisions that may be influenced by lenders themselves. While we can and do control for the obvious candidates in our analysis reported in section 3, the list of potential confounding factors is practically endless.

5 Securities lending as wholesale funding

To build a compelling case that there is an active securities lending channel, we adopt a two-fold strategy. First, 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 factors, in a reduced form that encompasses the cost of cash borrowing, as well as the availability and distribution of holdings, associated with each security. Second, we propose an instrumental variable to deal with possibly unobservable time-varying insurer heterogeneity. Our two-step approach is intended to approximate the theoretical ideal

experiment to establish an active lending channel: testing whether two life insurers with identical bond portfolios would make lending decisions differently if one exogenously engaged in greater maturity mismatch.

5.1 Controlling for bond-specific factors

Our proxy for the extent of active management ($Active_{jt}$) is the fraction of assets in the cash reinvestment portfolio of a life insurer j at year t that has a residual maturity of more than one year. This threshold captures investment in assets that are ineligible for purchase by MMFs under Rule 2a-7 and are therefore likely to offer a higher return than cash instruments.[21] As is clear from Figure 8, there is variation in this fraction across life insurers and over time. We include $Active_{jt}$ as the main explanatory variable in a linear specification that includes security-time and life insurer fixed effects:

$$Loan_{ijt} = \alpha_i^1 + \alpha_j^2 + \alpha_t^3 + \alpha_i^1 \times \alpha_t^3 + \beta Active_{jt} + \epsilon_{ijt} \tag{5}$$

Under a passive lending strategy, $Active_{jt}$ would be uncorrelated with $Lend_{ijt}$, that is $\beta = 0$. By contrast, in the presence of an active lending strategy, the proxy would be associated with a greater likelihood that a bond will be loaned.

Columns 1 and 2 of Table 6 report the results of estimating equation 5 with only life insurer fixed effects and then including security-time fixed effects, respectively.[22] The coefficient on $Active_{jt}$ suggests that, on average, a one standard deviation increase in the fraction of a life insurer's cash reinvestment portfolio invested in assets with maturity greater than 1 year is associated with a 2 percent increase in the probability that the bond is loaned. This association is significant at less than the 1 percent level.

5.2 Controlling for insurer-specific unobservable heterogeneity

The variable $Active_{jt}$ may itself be endogenous. The residual error term ϵ_{ijt} in equation 5 may contain unobservable insurer-specific time-varying factors that are correlated with $Active_{jt}$. While we can control for bond-specific, time-varying unobservable factors through the interacted fixed effects, we cannot control for all time-varying insurer heterogeneity that affect its ability to lend bonds. For example, life insurers may have bundles of bonds that facilitate lending in some years.

[21] By way of further comparison, this threshold is six times the regulatory limit on mutual fund cash reinvestment.

[22] The number of observations is much larger than in sections 3 and 4 because the sample is no longer restricted by the availability of rebate information.

To obtain exogenous variation in the degree of active cash collateral reinvestment by an insurer ($Active_{jt}$), 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 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 strategy is predicated on the idea that an active 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. Unrealized losses are themselves plausibly beyond the control of the manager of an insurer's securities lending program and, therefore, from the unobserved heterogeneity that is the source of the endogeneity concern.

Columns 3 and 4 of Table 6 report the first and second stage result of a regression of $Loan_{ijt}$ on $Active_{jt}$, instrumenting $Active_{jt}$ with $\Delta\, Unrealized\ gain_{jt}$. As with the reduced form in Column 2 of Table 6, the IV regression includes CUSIP, CUSIP-year and insurer fixed effects. Column 3 of Table 6 shows that there is a positive first-stage association between $Active_{jt}$ and $\Delta\, Unrealized\ gain_{jt}$. The coefficient on $Active_{jt}$ in Column 4 of Table 6 suggests that, on average, a one standard deviation increase in the fraction of an insurer's cash reinvestment portfolio invested in assets with maturity greater than 1 year is associated with a 11% increase in the probability that the bond is loaned.[23]

The parameter estimates imply there would be only a small reduction in lending if Rule 2a-7 limits were imposed on the securities lending programs of U.S. life insurance companies. Table 1 shows that life insurers have, on average in our post-crisis sample, about 17 percent of their cash collateral portfolio reinvested in bonds with a residual maturity of at least one year. Rule 2a-7 would remove these bonds entirely from the portfolio.[24] Using the coefficient estimate from Table 6 of the effect of $Active_{jt}$ on the probability of lending (0.4), the elimination of the active lending channel would reduce lending by 0.4×0.17, which is about 7 percent. Figure 7 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 regulation equivalent to Rule 2a-7 on cash collateral reinvestment by life insurers could enhance

[23] We suspect that our IV coefficient is larger than our OLS coefficient because our empirical approach places greater weight on life insurers that have more variation in active reinvestment over time (Angrist, Graddy & Imbens 2000).

[24] 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 13 months.

financial stability with only minor consequences for bond market functioning.

5.3 Robustness

Table 7 summarizes tests of the robustness of the association between the decision to lend securities and the degree of active cash collateral reinvestment. One concern is that variation in the size of an insurer's securities lending program over time may be driving the result. Columns 1 and 2 report the instrumental variable results including as a control the size of the insurer's securities lending program ($SL\ program\ size_{jt}$). A further concern is that life insurers may have a preference for lending particular securities. Columns 3 and 4 report the results from repeating the analysis including CUSIP-insurer fixed effects. The estimated coefficient of interest in both cases is similar to our previous results.

6 Conclusion

This paper offers the first empirical evidence that certain financial insitutions use securities lending as a source of wholesale funding. That is, some firms raise and maintain a level of cash collateral by lending lower-yielding securities and investing the proceeds in longer-term higher-yielding securities. Our main empirical exercise consists of showing that U.S. life insurers' lending decisions are driven in part by the degree of maturity mismatch in their securities lending programs. We acknowledge and address the stringent identification challenge posed by securities lenders' potential ability to influence unobservable factors that affect the borrowing decision. The finding stands in contrast to the widespread perception in the existing literature that securities lenders passively respond to borrower demands and reinvest their cash collateral in short-term funding markets.

Based on data from the period after the implementation of sweeping macro- and microprudential reforms since the 2008-09 financial crisis, our evidence demonstrates the vulnerabilities that securities lenders still pose to securities markets functioning. A sharp contraction in repo funding from securities lenders is one way a run on active securities lenders can adversely affect securities markets, as discussed in the introduction and emphasized by Brunnermeier & Pedersen (2009) and Gorton & Metrick (2010*a*,*b*). In addition, during times of financial distress, concerns about securities lenders' cash reinvestment portfolios may require borrowers to post larger margins to compensate broker-dealers for the risk to their cash. In both cases, the underlying vulnerability to runs from liquidity and/or maturity mismatch can be attributed to the active lending channel. One possible reason that life insurers remain active securities lenders 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 actively manage their securities lending programs.

In light of these vulnerabilities, measures such as the degree of maturity mismatch and the extent to which active 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. While 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.[25]

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Table 1: Descriptive statistics. Columns 2 through 5 report the number of observations, mean, median, and standard deviation of variables used in our analysis from the annual statutory filings of insurance companies compiled by the NAIC. Securities lending programs are scaled by the size of the general account. Active cash collateral reinvestment is the fraction of the fair value reinvestment portfolio that has a residual maturity of at least one year. The change in unrealized gains/losses are scaled by the size of the general account. Columns 6 through 9 show statistics after merging the statutory filings with the Mergent Fixed Income Securities Database, 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 10 through 13 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			
	Obs.	Mean	Median	SD	Obs.	Mean	Median	SD	Obs.	Mean	Median	SD
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
Active cash collateral reinvestment ($Active_{jt}$)	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 ($m)	549693	9.36	4	27.58	249483	10.03	5	22.76	192272	10.28	5	25.22
Dummy variable for lent security ($Loan_{ijt}$)	549693	.03	0	.16	249483	.05	0	.23	192272	.07	0	.25
Offering amount ($bn)	.	.	.	.	249483	.94	1	4.6	186852	1.14	1	2.81
Offering yield (percent)	.	.	.	.	204568	5.79	6	2.38	152168	5.59	6	2.48
Residual maturity (yrs)	.	.	.	.	248284	11.19	8	9.59	185988	11.3	8	9.34
Amount outstanding ($bn)	.	.	.	.	131144	.93	1	3.02	95419	1.19	1	3.43
Credit rating	.	.	.	.	239673	19.87	20	3.04	180086	19.8	20	3.08
Weighted avg rebate ($Rebate_{it}$)	.	.	.	.	.	.	.	.	192272	0	0	.07
% total lendable held ($Market\ share_{ijt}$)	.	.	.	.	.	.	.	.	192272	.03	0	.16
HHI of life insurers' holdings (HHI_{it})	.	.	.	.	.	.	.	.	192272	.37	0	7.85
Total lent/total lendable ($Market\ tightness_{it}$)	.	.	.	.	.	.	.	.	192272	.14	0	.43

Table 2: Descriptive 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: $Loan_{ijt} = 1$			
	Obs.	Mean	Median	SD	Obs.	Mean	Median	SD
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: Relationship between bond lending and market share. The dependent variable ($Loan_{ijt}$) takes the value 1 if insurer j is lending bond i at time t and 0 otherwise. The main explanatory variable ($Market\ share_{ijt}$) is the holding of the insurer relative to the amount of the bond made available to securities borrowers by all lenders. In addition to the insurer, year, and issuer fixed effects in the baseline specification, reported in column 1, we incrementally add a variety of bond and market controls, reported in columns 2-4. The sources for the data used in the analysis are described in the notes to Table 1. Huber-White robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Dependent variable:	(1)	(2)	(3)	(4)
$Loan_{ijt}$	Baseline	Security Control	Market Control	Concentration Index
$Market\ share_{ijt}$	0.0506***	0.0501***	0.0458***	0.0561***
	(0.00490)	(0.00781)	(0.00778)	(0.00831)
$Rebate_{it}$			-0.229***	-0.231***
			(0.0239)	(0.0239)
$Market\ tightness_{it}$			0.0339***	0.0337***
			(0.00375)	(0.00375)
HHI_{it}				-0.0129***
				(0.00344)
$Residual\ maturity_{it}$		0.000696***	0.000670***	0.000683***
		(0.000129)	(0.000129)	(0.000129)
$Offering\ yield_i$		-0.00340***	-0.00309***	-0.00296***
		(0.00101)	(0.000975)	(0.000961)
$Offering\ amount_i$		-0.00384	-0.00510	-0.00532
		(0.00356)	(0.00357)	(0.00356)
$Amount\ outstanding_{it}$		0.00901***	0.0110***	0.0106***
		(0.00318)	(0.00320)	(0.00319)
$Rating_{it}$		-0.00752***	-0.00553***	-0.00538***
		(0.00198)	(0.00198)	(0.00198)
Fixed effects:				
Insurer, issuer, year	Y	Y	Y	Y
Observations	182,315	69,459	69,459	69,459
R-squared	0.149	0.159	0.163	0.163

Table 4: Relationship between bond rebate and holdings distribution. The dependent variable ($Rebate_{it}$) is the percentage of cash collateral reinvestment income given by the securities lender to the borrower. The main explanatory variable (HHI_{it}) is the Herfindahl-Hirschman Index computed at the bond-year level using life insurers' holdings. We restrict the sample to bonds that have at least three holders in any given year. Columns 1-2 contain results including various bond and market controls, in addition to insurer, year, issuer, and bond type fixed effects. Columns 3 and 4 restrict the sample to bonds on loan and to bonds not loaned by any life insurer, respectively. The sources for the data used in the analysis are described in the notes to Table 1. Huber-White robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Dep. variable:	(1)	(2)	(3)	(4)
$Rebate_{it}$	All Securities	All Securities	Lent Securities	Not Lent Securities
HHI_{it}	-1.306***	-1.016***	-4.009**	-0.537***
	(0.0889)	(0.0974)	(1.748)	(0.109)
$Loan_{ijt}$	-1.313***	-1.201***		
	(0.0827)	(0.131)		
Market share$_{ijt}$		1.790***	27.69***	0.827***
		(0.232)	(5.189)	(0.292)
Market tightness$_{it}$		0.464***	1.440**	0.194
		(0.0746)	(0.731)	(0.159)
Residual maturity$_{it}$		0.0221***	-0.0560	0.0256***
		(0.00272)	(0.0370)	(0.00329)
Offering yield$_{i}$		0.0572***	1.043***	0.0117
		(0.0169)	(0.373)	(0.0113)
Offering amount$_{i}$		-0.170*	-1.221	0.155
		(0.0992)	(0.850)	(0.152)
Amount outst$_{it}$		0.541***	2.338***	0.595***
		(0.0971)	(0.780)	(0.159)
$Rating_{it}$		0.463***	2.297***	0.0136
		(0.0679)	(0.754)	(0.0745)
Fixed effects:				
Insurer, issuer, year	Y	Y	Y	Y
Bond type	N	Y	Y	Y
Observations	177,397	67,538	1,637	35,427
R-squared	0.526	0.577	0.803	0.679

Table 5: 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, respecitively, and include controls for various bond and market characteristics as well as insurer and year fixed effects. Columns 2-3 and 5-6 divide the groups into those that are above and below the median. The sources for the data used in the analysis are described in the notes to Table 1. Huber-White robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Dep. variable:	(1)	(2)	(3)	(4)	(5)	(6)
$Loan_{qjt}$	All perc.	32 parts $>$ 50 perc.	32 parts $\geq$ 50 perc.	All perc.	64 parts $>$ 50 perc.	64 parts $\geq$ 50 perc.
$Market\ share_{qjt}$	7.806**	9.984**	9.081*	5.242**	9.684**	4.736
	(3.532)	(5.028)	(5.013)	(2.463)	(3.801)	(3.301)
$Rebate_{qt}$	-27.13***	-41.13***	-28.23***	-28.10***	-55.50***	-30.28***
	(3.060)	(15.46)	(3.439)	(2.677)	(11.24)	(2.926)
HHI_{qt}	-5.496***	-5.614***	-4.974***	-3.910***	-3.150**	-3.709***
	(1.202)	(1.851)	(1.602)	(0.813)	(1.367)	(0.978)
$Residual\ mat_{qt}$	-0.0562	0.0179	-0.110*	-0.0139	0.0807*	-0.0934**
	(0.0432)	(0.0612)	(0.0606)	(0.0312)	(0.0464)	(0.0410)
$Offering\ yield_{qt}$	-0.217*	-0.00620	-0.386**	-0.282***	-0.158	-0.368***
	(0.123)	(0.185)	(0.164)	(0.0836)	(0.150)	(0.101)
$Offering\ amt_{qt}$	0.471***	0.335***	1.630***	0.473***	0.384***	1.457***
	(0.115)	(0.117)	(0.339)	(0.0992)	(0.0974)	(0.302)
$Amt\ outst_{qt}$	0.110	0.234*	-0.720	0.179	0.274**	-0.252
	(0.141)	(0.136)	(0.500)	(0.132)	(0.134)	(0.405)
$Rating_{qt}$	0.0385	0.0260	0.0444	0.0216	0.0119	0.0113
	(0.0652)	(0.0968)	(0.0913)	(0.0510)	(0.0730)	(0.0705)
Fixed effects:						
Insurer, year	Y	Y	Y	Y	Y	Y
Observations	9,941	4,926	5,015	16,703	8,208	8,495
R-squared	0.340	0.373	0.359	0.287	0.314	0.304

Table 6: Securities lending as wholesale funding. The dependent variable ($Loan_{ijt}$) takes the value 1 if insurer j is lending bond i at time t and 0 otherwise. The main explanatory variable ($Active_{jt}$) is the fraction of cash collateral reinvestment that has a residual maturity of more than one year. Columns 1-2 report reduced form correlations including insurer, CUSIP, year, and CUSIP-year fixed effects. Columns 3-4 contain the first and second stages, respectively, of a two-stage least squares estimation. The instrumental variable (Δ *Unrealized gain*$_{jt}$) is the unrealized gain/loss made by insurer j on its bond portfolio. The sources for the data used in the analysis are described in section 5 of the main text. *** p<0.01, ** p<0.05, * p<0.1

Dependent variable:	(1)	(2)	(3)	(4)
$Loan_{ijt}$	Reduced form	Reduced form	First stage	Second stage
$Active_{jt}$	0.071***	0.103***		0.389***
	(0.00431)	(0.00676)		(0.0520)
Δ *Unrealized gain*$_{jt}$			-2.904***	
			(0.0367)	
Fixed effects:				
Insurer	Y	Y	Y	Y
CUSIP	N	Y	Y	Y
Year	N	Y	Y	Y
CUSIP× *Year*	N	Y	Y	Y
Cragg-Donald Wald F statistic				3849.06
Stock-Yogo weak ID test critical values 10% maximal IV size				16.38
Observations	462,433	462,433	462,433	462,433
R-squared	0.0364	0.291	0.965	0.284

Table 7: Robustness tests. The dependent variable, main explanatory variable, and instrumental variable are the same as in Table 6. Columns 1-2 contain the first and second stages, respectively, of a two-stage least square estimation including as a control the size of insurer j's securities lending program. Columns 3-4 contain the first and second stages, respectively, of a two-stage least square estimation including CUSIP-Insurer fixed effects. The sources for the data used in the analysis are described in section 5 of the main text. *** p<0.01, ** p<0.05, * p<0.1

Dependent variable:	(1)	(2)	(3)	(4)
$Loan_{ijt}$	Stage 1	Stage 2	Stage 1	Stage 2
$Active_{jt}$		0.430***		0.394***
		(0.05127)		(0.05983)
$\Delta Unrealized\ gain_{jt}$	-3.437***		-3.133***	
	(0.04590)		(0.06566)	
$SL\ program\ size_{jt}$	0.007***	0.005***		
	(0.00236)	(0.00098)		
Fixed effects:				
Insurer, year, CUSIP	Y	Y	Y	Y
CUSIP× *Year*	Y	Y	Y	Y
CUSIP×*Insurer*	N	N	Y	Y
Observations	462,433	462,433	462,433	462,433

8 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 markets participants. The cloud represents the general functioning of securities markets, illustrated with the example of hedge funds taking long and short positions. Securities markets participants borrow both cash funding and securities. Securities lenders decide whether or not 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.

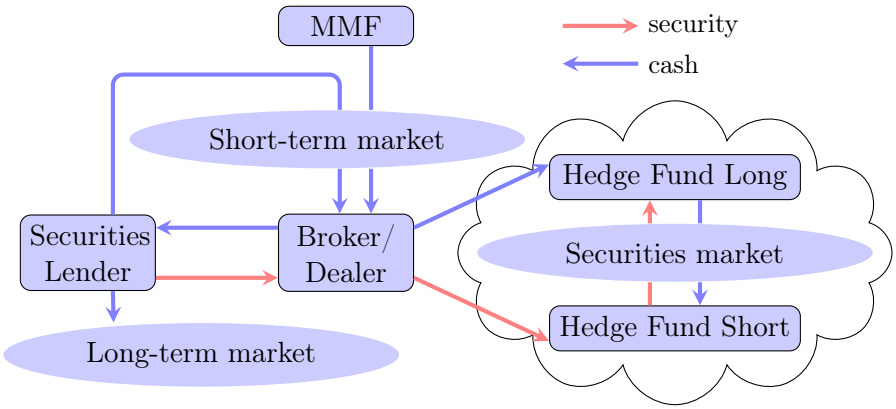
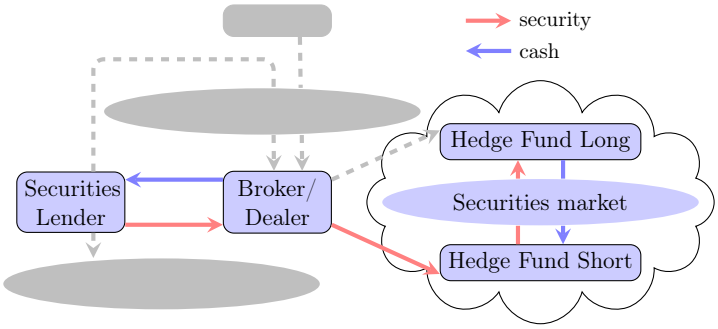
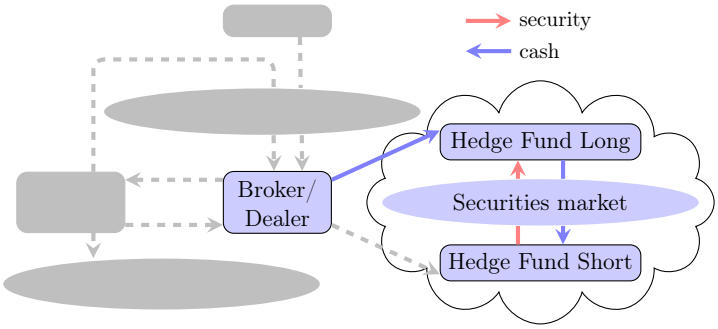


Figure 2: Coverage of the stylized map of securities lending by existing literature. Duffie et al. (2002) (Panel (a)) study the effect of interactions between securities lenders and broker-dealers on pricing in the securities market. Brunnermeier & Pedersen (2009) and Gorton & Metrick (2012) (Panel (b)) consider the effect of haircuts on cash funding on 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)

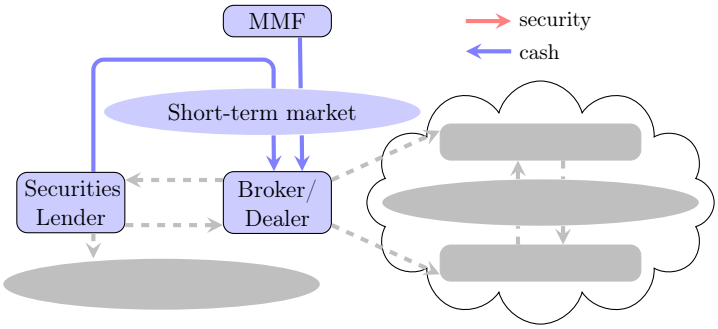
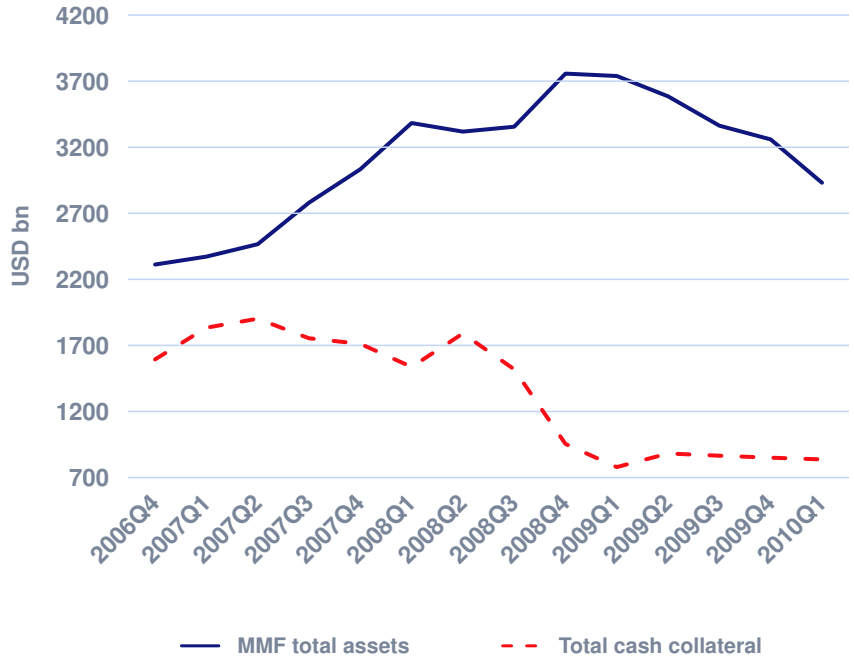


Figure 3: Securities lenders and MMFs tri-party repo market funding. Panel (a) shows the total resources potentially available to securities lenders and MMFs for lending. Panel (b) shows the amount of funding that securities lenders and MMFs provided through the tri-party repo market. Source: Krishnamurthy,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

(a) Total resources available to lend



(b) Tri-party repo funding

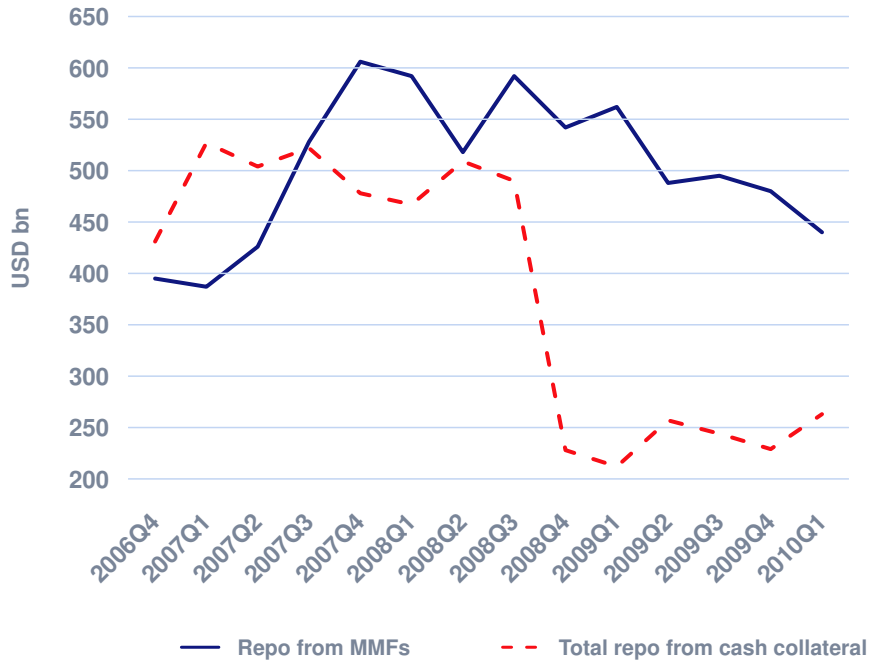


Figure 4: Securities lending against cash collateral in the U.S. These daily data aggregate fair value of all securities lent against cash collateral in the U.S., including equity, Treasuries, agency securities, and corporate bonds. The category of other lenders includes corporations, endowments, foundations, and government bodies. Source: authors' calculations based on data from Markit Securities Finance.

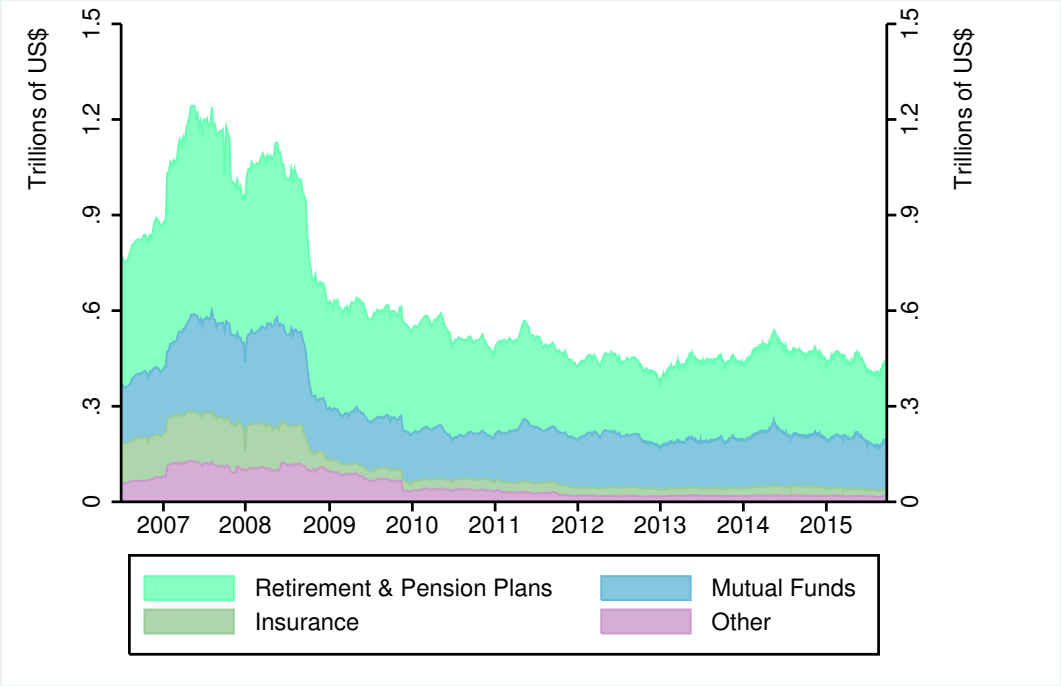


Figure 5: Corporate bond lending against cash collateral in the U.S. These daily data aggregate fair value of all corporate bonds lent against cash collateral in the U.S. The category of other lenders includes corporations, endowments, foundations, and government bodies. Source: authors' calculations based on data from Markit Securities Finance.

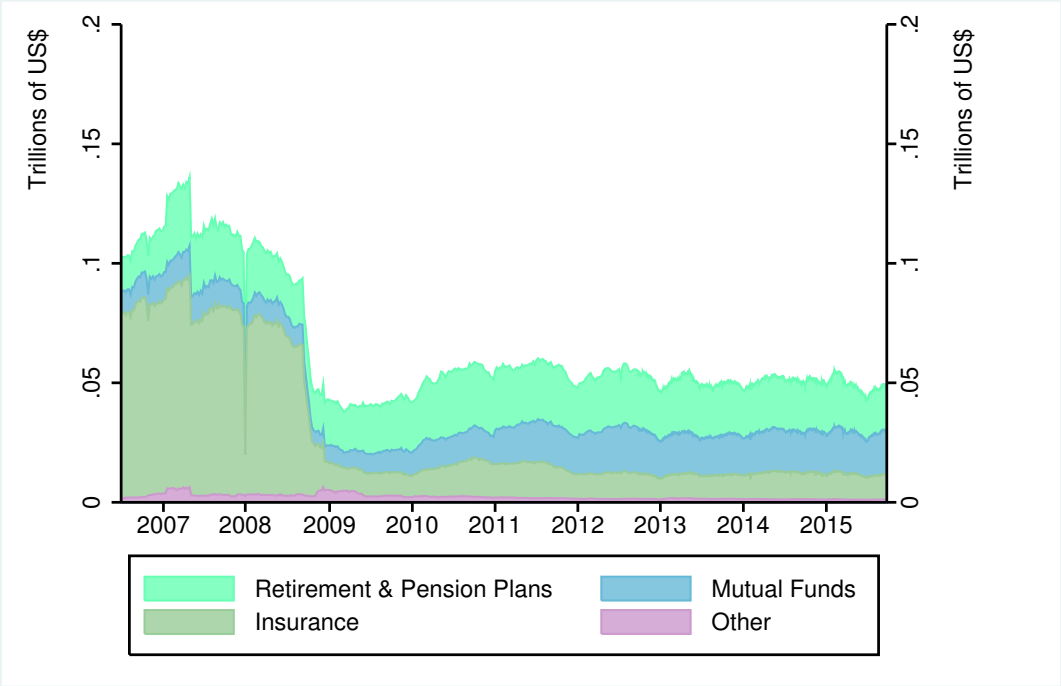


Figure 6: Securities lending cash collateral reinvestment. The blue shaded region shows the quarterly total amount of cash collateral received by securities lenders. The black and yellow lines, respectively, show the mean and median weighted average maturity of the reinvestment portfolio. Source: authors' calculations based on data from Risk Management Associates, from a survey of about 14 agent lenders.

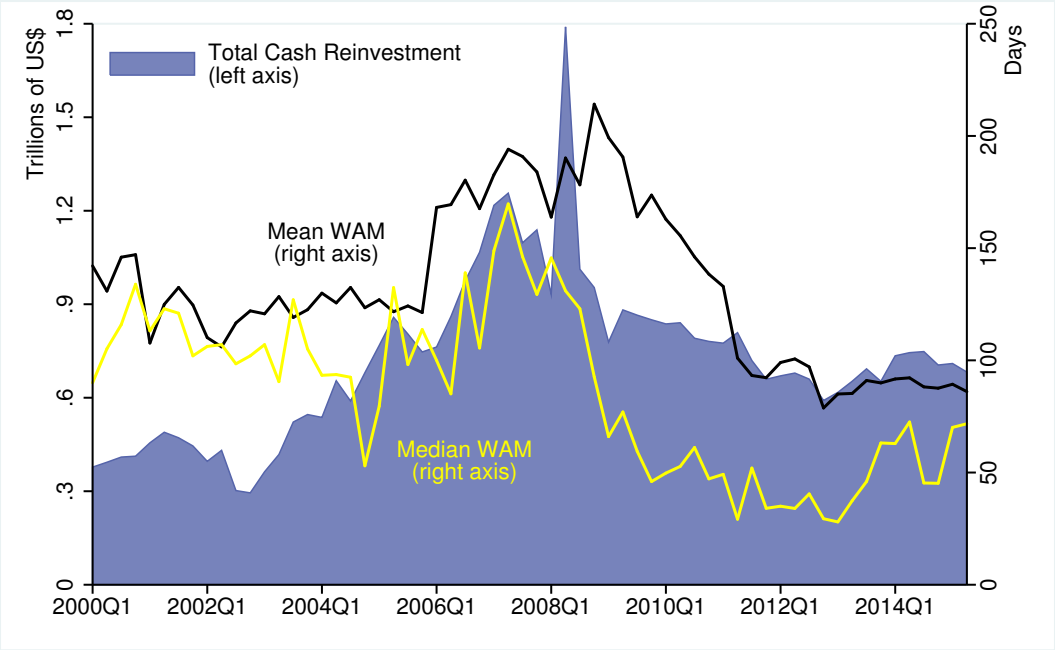


Figure 7: Securities lending by U.S. life insurers. The line shows the quarterly amount of cash collateral received by U.S. life insurers through their securities lending programs. Source: authors' calculations based on data from NAIC Quarterly Statutory Filings.

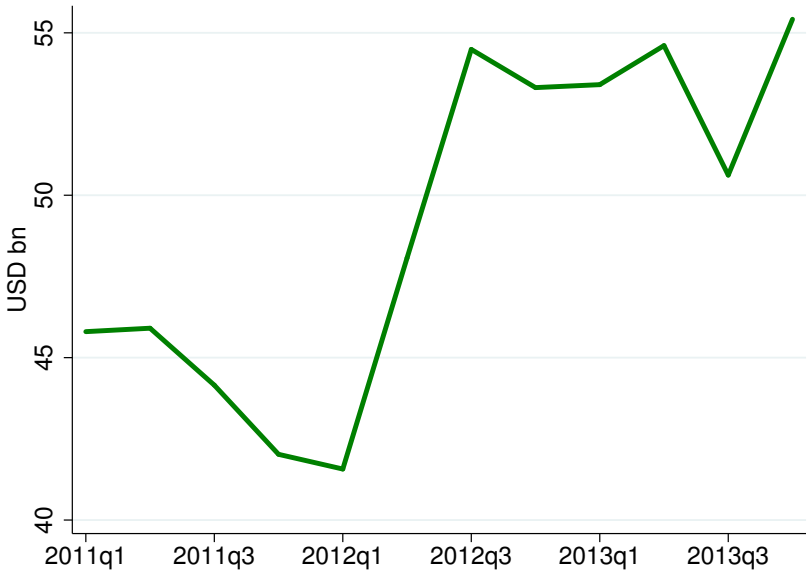


Figure 8: Maturity mismatch in the securities lending programs of U.S. life insurers. Each box-and-whisker plot represents the distribution of U.S. life insurance companies, with the solid area covering the 25^{th} to 75^{th} percentiles and the line within the solid area showing the median of the distribution. The whiskers reflect the remaining observations, up to 1.5 times the interquartile range, and the dots are outliers. The blue plot is calculated using the weighted average maturity of the cash collateral life insurers' received for lending securities, where the weights are the amounts of cash collateral received. The red plot is calculated using the weighted average maturity of life insurers' reinvestment portfolio, where the weights are the amounts reinvested. Source: authors' calculations based on data from NAIC Annual Statutory Filings.

