Who Limits Arbitrage?*

Nathan Foley-Fisher Borghan Narajabad Stéphane Verani †

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Abstract

This paper proposes and tests a theory of endogenous limits of arbitrage. We incorporate short-sale restrictions and an imperfectly competitive securities lending market into a model of securities traders with private information. The cost of short selling a security is an equilibrium outcome of the demand for short positions and the willingness of buy-and-hold institutional investors to supply their securities to short sellers. Securities lenders with greater risk tolerance are more willing to lend their securities, lowering the cost of taking short positions, which increases price informativeness in the spot trading market. We provide compelling evidence that the corporate bonds held by more risk tolerant insurance companies with securities lending programs tend to have greater spot market trade volume and more price informativeness. Controlling for each individual bond's demand, we identify the mechanism proposed by the model. Insurance companies with more risky cash collateral reinvestment portfolios are more willing to lend corporate bonds that are otherwise costly for short sellers to borrow. Our results suggest a new connection between liability-driven investment and asset pricing.

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†nathan.c.foley-fisher@frb.gov (corresponding author), 202-452-2350, 20^{th} & C Street, NW, Washington, D.C. 20551; borghan.narajabad@frb.gov; stephane.h.verani@frb.gov.

Introduction

Limits of arbitrage prevent securities prices from immediately and fully reflecting changes in their fundamental value. Past research has focused on how costly arbitrage prevents traders from eliminating mispricing, while more recent studies have emphasized the role of financial institutions and agency frictions (Gromb & Vayanos 2010). Nevertheless, the literature remains focused on the decisions of direct security spot market participants. This literature overlooks the decisions of institutions and agents outside of the spot market that can have a significant role in determining the limits of arbitrage.

We propose a theory of security prices based on a rational expectations strategic equilibrium framework with simultaneous market clearing in a secondary spot and a securities lending market. We build on a simplified version of Kyle (1989) and expand the framework to incorporate short sale restrictions and an imperfectly competitive securities lending market. Traders wishing to establish a short position must borrow the security from securities lenders by posting cash as collateral. The key innovation in the model is to endogenize the short-selling cost by considering the problem of a strategic securities lender. The cost of borrowing the security is an equilibrium outcome, as potential securities lenders take into account the price effects of their own supply of the security to short sellers.

The main result is that the informativeness of the security spot price depends on the securities lenders' cash collateral reinvestment decisions. In the model, the security spot and securities lending market are connected by the slope of the securities lenders' supply curve. Traders in the spot market wish to take opposite positions when they disagree about the security's liquidation value. Short-sellers confront the securities lenders' supply schedule when implementing their short position. When the supply of securities from securities lenders is relatively flat, short-sellers can borrow the security without significantly increasing the short-selling cost.

The slope of the securities lenders' supply curve depends on securities lenders' tolerance for cash collateral reinvestment risk. The higher is a strategic securities lender's risk tolerance, the higher is her willingness to lend the security. However, strategic securities lenders take into account the effect of their lending decision when deciding to lend to short-sellers, because supplying more securities decreases the lending fee. A lower security lending fee, in turn, decreases the risky reinvestment expected return. In equilibrium, the spot market is more active and the spot price is more informative when the strategic securities lender has a higher tolerance for reinvestment risk.

Limits of arbitrage arise in the model for two reasons. First, there are well-known limits because imperfectly competing traders have private information about the security's value and internalize the effects of their trading position on the security spot price (Kyle 1989, Vayanos 1999). Second, there are holding costs associated with implementing short positions that prevent arbitrage trades to fully reveal the true value of the security (Tuckman & Vila 1992, Dow & Gorton 1994, Duffie 1996, Krishnamurthy 2002, Gromb & Vayanos 2010). We show that short-selling costs depend on the risk tolerance of imperfectly competing securities lender that internalize the effect of their lending decisions on their cash collateral reinvestment return. Although we assume our traders have deep pockets, the limits of arbitrage that arise in the model are likely to be exacerbated by, for example, leverage constraints that affect the implementation of long and short trading positions (Brunnermeier & Pedersen 2009, Gorton & Metrick 2012, Krishnamurthy, Nagel & Orlov 2014, Dow, Han & Sangiorgi 2018).

We find strong empirical support for our model using microdata on corporate bond trading in the spot market and securities lending market. We use transaction-level spot market data from TRACE to obtain a measure of price informativeness for each corporate bond. We combine this information with data on individual securities lending market transactions from Markit Securities Finance. We then add new annual regulatory data on U.S. insurance companies that specify the bonds in each insurer's portfolio that are on loan at the time of filing as well as security-level data on each insurer's cash collateral reinvestment portfolio. These new data allow us to construct a measure of the cash collateral reinvestment risk of every insurance company that has a securities lending program.

Our data allow us to study a cross-section of more than 12,000 corporate bonds held by 109 insurance companies with individual securities lending programs and cash collateral reinvestment strategies. Consistent with the key predictions of our model, we find a robust positive relationship between the price informativeness of a bond and the cash collateral reinvestment strategies of securities lenders holding that bond. In addition, we find that bonds with greater trade volume in the spot market tend to be held by insurance companies that have more aggressive cash collateral reinvestment strategies.

We then use our microdata to delve deeper into the mechanism and study the actual decisions of the individual insurers in our dataset to lend specific corporate bonds. Adopting the same identification strategy as Foley-Fisher, Gissler & Verani (2019), we use fixed effects to absorb the demand conditions in the securities lending market for each corporate bond. We find that a security lender's decision to lend her holdings is associated with her cash collateral reinvestment strategy. Most importantly, her lending decisions are associated with the *interaction* between her reinvestment strategy and a bond's price informativeness.

Our empirical results contribute to the literature that identifies the securities lending market as a potential source of limits to arbitrage. Existing studies have documented regulations (Diether, Lee & Werner 2009, Boehmer, Jones & Zhang 2013, Beber & Pagano 2013), security ownership structure (Nagel 2005, Hirshleifer, Teoh & Yu 2011, Porras Prado, Saffi & Sturgess 2016, Foley-Fisher, Gissler & Verani 2019), the costs of short selling (Jones & Lamont 2002, Geczy, Musto & Reed 2002, Asquith, Au, Covert & Pathak 2013, Cohen, Diether & Malloy 2007, Engelberg, Reed & Ringgenberg 2018), and the availability of traded options (Figlewski & Webb 1993, Danielsen & Sorescu 2001) as having an effect on spot market trading through the securities lending market. Much of this literature identifies *exogenous* determinants of the limits to arbitrage. Our key empirical contribution to this literature is to document compelling evidence that the strategic decisions of securities lenders to reinvest their cash collateral in risky portfolios is an *endogenous* determinant of the limits to arbitrage.

The remainder of the paper proceeds as follows. In Section 2, we present the model. Section 1 provides an overview of the market for lending securities. Section 3 describes our data and provides summary statistics. Sections 4 present our empirical results. We conclude in Section 5.

1 The role of securities lenders in corporate bond trading

In this section, we first outline the role of securities lending in corporate bond market trading. We describe a typical corporate bond trade transaction, including the specific role played by securities lenders. Then, we outline the typical structure of a securities lending transaction, together with the motivations of each party to the deal.

1.1 Corporate bond trading

Corporate bonds are traded in a large over-the-counter (OTC) market. In 2015, U.S. corporations issued almost $1,500 billion of debt, compared with only $256 billion in equity.[1] After their initial offering in the primary market, most of this debt is tradable in an OTC spot market. In 2015, over 25,000 unique corporate bonds were publicly traded, with most of the trading taking place in investment grade bonds (61 percent). Between [[2011 and 2015, there were 44,082 daily transactions on average that amounted to almost $30 billion in daily volume traded.]] About two-thirds of these transactions were between a client and a dealer, and the other third of these transactions were between dealers.[2]

To buy and sell corporate bonds on the secondary market, intermediaries, such as broker-dealers, typically facilitate trading by either swiftly finding a matching counterparty for a client

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

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

in the market, or by trading itself with the client and maintaining its own inventory of bonds. Dealers inventories are naturally limited by the supply of individual bonds and the associated inventory maintenance costs.[3] The limitations on dealers' ability to fulfill client orders create an opportunity for buy-and-hold institutional investors, such as insurance companies and pension funds, as natural large repositories of securities to lend their securities. Among institutional investors in corporate bonds, insurance companies have the largest holdings, giving them a dominant position as potential bond lenders.[4] When a client wants to buy a bond that a dealer does not hold in its inventory, the dealer may borrow the bond elsewhere and deliver it to the buyer. The dealer can then wait until it can find another client willing to sell the same bond, which the dealer can return to the lender.

Corporate bond market participants, such as dealers and hedge funds, have a variety of reasons for borrowing a particular bond. It is common to borrow a bond to take a short position or to cover a naked short position (Duffie 1996, Merrick Jr, Naik & Yadav 2005). In addition to concerns about about future bond yields, bond short-sellers may be concerned with individual firm performance. For example, in a capital structure arbitrage trade, a firm's bond is shorted to hedge a long position in the firm equity (Liu & Mello 2011). Another example is a convertible bond arbitrage trade, in which firm's equity is sold short to hedge a long position in a bond issued by that firm (Agarwal, Fung, Loon & Naik 2011). In this second example, the hedge fund borrows the stock and the dealer might also borrow the convertible bond.

1.2 Securities lending and cash collateral reinvestment

In a prototypical corporate bond loan, full legal and economic ownership of the bond is transferred from the lender (e.g. insurance company) to the borrower. The ownership is essential for borrowers (e.g. dealers) to be able to deliver the bond to other counterparties (clients). To allow the borrower flexibility in the time needed to find another seller of the same bond, the term of the loan is usually open-ended, but either party is able to terminate the deal at any time by returning the security/collateral.[5]

In exchange, the bond borrower gives the bond lender collateral in the form of cash, which the lender may reinvest according to its own strategy and regulatory limitations.[6] Typically, the

[3] Dealer inventory cost may be affected by regulations, such as the Volcker Rule that restricts proprietary trading by banks (Bao, O'Hara & Zhou 2018, Schultz 2017, Dick-Nielsen & Rossi 2018).

[4] Insurance companies account for 20 percent of all corporate bonds outstanding as of 2018Q2 (Table L.213 of the Financial Accounts of the United States available at `https://www.federalreserve.gov/apps/FOF/Guide/L213.pdf`).

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

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

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

The ultimate securities 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 (Keane 2013, Foley-Fisher, Narajabad & Verani 2019).[7] Some institutional investors lend only opportunistically, lending securities that are special and reinvesting the cash collateral in cash-like debt instrument, such as treasury and agency repo. Others institutional investors may lend out a greater portion of their portfolio regardless of the rebate and reinvest the cash collateral in a portfolio of relatively illiquid assets. How aggressively a securities lender pursue securities-lending income depends on its risk tolerance. This suggests a non-trivial relationship between short-selling costs and securities lenders' cash collateral reinvestment strategy.[8] This relationship is likely to be more relevant for thin markets (Rostek & Weretka 2016), where, for example, life insurers hold a large fraction of individual corporate bond issue. In the next section, we propose a new theory to formalize the link between an institutional investor securities lending strategy and spot market trading.

2 A theory of security prices with endogenous short-selling costs

We propose a theory of security prices based on a rational expectations strategic equilibrium framework with double auctions in the spot market and the securities lending market. We start from a simplified version of the model introduced in Kyle (1989) that we expand to incorporate short-sale restrictions and an imperfectly competitive securities lending market. Traders wishing to establish a short position must borrow the security from securities lenders and post cash as collateral. From the perspective of the short-seller, the securities lending transaction corresponds to a reverse repurchase agreement.[9] The cost of borrowing the security affects the short-selling

cash collateral.

[7] 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.

[8] Focusing on the 2008-09 financial crisis, Foley-Fisher, Gissler & Verani (2019) shows corporate bonds liquidity was adversely affected by the shutdown of AIG's securities lending program after the company experienced a run on its securities lending program.

[9] As will become clear, our framework also applies to securities lending against non-cash collateral.

cost and is an equilibrium outcome, as potential securities lenders' take into account the price effects of their own supply of the security to short sellers. The endogenous short-selling cost affects traders' short positions, and, therefore, the informativeness of the security price in the spot market. Limits of arbitrage arise because traders and securities lenders rationally internalize the price effects of their position in the spot market and in the securities lending market.

2.1 Market structure

There is a single risky security traded in a single period. Let $\nu \sim N(0, \tau_\nu^{-1})$ be the normalized random liquidation value of the security that is realized after the one-period trading session.

2.1.1 Spot market participants

Two types of traders participate in the spot market. All traders have a non-stochastic endowment, which is normalized to zero. A single privately informed trader trades strategically against the residual demand from a large number of small, privately informed non-strategic traders, whose combined position is assumed to be exogenous.

The first type of trader is a single strategic *informed trader* who receives a private signal $s = \nu + \varepsilon$ about the value of the security, where $\varepsilon \sim N(0, \tau_\varepsilon^{-1})$ is random noise. The informed trader has an exponential utility function with risk-aversion parameter ρ_i given by

$$- \exp\left(-\rho_i \cdot (\nu - \hat{p}) \cdot x\right) \ , \tag{1}$$

where $x \in \mathbb{R}$ denotes her trading position and $\hat{p}$ denotes the per unit cost of taking a position. These quantities and prices are determined in equilibrium.

The second type of trader is a unit measure continuum of atomistic non-strategic *chartists.* These traders' combined position in the trading session is random and exogenously given by

$$(z - \hat{p}) \cdot \kappa \ , \tag{2}$$

where $z = \nu + \zeta$ and $\zeta \sim N(0, \tau_\zeta^{-1})$. We use the label "chartists" for the second type of traders because they implement a position that is proportional to the difference between their benchmark, z, and the cost of the position, $\hat{p}$. The parameter κ is the slope of the residual demand from the chartists' combined position.[10]

The unit cost of trading, $\hat{p}$, depends on the direction of the position. When taking a long

[10] Note that these chartist traders are essentially a combination of the noise traders and informed speculators in Kyle (1989).

position, traders pay the spot price p to acquire the security. When taking a short position, traders need to borrow the security from a securities lender by posting cash collateral. We follow the institutional setup of the *rebate*, described in Section 1, when modeling the cost of borrowing the security, which we denote by r. The *rebate* is the percentage of the cash collateral reinvestment income that the securities lender pay to the securities borrower. The rebate r is a non-positive amount in our model because we normalize the risk-free interest rate to zero. The rebate is more negative when the security is in high demand from short-sellers. The net per unit short-selling cost is therefore $p + r$. When a trader thinks the security is overvalued and would like to take a short position, a more negative rebate r decreases the attractiveness of short selling, as $p + r$ is lower. In summary, the cost of trading is given by:

$$\hat{p} = \begin{cases} p & \textit{if } x \geq 0 \\ p + r & \textit{if } x < 0. \end{cases}$$

2.1.2 Securities lending market participants

Traders that borrow securities to take a short position participate in the securities lending market together with two types of potential securities lenders. Both types of securities lenders are endowed with an unlimited and unconstrained stock of the security. A single potential securities lender has access to a risky cash collateral reinvestment opportunity and strategically chooses how much of the security to lend taking as given the combined supply of the security supplied to short-sellers by a large number of small and non-strategic potential securities lenders.

The first type of securities lender is a unit measure continuum of atomistic *non-strategic* securities lenders supplying $L_n = -\ell_n \cdot r$ units of the security to short-sellers, where $\frac{1}{\ell_n} > 0$ denotes the slope of the non-strategic securities lenders' aggregate supply curve. When the demand from short-sellers is high, the non-strategic security lenders respond to the more negative rebate r by increasing their supply of the security. If the supply curve steep, ℓ_n is low, a high demand for borrowing the security results in a more negative rebate rate, r, which in turn, as we discussed above, decreases the attractiveness of short selling.[11]

The second type of securities lender is a single strategic securities lender who reinvests the cash collateral in a risky project with return $R \sim N\left(0, \tau_R^{-1}\right)$. The strategic securities lender has an exponential utility function with risk-aversion parameter ρ_s given by

$$-\exp\left(-\rho_s \cdot (R - r) \cdot L_s\right) \ , \tag{3}$$

[11] A more negative rebate is usually associated with the "specialness" of the security.

where L_s is the quantity of the security that is lent to short-sellers.

2.2 Equilibrium

Any equilibrium requires the spot and securities lending markets to clear simultaneously. An intimate connection between the spot market and securities lending market arises because traders wishing to take short positions in the spot market need to borrow the security in the securities lending market. The strategic securities lender's supply affects the positions of the spot market traders through the rebate, which is the short-selling cost. At the same time, the informed trader's position can affect the rebate through her demand for borrowing the security.

We follow Kyle (1989) and focus on existence and characteristics of the *linear* Nash equilibrium. Specifically, we assume that the strategic informed trader and the strategic securities lender consider the effects of their decisions on equilibrium prices to be linear. We then characterize their optimal decision and verify that the market clearing prices are indeed linear in the decisions of the informed trader and the strategic securities lenders.

2.2.1 Securities spot market

We begin by holding the supply of security and the rebate constant. The informed trader chooses her trading position x to maximize her expected utility, which solves the following problem:

$$\begin{aligned} \max_x \quad & \mathbb{E}\left[-\exp\left(-\rho_i \cdot (\nu - \hat{p}) \cdot x\right) | s, p, r\right] \\ s.t. \quad & \hat{p} = \begin{cases} p & x \geq 0 \\ p + r & x < 0. \end{cases} \end{aligned} \tag{4}$$

The first order condition for the solution of (4) implies that

$$x \quad = \quad \frac{\mathbb{E}\left(\nu | s, p, r\right) - \hat{p}}{\mathbb{VAR}\left(\nu | s, p, r\right) + \hat{p}'(x)}. \tag{5}$$

The marginal effect of the informed trader's position on the cost of the trading position, $\hat{p}'(x)$, depends on the security equilibrium spot price and rebate.

The spot market clears when $x + (z - p) \cdot \kappa = 0$, which implies that $p = z + \frac{x}{\kappa}$. We assume that the rebate r is linear in the trading position x, and that if $x = 0$ then $r = 0$. We verify that this is indeed the case in Section 2.2.2 below. The linearity of r and the spot market clearing condition imply that $r = -\frac{|x|}{\ell}$ for a positive ℓ. Therefore, the informed trader's marginal cost of taking a long position $x \geq 0$ and short position $x < 0$ is given by

$$\hat{p}'(x) \quad = \quad \begin{cases} \frac{1}{\kappa} & x \geq 0 \\ \frac{1}{\kappa} + \frac{1}{\ell} & x < 0 \end{cases} . \tag{6}$$

Note that when taking a short position, $x < 0$, the informed trader takes into account the effect of her position on both the security spot price p and rebate r.

It remains to determine $\mathbb{E}(\nu|s,p,r)$ and $\mathbb{VAR}(\nu|s,p,r)$ to fully characterize the solution of the informed trader's problem (5). Note that the information content of s, p, and r for the liquidation value ν is same as the information content of the informed trader's signal and chartist traders' benchmark, $s = \nu + \varepsilon$ and $z = \nu + \zeta$, respectively. Given that ε and ζ are independent, this implies that the trader's learning—i.e., Bayesian inference—about the liquidation value is given by:

$$\begin{aligned} \mathbb{E}(\nu|s,p,r) = \mathbb{E}(\nu|s,z) \quad &= \quad \frac{\tau_\varepsilon}{\tau_\nu + \tau_\varepsilon + \tau_\zeta} \cdot s + \frac{\tau_\zeta}{\tau_\nu + \tau_\varepsilon + \tau_\zeta} \cdot z \\ &= \quad \frac{\tau_\varepsilon}{\tau_\nu + \tau_\varepsilon + \tau_\zeta} \cdot s + \frac{\tau_\zeta}{\tau_\nu + \tau_\varepsilon + \tau_\zeta} \cdot \left(\hat{p} - x \cdot \left(\frac{1}{\kappa} + \frac{1}{\ell}\right)\right) , \end{aligned} \tag{7}$$

where the second equality follows from the traders' inference of about ν from the noisy signal, and the last equality follows from the spot market clearing condition. Similarly, the precision of the traders' inference about the true liquidation value is given by

$$\mathbb{VAR}(\nu|s,p,r) = \mathbb{VAR}(\nu|s,z) \quad = \quad \frac{1}{\tau_\nu + \tau_\varepsilon + \tau_\zeta}. \tag{8}$$

Plugging (6), (7), and (8) into (5) yields the informed trader's optimal trading position as a function of the endogenous security spot price and security borrowing cost.

$$x \quad = \quad \frac{\tau_\varepsilon \cdot s - (\tau_\nu + \tau_\varepsilon) \cdot \hat{p}}{\rho_i + (\tau_\nu + \tau_\varepsilon + 2\tau_\zeta)\left(\frac{1}{\kappa} + \frac{1}{\ell}\right)} , \tag{9}$$

where the cost of taking the position, $\hat{p}$, depends on the direction of the informed trader's position:

$$\hat{p} \quad = \quad \begin{cases} p & x \geq 0 \\ p + \frac{x}{\ell} & x < 0 \end{cases} . \tag{10}$$

Because the informed trader takes into account the effect of her short position on the cost of borrowing the security, $r = \frac{x}{\ell}$, the informed trader' short position is given by:

$$x \quad = \quad -\frac{(\tau_\nu + \tau_\varepsilon) \cdot p - \tau_\varepsilon \cdot s}{\rho_i + (\tau_\nu + \tau_\varepsilon + 2\tau_\zeta)\,\frac{1}{\kappa} + 2\,(\tau_\nu + \tau_\varepsilon + \tau_\zeta)\,\frac{1}{\ell}}, \tag{11}$$

In the model, short-sellers are the *supply* side of the spot market. For example, the chartists take a long position when their benchmark, z, is more optimistic than the informed trader's signal, s, and the informed trader takes the opposite position and shorts the security. The chartists' position, $(z - p) \cdot \kappa$ is the downward sloping demand schedule in the spot market and the informed trader's short position, $-x$, is the upward slopping supply schedule. It follows that the equilibrium security spot price necessarily falls between s and z.

Equation (11) shows that the slope of the supply of securities in the securities lending market, ℓ, directly affects the slope of the upward sloping supply schedule in the spot market. For example, the supply schedule of the spot market is relatively flat when the supply of securities in the securities lending market is also relatively flat. In this case, short sellers can borrow the security in relatively large proportion without significantly increasing the short-selling cost.

Figure 1 illustrates how the slope of the supply of securities in the securities lending market affects the equilibrium spot price. In this example, we assume that the informed trader shorts the security, $x < 0$ and the realization of ν and ϵ is such that $\nu = \epsilon = 0$.[12] We also assume that $1/\kappa \to 0$, which neutralizes the effects emphasized by Kyle (1989) to focus on the contribution of the securities lending market. Figure 1 plots the supply schedules in the spot market corresponding to high and low levels of security supply from securities lenders, ℓ, and demand schedules for high and low levels of the chartists' benchmark value about the security, z. Each of the four black dots represent an equilibrium security spot price and quantity for a given level of ℓ and z. The equilibrium spot price and quantity corresponding to a relatively low value of ℓ and z is represented by the point (p_1, x_1). A steeper supply curve in the securities lending market yields a greater and lower equilibrium spot price and quantity, which is represented by (p_2, x_2). This is because a lower ℓ means that it is more expensive for short sellers to borrow the security from securities lenders. Because implementing the short position is more costly, it is also more revealing of the signal received by the informed trader. As a result, there is less trade and the spot price is higher. This effect is larger when the chartists are more optimistic and their benchmark security value z is higher, which is represented by a move from (p_1', x_1') to (p_2', x_2'). In this case the price effect of the short-seller is greater, which leads to an even less revealing security spot price.

[12] The other model parameters are set as follows: $\rho_i = 0.1$; $\ell_n = 1$; $\tau_\nu = \tau_\epsilon = \tau_\zeta = \tau_R = 1$; $\nu = 0$; $\epsilon = 0$; $\zeta_h = 1$; $\zeta_l = 0.7$.

To find the equilibrium quantity and price of security traded in the spot market, we use the spot market clearing condition in equation (9) to obtain:

$$\begin{aligned} x^* &= \frac{\tau_\varepsilon \cdot s - (\tau_\nu + \tau_\varepsilon) \cdot z}{\rho_i + 2(\tau_\nu + \tau_\varepsilon + \tau_\zeta) \cdot \left(\frac{1}{\kappa} + \frac{1}{\ell}\right)} \\ p^* &= \begin{cases} \hat{p}^* & x \geq 0 \\ \hat{p}^* - \frac{x^*}{\ell} & x < 0 \end{cases}, \end{aligned} \tag{12}$$

where

$$\hat{p}^* = \frac{\tau_\varepsilon \left(\frac{1}{\kappa} + \frac{1}{\ell}\right) \cdot s + \left(\rho_i + (\tau_\nu + \tau_\varepsilon + 2\tau_\zeta)\left(\frac{1}{\kappa} + \frac{1}{\ell}\right)\right) \cdot z}{\rho_i + 2(\tau_\nu + \tau_\varepsilon + \tau_\zeta) \cdot \left(\frac{1}{\kappa} + \frac{1}{\ell}\right)}.$$

Equation (12) illustrates further the effect of securities lending on the equilibrium quantity and price of security traded in the spot market. When there is a lot of disagreement among traders about the liquidation value of the security—i.e., $\mid s - z \mid$ is large—traders want to take opposite positions. When the supply of securities by securities lender is flat, $\frac{1}{\ell}$ is small, traders can borrow the security without significantly increasing the short-selling cost. In this case, the spot market is more active, and the spot price is more informative about the security's liquidation value. In the limit $\ell \to \infty$, thus $\frac{1}{\ell} \to 0$, our model collapses to a simple version of Kyle (1989). In this special case, arbitrage is limited because the disagreement among traders means that trading in the spot market does not fully reveal the true liquidation value. We turn to the securities lending market next.

2.2.2 Securities lending market

Proposition 2.1 explains how the supply of securities by securities lenders affect spot market trading.

Proposition 2.1 *The expected trading volume $\mathbb{E}(\mid x^* \mid)$ and the informativeness of the security price $\frac{d}{d\nu}\mathbb{E}(p^*|\nu)$ in the spot market are decreasing in the slope of the securities lending supply, $\frac{1}{\ell}$.*

Proof The proof follows from substituting $s = \nu + \varepsilon$ and $z = \nu + \zeta$ in equation (12) and noting that when $x > 0$

$$\frac{d}{d\nu}\mathbb{E}(p^*|\nu) = 1 - \frac{\tau_\nu}{\frac{\rho_i}{\frac{1}{\kappa}+\frac{1}{\ell}} + 2(\tau_\nu + \tau_\varepsilon + \tau_\zeta)}, \tag{13}$$

and when $x < 0$

$$\frac{d}{d\nu}\mathbb{E}\left(p^*|\nu\right) \quad = \quad 1 - \frac{\tau_\nu\left(1 - \frac{1}{\frac{1}{\kappa}+\frac{1}{\ell}}\right)}{\frac{\rho_i}{\frac{1}{\kappa}+\frac{1}{\ell}} + 2\left(\tau_\nu + \tau_\varepsilon + \tau_\zeta\right)}. \qquad \blacksquare \tag{14}$$

The spot and securities lending market are connected by the slope of the securities lenders' supply curve, $\frac{1}{\ell}$. To solve for an equilibrium, we need to characterize the solution for the strategic lender's problem, because the total supply of security to short sellers, $-\ell \cdot r$, is the sum of the security supplied by the non-strategic lenders, $L_n = -\ell_n \cdot r$, and by the strategic lender, L_s. We also need to verify that the optimal strategic securities supply function is linear, as previously assumed.

The strategic lender chooses how much security to lend to short sellers to maximize his expected profit given in problem (3). In doing so, the strategic lender takes into account the effect of his lending decision on the rebate r. The first-order-condition for problem (3) is

$$-\rho_s \cdot \mathbb{E}\left(R|r\right) + \rho_s^2 \cdot \mathbb{VAR}\left(R|r\right) \cdot L_s + \rho_s \cdot r\left(L_s\right) + \rho_s \cdot L_s \cdot r'\left(L_s\right) \quad = \quad 0 \; ,$$

which implies that

$$\begin{aligned} L_s \quad &= \quad \frac{\mathbb{E}\left(R|r\right) - r\left(L_s\right)}{\rho_s \cdot \mathbb{VAR}\left(R|r\right) + r'\left(L_s\right)} \\ &= \quad -\frac{r}{\frac{\rho_s}{\tau_R} + \frac{1}{\ell}} \; . \end{aligned} \tag{15}$$

The second equality follows from the assumption that the strategic securities lender's reinvestment project and the short interest are independent.

We check that the securities lending market clears to verify that the strategic lender's linear supply—equation (15)— is indeed optimal. Market clearing requires that,

$$\begin{aligned} -\ell \cdot r \quad &= \quad -\ell_n \cdot r + L_s \\ &= \quad -\ell_n \cdot r - \frac{r}{\frac{\rho_s}{\tau_R} + \frac{1}{\ell}} \; , \end{aligned}$$

which implies that the slope of the securities lenders' supply curve is

$$\ell \quad = \quad \frac{\ell_n}{2} \cdot \left(1 + \sqrt{1 + \frac{4\tau_R}{\rho_s \cdot \ell_n}}\right). \tag{16}$$

Proposition 2.2 below follows immediately.

Proposition 2.2 *The slope of of the securities lenders' supply curve, $\frac{1}{\ell}$, is increasing in the slope of the non-strategic lender's supply curve, $\frac{1}{\ell_n}$, and is decreasing in the strategic lender's risk tolerance, $1/\rho_s$.*

Proof The proof follows from (16). $\blacksquare$

Figure 2 and 3 plots the equilibrium spot quantity and price as a function of the the strategic securities lender's risk tolerance, $1/\rho_s$, respectively. Recall that equation (16) implies that that ℓ is lower when $1/\rho_s$ is lower. The black dots in Figure 2 and 3 corresponds to the equilibrium plotted in Figure 1. The quantity traded in the spot market is increasing in the securities lenders' risk tolerance, while the security spot price is decreasing in the securities lenders' risk tolerance.

The strategic securities lender with a higher risk tolerance for reinvestment risk—i.e., a lower ρ_s— has a higher willingness to lend the security. In this case, an increase in short interest does not result in a significant increase in short-selling cost. Conversely, arbitrage could be severely limited if the strategic securities lender's risk aversion is very high. Corollary 2.3 below summarizes this property.

Corollary 2.3 *The expected trading volume $\mathbb{E}\left(\mid x^* \mid\right)$ and the informativeness of the security price, $\frac{d}{d\nu}\mathbb{E}\left(p^*|\nu\right)$, are decreasing in the strategic securities lender coefficient of risk-aversion, ρ_s.*

Proof The proof follows from propositions (2.1) and (2.2). $\blacksquare$

Figure 4 plots the informativeness of the security spot price as a function of the the strategic securities lender's risk tolerance, $1/\rho_s$. When the strategic lender risk tolerance is very high—i.e., $1/\rho_s \to \infty$— the slope of the securities lenders' supply curve becomes flat—i.e., $1/\ell \to 0$. Proposition (2.1) shows that the security spot price is more informative about the security liquidation value for lower value of $1/\ell$. As we discussed above, our model collapses to a simple version of Kyle (1989) in the limit where $1/\rho_s \to \infty$ and $1/\ell \to 0$. Note that we have neutralized the effects of the Kyle (1989) in our model by setting $1/\kappa \to 0$. Therefore, the distance between the blue solid line to the 100 percent level in Figure 4 is precisely the variation in price informativeness that can be attributed to changes in the securities lending market.

Our theory suggests a novel link between securities lenders' cash collateral reinvestment and the informativeness of spot market trading. As in Kyle (1989), natural limits of arbitrage arise because imperfectly competing traders receive different signals about the security's liquidation value and internalize the effects of their trading position on the spot price. When traders need to cover their short position by borrowing the security against cash collateral, the short-selling cost affects their position. The short-selling cost depends on imperfectly competing lenders that also internalize the effects of their lending decision on the rebate. In equilibrium, the security is more actively traded and its price is more informative when potential securities lenders have a higher tolerance for reinvestment risk.

The model predicts that the informativeness of the security price in the spot market depends on the securities lender reinvestment decision, which is depicted in Figure 4. This testable implication of the model highlights the potentially important role of securities lending market for liquidity in the spot market. It is clear that testing the implication of the model requires price and quantity data for securities spot and lending market, as well as some information about securities lenders' risk tolerance. The remainder of the paper discuss how we constructed this data for the universe of U.S. corporate bonds and implemented our tests.

3 Data sources and key variables

We combine several data sources to obtain the dataset we use in our analysis. This section first lays out how we combine data from the corporate bond spot trading market, the securities lending market, and insurer's Statutory filings. We then discuss the key variables that we use in our analysis and present some summary statistics.

Our data on corporate bond spot trading come from TRACE, created by the Financial Regulatory Authority (FINRA). Under regulations introduced in 2002 by FINRA, dealers are required to file detailed reports of their transactions, including trade time, quantity, price, and counterparty. We follow standard procedures for cleaning these data, including deleting all small noise-generating trades below $10,000 and removing duplicate transactions.[13] We aggregate the data to a daily frequency by constructing transaction-weighted average prices. Using these daily data, we calculate the median daily price for each corporate bond over a 28-day period around the end of each year.

We merge the TRACE data with Mergent's Fixed Income Securities Database (FISD) by CUSIP identifier to obtain corporate bond characteristics, including offering amount, offering yield, amount outstanding, credit rating, and a range of indicators on the type of each bond. We exclude from our sample all bonds that are convertible, putable, privately-placed, asset-backed, or sold as part of a unit deal. We account for reissuance and early retirement when computing the amount outstanding over time. We define rating changes using the date of the first action by a rating agency (Ellul, Jotikasthira & Lundblad 2011).

We match the TRACE data with securities lending market data from Markit Securities

[13] See, for example, Dick-Nielsen (2009) and Bao et al. (2018).

Finance (MSF) dataset using CUSIP identifiers.[14] These data include both equity and fixed income loans and cover about 85 percent of the global market and more than 90 percent of the U.S. securities lending market. Securities lenders report information about each loan they have outstanding on a given day, including the security on loan, the value of the loan, duration, lending fee, rebate rate, and the type of collateral posted. In addition, securities lenders report on each day the total value of every security that they have available to lend. We first aggregate these transaction-level data to a daily frequency by calculating for each corporate bond the total amount available for borrowing, the total amount on loan, and the transaction-weighted average rebate. Using these daily measures, we compute the median daily values for the amount available, the amount on loan, and the rebate for each corporate bond over a 28-day period around the end of each year.

Lastly, we combine our TRACE-FISD-MSF merged dataset with information about insurance companies' corporate bond holdings, securities lending decisions, and cash collateral reinvestment portfolios from the NAIC Annual Statutory Filings. This information is reported as of the end of each year over the period from 2011 through to 2015. Within these filings, Schedule D reports each life insurer's holdings of individual fixed income securities, together with cross-sectional information about each security, including the CUSIP identifier and whether the bond was on loan as part of the insurer's securities lending program or subject to a repurchase agreement.[15] We drew information about the total size and performance of the 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.

The NAIC Quarterly and Annual Statutory Filings also contain Schedule DL, a relatively new report of individual investments made by insurers using cash collateral received from securities lending, both on-balance sheet and off-balance sheet.[16] 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.[17] Figure 5 shows an extract

[14] Foley-Fisher, Gissler & Verani (2019) construct a similar dataset covering the period from 2006 to 2010. The dataset of Foley-Fisher, Gissler & Verani (2019) lacks data on life insurers' securities lending cash collateral reinvestment portfolios, which became available only from 2011.

[15] The amount of each bond on loan is not reported. The statutory filings only indicate whether or not the bond is on loan as of each yearend.

[16] We also use Schedule DL in Foley-Fisher, Narajabad & Verani (2019) in which we study the supply side of the securities lending market.

[17] The new guidelines stem from a review of the securities lending practices at AIG that contributed to its collapse during the 2007-09 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.

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, these 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.[18] 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 6 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.

Our final merged dataset covers five yearends (2011-2015) with information on 12,411 unique bonds. We identify 109 insurance companies with securities lending programs. In 2015, this set of insurers held more than $2.5 trillion in general account assets, or about 43 percent of the industry total.

3.1 Key variables and summary statistics

The key variables for our study are the price informativeness of each bond in its spot market and the riskiness of the cash collateral reinvestment strategies of insurance companies that have securities lending programs. We now describe how we measure these two variables in our data. Summary statistics for all the variables in our dataset are reported in Table 1. The table is divided in two, with summary statistics for bond-year data aggregated over insurance companies reported in the upper panel and summary statistics for bond-insurer-year data reported in the lower panel.

The concept of bond price informativeness in our model is closely related to an empirical measure of the bid-ask spread on spot market transactions. Intuitively, when traders with different information sets can more easily trade in the spot market, the bid-ask spread will be tighter because movements in the price will be more informative about changes in the underlying value of the security.[19] By contrast, when traders are unable to trade in the spot market, for example because a securities lender does not make its asset available for short positions, then

http://www.dfs.ny.gov/insurance/circltr/2010/cl2010_16.htm
http://www.naic.org/capital_markets_archive/110708.htm

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

[19] Bollen, Smith & Whaley (2004) propose a model of bid-ask spreads as compensation for dealers bearing price risk. Greater price informativeness can lead to lower bid-asks spreads in that model through lower price volatility.

movements in the equilibrium market price will not be as informative about changes in the underlying value of the security and the bid-ask spread will be wider.

We exploit the inverse relationship between the bid-ask spread and price informativeness to use the label of price informativeness for the negative of the bid-ask spread in the remainder of our analysis. We take the negative of the spread to make the interpretation of the sign of the coefficients easier: The transformed variable is increasing in price informativeness. To construct our empirical measure of price informativeness as the negative of the bid-ask spread, we first calculate for each bond on each day the volume-weighted average buy and sell prices between dealers and their clients. We then compute price informativeness as the negative of the *average realized bid-ask spread*, which is the difference between the average daily price at which a dealer sells a bond to a client and the average daily price at which a dealer buys the same bond from a client. We compute the median daily price informativeness for each bond over the 28-day period around the end of each year. Line 6 of Table 1 reports summary statistics for price informativeness, indicating that in our sample of corporate bonds the average is -0.64 percentage points with a standard deviation of 0.81 percentage points.

Our proxy for the riskiness of an insurer's cash collateral reinvestment strategy is based on the residual maturity that is reported for all types of securities in the regulatory filings. Specifically, we first calculate the fraction of assets in an insurer's cash collateral reinvestment portfolio that have a residual maturity of more than one year. We then subtract the fraction of cash collateral that is received by the insurer for a duration of more than one year. The one-year threshold in our calculation 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.[20] It follows that these assets are likely to offer a higher return than cash instruments.

For each bond i at the end of year t, we construct a bond-level index for the reinvestment risk of insurance companies that have securities lending programs. Let m_{jt} be the fraction of life insurer j's cash collateral reinvestment portfolio at the end of year t that has a residual maturity of more than one year. Let h_{ijt} be the amount of bond i held by life insurer j at the end of year t. We construct an insurer-only reinvestment risk index as: $\sum_j h_{ijt} m_{jt} / \sum_j h_{ijt}$. We also construct a full-lender index assuming that all other securities lenders of a bond do not have any reinvestment risk (cash collateral maturity transformation).[21] Let H_{jt} be the total amount

[20] Our one year threshold is six times the regulatory limit on the overall maturity of a mutual fund's cash reinvestment portfolio. Amendments to regulation Rule 2a-7, adopted by the SEC in July 2014, impose 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. `https://www.sec.gov/rules/final/2014/33-9616.pdf`

[21] The industry's cash collateral reinvestment weighted average maturity transformation if about 90 days.

of bond j that is available for securities lending transactions at the end of year t. We construct the all-lender reinvestment risk index as: $\sum_j h_{ijt} m_{jt}/H_{jt}$. Summary statistics for these indexes are reported in the first two lines of Table 1. Across all bonds and years, the mean values of the two reinvestment risk indexes are 0.18 and 0.13, with standard deviations of 0.16 and 0.17, respectively.

4 Empirical analysis and results

In this section, we test the empirical predictions of the model of bond trading and securities lending that was presented in Section 2. We first study data on individual bonds aggregated over insurance companies at the end of each year, as described in the previous section. We show that price informativeness of a bond is associated with the cash collateral reinvestment strategies of securities lenders holding that bond. We then study data on insurance companies' decisions to lend individual bonds. We show that individual bond lending decisions are associated with the *interaction* between the cash collateral reinvestment strategies and the [[market conditions]] for that bond.

4.1 Price informativeness, spot market trading, and securities lending

Consistent with Proposition XX in Section 2, Table 2 shows a robust association between the price informativeness of a bond (*Price informativeness*$_{it}$) and the reinvestment strategy of securities lenders that hold the bond. The positive coefficient suggests that greater price informativeness is associated with greater maturity transformation by securities lenders. Column 1 reports the simple correlation using the insurer-only reinvestment risk index. Column 2 reports the correlation using the full-lender reinvestment risk index and controls for the share of the bond held by life insurers that have securities lending programs (*Insurers share*$_{it}$ $= \sum_j h_{ijt}/H_{jt}$). Column 3 adds control variables for the specific market for bond i. Column 4 adds controls for the type of bond. In all cases, we include year fixed effects to absorb aggregate market conditions and to focus our analysis on the cross-section of bonds.[22]

Table 3 repeats the regression analysis of the previous table using the volume of trade in the spot market as the dependent variable. We find a robust positive relationship between volume

By contrast, we estimate that the U.S. life insurance industry's cash collateral reinvestment weighted average maturity transformation if at least 500 days.

[22] Consistent with the findings in the literature on corporate bond liquidity (e.g. Bao et al. (2018)) we find that price informativeness is negatively associated with residual maturity and offering yield and is positively associated with the amount outstanding and the credit rating. We also find that price informativeness is negatively associated with concentration of holdings among securities lenders (HHI_{it}) indicating that securities lenders may have some market power (Foley-Fisher, Narajabad & Verani 2019).

($Volume_{it}$) and the reinvestment strategy of securities lenders that hold the bond. Column 1 reports the simple correlation using the insurer-only reinvestment risk index. Column 2 reports the correlation using the full-lender index and controls for the share of the bond held by life insurers that have securities lending programs ($Insurers\ share_{it} = \sum_j h_{ijt}/H_{jt}$). Column 3 adds control variables for the specific market for bond i. Column 4 adds controls for the type of bond. We continue to include year fixed effects as in the previous regression specifications.

4.2 Life insurers' decisions to lend bonds

Our results so far show that securities lenders' cash collateral reinvestment strategies have an effect on price informativeness and trading in the secondary spot market for corporate bonds. These results are consistent with our model's predictions. We now probe the mechanism behind our empirical findings by studying securities lenders' decisions to lend specific corporate bonds. We use our microdata to study the decision of life insurer j to lend bond i at time t. We find that a securities lender's decision to lend an individual bond is associated with that lender's cash collateral reinvestment strategy. Moreover, the lending decisions is associated with the interaction between the lender's reinvestment strategy and each bond's [[market conditions.]]

The dependent variable in the specifications reported in Table 4 is a dummy variable for whether insurer j is lending bond i at the end of year t ($Loan_{ijt}$).[23] Our main explanatory variables are the fraction of insurer j's cash collateral reinvestment portfolio that has a residual maturity of more than one year ($Reinvestment\ risk_{jt}$) and the weighted average rebate on bond i ($Rebate_{it}$). Column 1 of the table reports the simple correlation between the variables. The interaction between the securities lender's cash collateral reinvestment strategy and a bond's rebate is positively associated with the securities lender's decision to lend that particular bond. The association is statistically and economically significant. The result suggests that, consistent with the predictions of the model, securities lenders that reinvest their cash collateral aggressively are more likely to lend bonds that have a *higher* rebate. These bonds are less profitable for securities lenders because the lender must pay a higher rebate to the securities borrower.

This empirical result survives a battery of controls for the type of bond being lent and its market conditions. Column 2 reports the results from adding control variables for the percentage of the bond held by insurers, the concentration of holdings among insurers, and the total amount on loan relative to the amount that could be lent. In addition, we control for the residual maturity of the bond, the offering yield, the offering amount, the amount outstanding, the credit rating, and the bond issuer (CUSIP6). Going further, Column 3 replaces the bond and market control

[23] As noted in Section 3, the statutory filings only contain data on whether or not an insurer is lending a particular bond. We do not know the quantity on loan.

variables with bond-time fixed effects that absorb the control variables used in Column 2 as well as unobserved bond-time specific heterogeneity related to the decision to lend bond i at time t. Column 4 replaces the robust standard errors with errors two-way clustered by insurer and year.

The results in Table 4 support our model's prediction that securities lenders with more aggressive cash collateral reinvestment strategies are the lenders who are more willing to lend bonds with higher rebates. Intuitively, those lenders can afford to lend less profitable bonds because they make a higher return by reinvesting the cash collateral they receive in more risky assets. A key implication of this pattern of securities lending is that the pricing of those bonds will be more informative.

Table 5 reports the results from testing the hypothesis that securities lenders with more aggressive cash collateral reinvestment strategies are more willing to lend bonds with greater price informativeness. The dependent variable in these tests remains the binary decision of insurer j to lend bond i at the end of year t. The specifications are identical to the previous table, replacing the key interaction term with the interaction between the insurer's cash collateral reinvestment strategy and the price informativeness of bond i at time t. The correlation between the interaction term and the insurer's decision to lend a bond is positive, as hypothesized. Importantly, this empirical result remains statistically and economically significant even after including fixed effects that absorb bond-time variation.

5 Conclusion

[to be completed]

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6 Figures

Figure 1: Equilibrium spot market price and quantity.

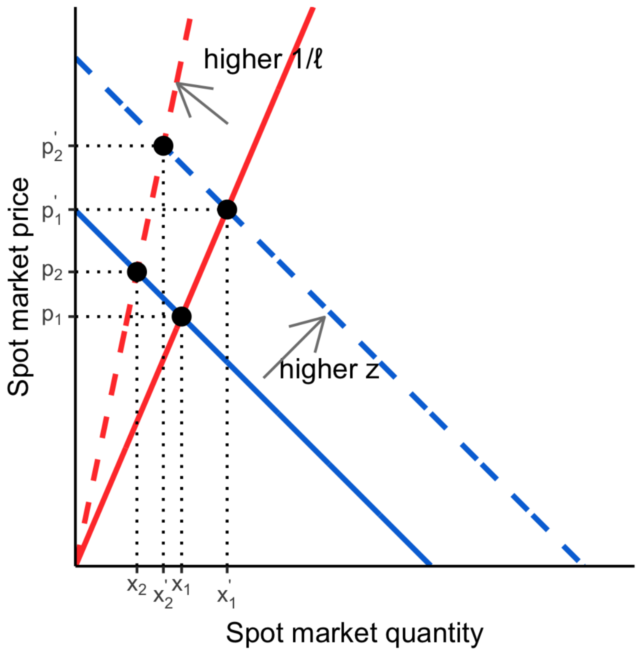


Figure 2: Equilibrium spot market quantity and securities lenders' risk tolerance.

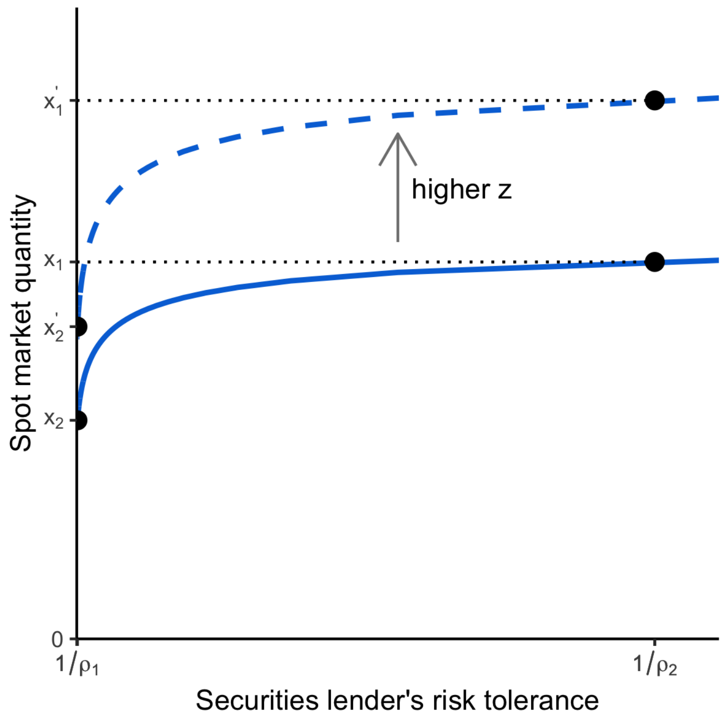


Figure 3: Equilibrium spot market price and securities lenders' risk tolerance.

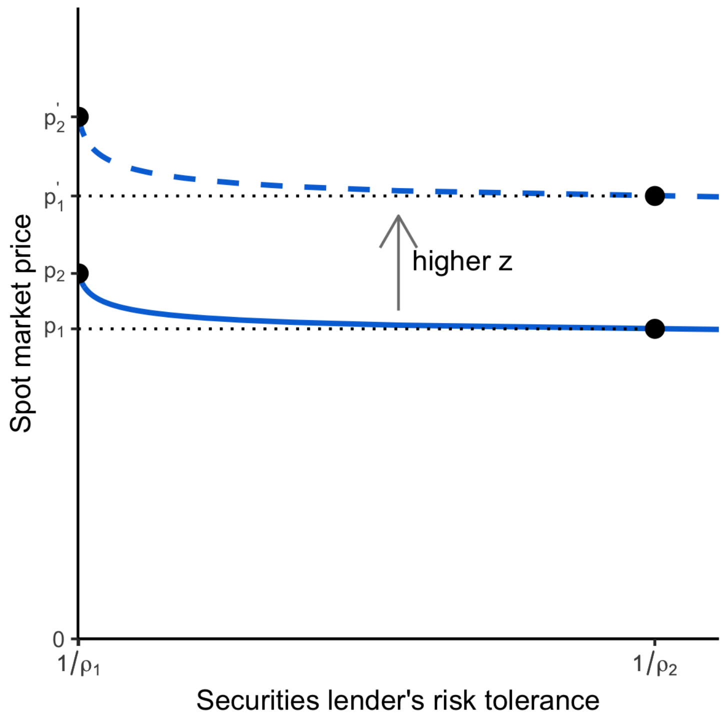
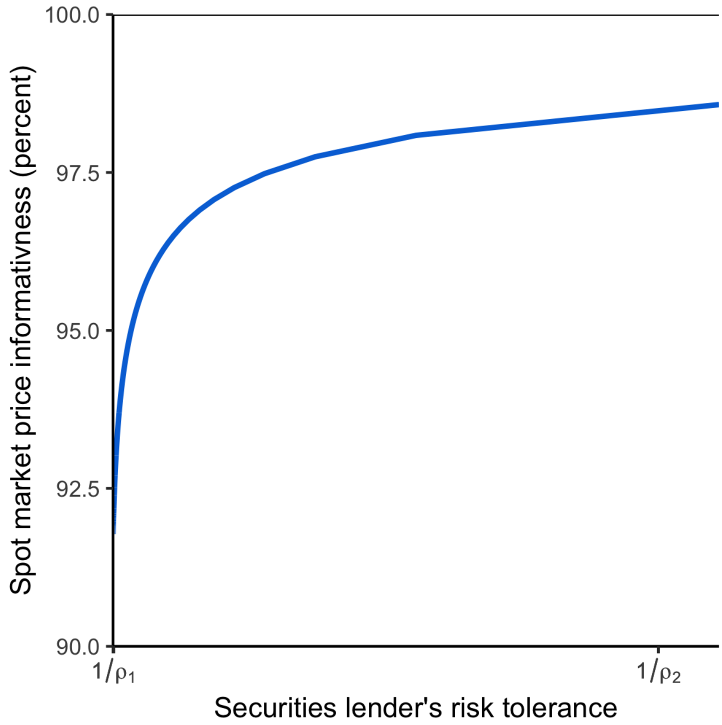


Figure 4: Informativeness of the equilibrium spot market price and securities lenders' risk tolerance.



7 Tables

Table 1: Summary statistics. Reinvestment risk is the fraction of the cash collateral reinvestment portfolio that has a residual maturity of more than one year. Lending dummy is 1 when an insurer is lending a bond. Credit rating is the numerical translation and average of 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. Rebate is the amount paid by the securities lender to a securities borrower that provided cash collateral. The reinvestment risk index is the weighted average maturity transformation of all securities lenders holding a bond. Price informativeness is the negative of the bod-ask spread, the difference between the weighted average price a bond is sold by a dealer to client and the weighted average price the same bond is purchased by a dealer from a client. We take the negative of the spread to make the interpretation of the sign of the coefficients easier: The transformed variable is increasing in liquidity.

	Obs	**Mean**	**St. Dev.**	**p25**	**Median**	**p75**
Bond-Year Data						
Reinvestment risk index (insurers only)	31,875	0.18	0.16	0.06	0.14	0.25
Reinvestment risk index (all lenders)	31,875	0.13	0.17	0.02	0.07	0.17
Offering amount	30,627	1.27	3.66	0.4	0.6	1
Offering yield	24,856	75.83	11099.99	3.98	5.29	6.35
Residual maturity (yrs)	30,422	10.74	9.66	5	7	12
Price informativeness	9,583	-0.64	0.81	-0.18	-0.44	-0.88
Log(daily volume)	12,517	-7.02	1.44	-8.1	-7.05	-5.99
% lendable held (*Insurers share$_{it}$*)	31,875	0.73	0.59	0.29	0.59	1
Amount outstanding	16,700	1.4	4.67	0.38	0.6	1
Credit rating	30,028	19.75	3.36	18	20	22
Weighted average rebate (*Rebate$_{it}$*)	31,875	0.04	0.13	-0.01	0.03	0.08
HHI of life insurers' holdings (*HHI$_{it}$*)	31,875	0.17	0.27	0.02	0.07	0.2
Total lent/lendable (*Market tightness$_{it}$*)	31,875	0.05	0.11	0	0.01	0.05
Bond-Insurer-Year Data						
Reinvestment risk	272,660	0.18	0.27	0	0	0.29
On loan dummy	335,710	0.07	0.25	0	0	0
Offering amount	327,183	1.12	2.62	0.4	0.65	1
Offering yield	269,504	31.45	6741.92	4.25	5.44	6.35
Residual maturity	325,773	11.5	9.3	5	8	17
Amount outstanding	173,932	1.22	3.69	0.4	0.65	1.02
Credit rating	321,132	19.83	2.98	18	20	22
Weighted average rebate (*Rebate$_{it}$*)	335,710	0.05	0.12	-0.01	0.03	0.08
% lendable held (*Market share$_{ijt}$*)	335,710	0.07	0.11	0.01	0.03	0.08
HHI of life insurers' holdings (*HHI$_{it}$*)	335,710	0.17	0.26	0.03	0.07	0.19
Total lent/lendable (*Market tightness$_{it}$*)	335,710	0.04	0.1	0	0.01	0.04

Table 2: The bonds that are greater price informativeness tend to be held by insurers that have more aggressive cash collateral reinvestment strategies. The unit of observation is a bond i at the end of year t. The dependent variable is the price informativeness of a bond ($Price\ informativeness_{it}$). The main explanatory variables are the reinvestment risk index ($Reinvestment\ risk\ index_{it}$) and the share of the bond held by insurers ($Insurers\ share_{it}$). Column 5 reports standard errors two-way clustered by bond in parentheses. All other columns report robust standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively.

Dependent variable: $Price\ informativeness_{it}$	(1)	(2)	(3)	(4)	(5)
$Reinvestment\ risk\ index_{it}$	0.285***				
	(0.064)				
$Reinvestment\ risk\ index_{it}$		0.359***	0.380***	0.347**	0.347*
		(0.130)	(0.128)	(0.161)	(0.191)
$Insurers\ share_{it}$		-0.497***	-0.325***	-0.151**	-0.151**
		(0.032)	(0.046)	(0.059)	(0.070)
HHI_{it}			-0.539***	-0.568***	-0.568***
			(0.120)	(0.146)	(0.166)
$Market\ tightness_{it}$			-0.122	-0.200	-0.200
			(0.107)	(0.124)	(0.132)
$Residual\ maturity_{it}$				-0.031***	-0.031***
				(0.002)	(0.003)
$Offering\ yield_{i}$				-0.065***	-0.065***
				(0.007)	(0.008)
$Offering\ amount_{i}$				-0.058	-0.058
				(0.046)	(0.061)
$Amount\ outstanding_{it}$				0.207***	0.207***
				(0.046)	(0.062)
$Credit\ rating_{it}$				0.014***	0.014**
				(0.005)	(0.006)
Year FE	Y	Y	Y	Y	Y
R^2	0.027	0.074	0.078	0.224	0.224
Observations	9,583	9,583	9,583	4,381	4,381

Table 3: The bonds that have greater trade volume tend to be held by insurers that have more aggressive cash collateral reinvestment strategies. The unit of observation is a bond i at the end of year t. The dependent variable is the log of daily trade volume ($Ln(volume)_{it}$). The main explanatory variables are the reinvestment risk index ($Reinvestment\ risk\ index_{it}$) and the share of the bond held by insurers ($Insurers\ share_{it}$). Column 5 reports standard errors two-way clustered by insurer and bond in parentheses. All other columns report robust standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively.

Dependent variable: $Ln(volume)_{it}$	(1)	(2)	(3)	(4)	(5)
$Reinvestment\ risk\ index_{it}$	0.960***				
	(0.091)				
$Reinvestment\ risk\ index_{it}$		0.942***	0.908***	0.494***	0.494***
		(0.136)	(0.136)	(0.170)	(0.183)
$Insurers\ share_{it}$		-1.144***	-1.176***	-0.554***	-0.554***
		(0.037)	(0.055)	(0.073)	(0.084)
HHI_{it}			0.108	0.053	0.053
			(0.127)	(0.157)	(0.174)
$Market\ tightness_{it}$			2.657***	1.864***	1.864***
			(0.172)	(0.216)	(0.240)
$Residual\ maturity_{it}$				0.020***	0.020***
				(0.003)	(0.003)
$Offering\ yield_i$				-0.173***	-0.173***
				(0.010)	(0.012)
$Offering\ amount_i$				-0.203***	-0.203**
				(0.064)	(0.099)
$Amount\ outstanding_{it}$				1.015***	1.015***
				(0.067)	(0.094)
$Credit\ rating_{it}$				-0.127***	-0.127***
				(0.008)	(0.010)
Year FE	Y	Y	Y	Y	Y
R^2	0.016	0.101	0.124	0.325	0.325
Observations	12,517	12,517	12,517	5,586	5,586

Table 4: The bonds that are lent by insurers that reinvest aggressively tend to be those bonds that have a higher rebate. The unit of observation is a bond i held by insurer j in year t. The dependent variable ($Loan_{ijt}$) is 1 when the bond is on loan and 0 otherwise. The main explanatory variables are the fraction of the cash collateral reinvestment portfolio that has a residual maturity of more than one year ($Reinvestment\ risk_{jt}$) and the weighted average rebate ($Rebate_{it}$). See Table 1 for a description of the other variables. Column 4 reports standard errors two-way clustered by insurer and bond in parentheses. All other columns report robust standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively.

Dependent variable: $Loan_{ijt}$	(1)	(2)	(3)	(4)	(5)
$Reinvestment\ risk_{jt}$	0.099***	0.103***	0.107***	0.107***	0.111***
	(0.009)	(0.013)	(0.009)	(0.030)	(0.009)
$Reinvestment\ risk_{jt} \times Rebate_{it}$	0.220***	0.273***	0.205***	0.205***	0.036
	(0.016)	(0.030)	(0.019)	(0.061)	(0.024)
$Rebate_{it}$	-0.364***	-0.196***			
	(0.011)	(0.020)			
$Market\ share_{ijt}$		0.074***			
		(0.009)			
HHI_{it}		-0.013***			
		(0.004)			
$Market\ tightness_{it}$		0.730***			
		(0.021)			
$Residual\ maturity_{it}$		0.001***			
		(0.000)			
$Offering\ yield_i$		-0.002***			
		(0.001)			
$Offering\ amount_i$		-0.005*			
		(0.003)			
$Amount\ outstanding_{it}$		0.011***			
		(0.003)			
$Credit\ rating_{it}$		-0.001			
		(0.002)			
Fixed effects:					
Insurer, Year	Y	Y	Y	Y	Y
Bond issuer	N	Y	N	N	N
Bond×Year	N	N	Y	Y	Y
Bond×Insurer	N	N	N	N	Y
R^2	0.102	0.164	0.280	0.280	0.572
Observations	272,660	109,671	272,215	272,215	228,733

Table 5: The bonds that are lent by insurers that reinvest aggressively tend to be those bonds with more price informativeness. The unit of observation is a bond i held by insurer j in year t. The dependent variable ($Loan_{ijt}$) is 1 when the bond is on loan and 0 otherwise. The main explanatory variables are the fraction of the cash collateral reinvestment portfolio that has a residual maturity of more than one year ($Reinvestment\ risk_{jt}$) and the price informativeness ($Price\ informativeness_{it}$). See Table 1 for a description of the other variables. Column 4 reports standard errors two-way clustered by insurer and bond in parentheses. All other columns report robust standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively.

Dependent variable: $Loan_{ijt}$	(1)	(2)	(3)	(4)	(5)
$Reinvestment\ risk_{jt}$	0.131***	0.103***	0.136***	0.136***	0.144***
	(0.016)	(0.024)	(0.017)	(0.036)	(0.019)
$Reinvestment\ risk_{jt} \times Price\ informativeness_{it}$	0.016***	0.018***	0.013***	0.013*	0.024***
	(0.004)	(0.006)	(0.004)	(0.007)	(0.008)
$Price\ informativeness_{it}$	-0.009***	-0.009***			
	(0.002)	(0.003)			
$Market\ share_{ijt}$		0.140***			
		(0.023)			
HHI_{it}		-0.041***			
		(0.014)			
$Market\ tightness_{it}$		0.821***			
		(0.033)			
$Residual\ maturity_{it}$		0.001***			
		(0.000)			
$Offering\ yield_{i}$		-0.005***			
		(0.001)			
$Offering\ amount_{i}$		-0.010*			
		(0.005)			
$Amount\ outstanding_{it}$		0.013**			
		(0.005)			
$Credit\ rating_{it}$		-0.007**			
		(0.003)			
Fixed effects:					
Insurer, Year	Y	Y	Y	Y	Y
Bond issuer	N	Y	N	N	N
Bond×Year	N	N	Y	Y	Y
Bond×Insurer	N	N	N	N	Y
R^2	0.122	0.195	0.304	0.304	0.595
Observations	89,530	38,889	89,404	89,404	68,872

Figure 5: 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 6: 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.

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

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).