Unrealized Trading Gains

Chuck Fang*

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Abstract

I show that regulatory accounting rules governing capital gains and losses shape insurance companies' responsiveness to trading opportunities during crisis periods. In response to outflow-induced fire sales by mutual funds, insurers are less likely to trade if doing so requires marking to market unrealized losses that would otherwise remain shielded under held-to-maturity accounting. To isolate the role of unrealized losses, I use granular fixed effects to compare different insurers' trading decisions on the same bond at the same time. When insurers are less elastic due to larger unrealized losses, bond prices become more sensitive to mutual fund outflow-induced fire sales. This trade-off between trading gains and regulatory capital losses motivates a new method to quantify the shadow cost of regulatory capital, which I estimate to average $0.81 during crisis periods and significantly higher for capital-constrained insurers.

Keywords: held-to-maturity accounting, market elasticity, shadow cost of capital

*Chuck Fang is with Drexel University; chuck.fang@drexel.edu. I thank discussions by Yiming Ma, Rex Wang, Andrew Ellul and conference and seminar participants at Wharton Liquidity Conference, IWH-FIN-FIRE Workshop, European Central Bank, Risk Theory Society, OFR-RCFS Rising Scholars Conference, CUHK Shen Zhen.

1 Introduction

The corporate bond market can be fragile to liquidity shocks. During the COVID crisis in 2020, for instance, large outflows from bond mutual funds led to widespread fire sales and bond mispricings (Vissing-Jorgensen, 2021; Ma et al., 2022). A key question is why was there a lack of elastic capital to absorb these liquidity shocks. In the language of Duffie (2010), why was arbitrage capital so slow-moving? In particular, insurance companies – the largest holders of corporate bonds – were uniquely positioned to respond to trading opportunities during crisis periods because of their stable funding structure (Coppola, 2025; O'Hara et al., 2025). In this paper, I show that unrealized gains and losses can constrain the elasticity of capital that insurers – and potentially banks and CLOs that are also subject to held-to-maturity accounting – supply to the debt market.

The main insight is that responding to trading opportunities may trigger regulatory capital losses, which would otherwise remain shielded under held-to-maturity accounting. Consider a bond being fire-sold by mutual funds due to outflows. It would be profitable to purchase this bond at a discount, financed by selling holdings of some other bonds, ideally those with very similar characteristics (e.g. same credit rating and duration) so that there is minimal portfolio distortion. This bond swap generates a trading gain equal to the fire-sale discount, which would gradually materialize as the price gets corrected over time. However, an insurer may be reluctant to pursue this trading opportunity because of concerns over its regulatory capital. Specifically, there may be large unrealized losses on the insurer's existing bond holdings, and selling these bonds would recognize the losses on its balance sheet.

I have three findings, focusing on U.S. insurance companies during crisis periods. First, insurers with more unrealized losses on the relevant positions are less responsive to trading opportunities arising from mutual fund flow-induced purchases and sales. Importantly, this finding holds true when I compare different insurers' actions on the same bond at the same time, which rule out a wide set of confounding effects (e.g. momentum trading). Second, bond prices are more sensitive to mutual fund flow-induced liquidity shocks when their insurer holders face more unrealized losses and are therefore less elastic. Lastly, the trade-off between trading gains and loss realization motivates a new method to quantify the shadow cost of regulatory capital, which I estimate to average $0.81 during crisis periods and significantly higher for capital-constrained insurers.

I begin by describing the relevant regulatory accounting rules on investment gains and losses for insurance companies. Most of insurers' holdings are in investment-grade debt securities, where they follow held-to-maturity (HTM) accounting, as opposed to mark-to-market (MTM) accounting. This means that, as long as the bond is not traded, moderate appreciation or depreciation in its market value does not affect its book value. When the insurer sells the bond, however, any gains and losses accumulated since its purchase are realized and recognized on the insurer's balance sheet. Depending on the size of accumulated gains and losses, trading can therefore trigger large increase or decrease in the insurer's regulatory capital. One thing to emphasize is that trading only triggers the realization of gains and losses on the insurer's *regulatory* capital, while the true *economic* capital should have factored in any gains and losses as soon as they emerge in the first place.

Due to held-to-maturity accounting, insurers must additionally consider the impact on regulatory capital when deciding whether to act on trading opportunities. When a bond is over-priced – for example, due to mutual fund inflow-induced purchases – the insurer may be reluctant to sell if it has accumulated large unrealized losses on that particular bond. When a bond is under-priced, on the other hand, the relevant state variable is unrealized losses on *other* bonds that the insurer can sell in order to buy the under-priced bond. The relevant bonds should be those with similar characteristics, as insurers have incentives to trade "locally" so that there is minimal distortion on overall portfolio allocation.

I study how insurers respond to trading opportunities during the Great Financial Crisis

(GFC) in 2007-2009 and the COVID crisis in 2020. There are two reasons why I focus on crisis periods. First, insurers' regulatory capital is particularly constrained during crisis periods due to large drops in values of their asset holdings (which decrease capital), widespread rating downgrades (which increase *required* capital), and large increases in the moneyness of variable annuity guarantees (which decrease capital). This makes them particularly averse to realizing investment losses, whereas in normal times insurers may be willing to realize investment losses for tax reasons. Second, crisis periods coincide with the largest mutual fund flow-induced liquidity shocks and a sharp contraction of arbitrage capital elsewhere (e.g. dealers and hedge funds), so that the elasticity of insurer capital becomes particularly relevant.

I develop two hypotheses. First, insurers should be less responsive to trading opportunities – such as fire sales by mutual funds driven by outflows – when the relevant positions carry larger unrealized losses. For over-pricing opportunities, the relevant positions are the over-priced bonds themselves, which the insurer would wish to sell. For under-pricing opportunities, the relevant positions are the *peer* bonds – those with similar characteristics as the under-priced bonds – which the insurer would sell in order to purchase the under-priced bonds. Second, if liquidity shocks are less absorbed by insurers concerned with unrealized losses, they must have larger effects on equilibrium prices. Specifically, we should observe greater price impact per unit of liquidity shock on bonds where the insurer sector as a whole faces more unrealized losses on the relevant positions. Following the logic above, the relevant positions are the bonds themselves for liquidity purchases and the *peer* bonds for liquidity sales.

I find robust evidence in support of the two hypotheses above. In the cross section of bonds, the prices of those where insurers face more unrealized losses in aggregate are much more sensitive to liquidity shocks, measured by mutual fund flow-induced trading (FIT). Specifically, higher outflow-induced sales (inflow-induced purchases) lead to higher (lower) bond yields, consistent with existing literature (e.g. Ma et al., 2022). However, this yield sensitivity to FIT is significantly amplified for bonds where insurers face higher unrealized losses. Importantly, the bond's *own* unrealized losses affect its yield sensitivity to inflow-induced purchases, whereas the bond's *peer* unrealized losses affect its yield sensitivity to outflow-induced sales, consistent with my hypothesis. The price effects revert over time, confirming the interpretation of FIT as liquidity shocks that are orthogonal to firm fundamentals. The results are robust to including granular rating-by-duration-by-industry-by-time fixed effects and measuring mispricing through bond-CDS basis.

I examine insurers' trading activities to sharpen the causal interpretation. On average, insurers are responsive to trading opportunities, increase (decreasing) holdings of the bond that experiences mutual fund outflow-induced sales (inflow-induced purchases). However, this elasticity to FIT is significantly dampened when there are larger unrealized losses. Consistent with my hypothesis, *own* unrealized losses dampen insurer responses to inflow-induced purchases, whereas *peer* unrealized losses dampen responses to outflow-induced sales. All in all, insurers are less likely to respond to trading opportunities that require the realization of larger regulatory capital losses. Importantly, these results hold when I control for bond-by-time fixed effects – in effect, I compare different insurers' trading of the same bond CUSIP at the same time. These granular fixed effects rule out a wide set of confounders such as trading on momentum or reversal (Jostova et al., 2013) and further support unrealized losses as the underlying mechanism.

If held-to-maturity accounting is responsible for the effect of unrealized losses, then such effect should be absent for investors not subject to held-to-maturity accounting, such as mutual funds. In other words, mutual funds provide a placebo test for my proposed mechanism. Indeed, I find that mutual funds' unrealized losses do not have the same effect on their trading decisions or bond prices as insurers' unrealized losses. This placebo test further pinpoints held-to-maturity accounting as the key underlying driver.

Finally, I show that my findings above imply a new method to quantify the shadow cost of regulatory capital. Specifically, each trading opportunity can be mapped to a two-dimensional space, with trading gains on one axis and associated regulatory capital losses on the other axis. Insurers trade off these two quantities, giving rise to an action region – where trading gains outweigh regulatory capital losses – and a corresponding inaction region. Using machine learning methods, I identify the indifference line that separates the two regions, where trading gains exactly equal regulatory capital losses, as revealed by each insurer's actual trading decisions. The slope of this indifference line indicates the economic compensation required for one unit of regulatory capital loss, which I estimate to average \$0.81 during crisis periods and varies substantially across insurers. In the cross section of insurers, when regulatory capital is more scarce – i.e., when RBC ratio is lower – its economic price is significantly higher.

1.1 Literature

This paper contributes to the understanding of insurance companies' trading behavior (Ellul et al., 2015; Ozdagli and Wang, 2019; Hanley and Nikolova, 2020; Ge and Weisbach, 2021; Girardi et al., 2021; Eastman et al., 2024). The most related paper is Ellul et al. (2015), who show that insurers subject to held-to-maturity accounting are incentivized to realize investment gains in order to make up for the loss of regulatory capital due to ABS downgrades. Building on this insight, I show that unrealized losses disincentivize insurers to react to trading opportunities. Both papers are about held-to-maturity accounting's distortion of trading behavior. Whereas they focus on the unconditional incentive to trade, I focus on the *disincentive* to trade conditional on trading opportunities. More importantly, I use the trade-off with trading gains as a novel setting to quantify the shadow cost of regulatory capital across insurers.

This paper contributes to the understanding of bond market elasticity, i.e. how efficient the market is in absorbing liquidity shocks. Papers such as Bretscher et al. (2021), Ma et al. (2022) and Chaudhary et al. (2022) focus on measuring the magnitude of bond market elasticity. Consistent with these papers, I show that bond market elasticity is limited, even for bonds that are highly substitutable to each other, particularly during crisis periods. Coppola (2025) and O'Hara et al. (2025) show that insurance companies are insulated against macroeconomic shocks due to their stable funding structure, which begs the question of why didn't insurers provide more elasticity to the market. Common narratives attribute this inelasticity to inattention or trading frictions, and simply label inelastic investors as "buy-and-hold". This paper offers a rational explanation: investors subject to held-to-maturity accounting can be inelastic on the positions that have accumulated large unrealized losses for fear of incurring regulatory capital reductions.[1]

This paper contributes to the literature on the shadow cost of regulatory capital for financial intermediaries. The most related papers are Koijen and Yogo (2015), Ge (2022) and Sen (2023), which also focus on insurance companies and quantify the trade-off between economic gains and regulatory capital losses context of selling insurance products or hedging with derivatives. This paper presents a new method to estimate the shadow cost of regulatory capital, namely by identifying the indifference line that equates the trading gains with the associated regulatory capital losses, revealed from each insurer's responses to trading opportunities, identified from mutual fund flow-induced liquidity shocks. This revealed preference approach is related to Kisin and Manela (2016), who estimate banks' shadow cost of capital through their decisions on exploiting the ABCP loophole.

There is growing evidence on the distortionary effects of held-to-maturity accounting, mostly focusing on banks. Orame et al. (2024) show that banks holding assets under held-to-maturity accounting were much less responsive to monetary policy than those holding assets

[1]The interactions between mutual funds and insurance companies documented here also contribute to the understanding of institutional synergies in fixed income markets (Emin et al., 2023).

under mark-to-market accounting. Fuster et al. (2024) show that banks' duration rebalancing activities were particularly muted on held-to-maturity securities with large unrealized losses. This paper brings new evidence from insurance companies and uncovers implications for bond market efficiency.

2 Background and Hypothesis Development

2.1 Insurers' capital accounting

The law of motion for insurers' regulatory capital (see Figure A2 for an example) can be summarized by the following equation:

$$Capital_{i,t} = Capital_{i,t-1} + UnderwritingIncome_{i,t} + InvestmentIncome_{i,t} + Financing_{i,t} \quad (1)$$

Underwriting income includes premiums collected, claims paid, and, importantly, changes in life insurance reserves, where a key driver is the moneyness of variable annuity guarantees (Koijen and Yogo, 2022). Investment income has two components: distributions such as coupons and dividends, and investment gains and losses, which are further divided into ones that are realized (for assets sold) and ones that are not. This paper focuses on the accounting of unrealized gains and losses, when they are recognized on balance sheet versus when they are not. Financing includes new capital raised minus capital paid out (e.g. dividends). If, for example, an insurer incurs large increases in reserves from its variable annuity business, its regulatory capital would decrease, unless it can, for example, obtain large realized investment gains from some asset sales.

Unrealized gains and losses are governed by held-to-maturity accounting for investment-grade debt securities (NAIC 1 and 2), which account for 90% of insurers' holdings.[2] Under held-to-maturity accounting, the value of a bond follows a linear interpolation between its historical cost at acquisition and its par value at maturity. Therefore, if the market value of a bond drops temporarily (e.g. due to monetary policy tightening), its accounting value would not be affected. This way there is much more stability for insurers' regulatory capital, in terms of accounting. However, if it sells the bond, the insurer needs to reset the bond's book value to its trading value, thereby recognizing all *cumulative* gains or losses previously shielded under held-to-maturity accounting.[3] Figure A1 illustrates this accounting treatment.

Life insurance companies are further required to amortize realized gains and losses over the remaining life of the bond sold. This rule, called interest maintenance reserve (IMR), reduces the strategic (dis)incentive to realize gains and losses. Nonetheless, Eastman et al. (2024) show that life insurers, particularly the ones experiencing the tail end of capital losses, time the realization of gains and losses. I will show that the trading behavior that I document applies less to life insurers (albeit still significant) than to P&C insurers, where IMR does not apply.

Equation 1 shows that the realization of gains and losses simultaneously affects income and capital. Existing literature has shown strategic realization of gains and losses related to both income smoothing (e.g. Barth et al., 2017) and capital smoothing (e.g. Ellul et al., 2015). My results do not depend on whether insurance companies intend to smooth income or smooth capital, but I will provide evidence that differentiates the two mechanisms whenever possible, for example by comparing insurers with similar income but different capital).

Taxes affect the decision to realize gains and losses. As opposed to individual capital gain tax rate (Poterba and Weisbenner, 2001), corporate tax rate is invariant to the level of

[2]Mark-to-market accounting is required for securities that are in or near default (NAIC 6) for life insurers and for all non-investment-grade securities (NAIC 3, 4, 5 and 6) for P&C insurers.

[3]Insurers also need to recognize unrealized losses for other than temporary impairment (OTTI), which is defined for bonds that drop from investment grade to below investment grade.

income or the length of holding, so tax incentives are less for c-corporations, where insurance companies are categorized. Jin (2006) shows that, under normal circumstances, investors are incentivized to delay the realization of capital gain taxes. However, tax incentives seem to be overpowered by regulatory capital concerns during crisis periods, which are what I focus on. To confirm this, I replicate the findings from Ellul et al. (2015) in Table A2 with an expanded sample covering the recent COVID crisis and more stringent fixed effects. The coefficients show that, during crisis periods, insurers – especially those that have experienced large drawdowns in regulatory capital – are less likely to sell positions with high unrealized loss.

2.2 Insurers' response to trading opportunities

There are several ways that insurance companies can respond to trading opportunities, such as mutual fund flow-induced mispricings during the onset of COVID in March 2020. For starters, insurers can use cash or cash equivalents such as money market instruments. However, insurers' cash holdings actually *increased* by $29 billion during 2020Q1, possibly to fulfill liquidity regulations or to guard against future liquidity shocks. Insurers can also trade with new capital from sales of insurance policies. However, during 2020Q1, insurers' operating cash flow (excluding investment income) was negative $5 billion.

Importantly, insurers can respond to trading opportunities with existing capital: they can sell old bonds to buy new bonds that are mispriced. Insurers can sell the old bonds with similar characteristics to the new bonds, so that there is minimal distortion to their portfolios' risk exposure.[4] Insurers held $4,305 billion of bonds entering 2020 and sold $103 billion bonds on the secondary market during March 2020. Therefore, trading with existing capital seemed to be a viable, if not the dominant, strategy for insurance companies, and the question is

[4] Rather than selling the old bonds immediately, the insurer can temporarily use cash to buy the new bonds, similar to how dealers provide liquidity.

why they did not do more.

Due to the favorable regulatory treatment of unrealized loss under held-to-maturity accounting, there is a trade-off that insurance companies face when deciding whether to take advantage of a trading opportunity. Panel A of Figure 1 illustrates this with an example. Suppose there are two bonds A and B with identical future cash flows, and Bond A has larger price discount compared to Bond B due to liquidity shocks (e.g. mutual fund outflow-induced fire sales). Any investor would have an incentive to simultaneously sell Bond B and buy Bond A in equal par amount, which would yield an immediate gain while leaving future cash flows intact (or alternatively swap the bonds in equal market value, which would yield more cash flows in the future). However, suppose that Bond B carries large unrealized losses on the insurer's book, because risk-free rates have risen during contractionary monetary policy or risk premium has risen due to crises. As a result, if the insurer acts on the trading opportunity and sells Bond B, it would realize the losses that decrease its regulatory capital. On the other hand, if the insurer does not trade, the unrealized losses would remain shielded and its regulatory capital would evolve smoothly, but it the trading gain would also be unrealized.

When a bond is over-priced, for example due to mutual fund inflow-induced buying, the insurer may decide not to sell if it has accumulated large unrealized loss on that particular bond. When a bond is under-priced, on the other hand, the relevant state variable is unrealized losses on other bonds that the insurer can sell in order to buy the under-priced bond. This is an important heterogeneity for my identification strategy. To summarize:

Hypothesis 1: Insurance companies with more unrealized losses on the relevant positions are less likely to respond to trading opportunities arising from mutual fund flow-induced trading. For over-priced bonds due to inflow-induced purchases, the relevant positions are the bonds themselves. For under-priced bonds due to outflow-induced fire sales, the relevant positions are peer bonds with similar characteristics.

When a large number of insurers hold unrealized losses on the relevant positions, they may simultaneously decide not to respond to mutual fund flow-induced mispricing. As a result, flow-induced trading can cause large price impacts, due to the shortage of willing counterparties. In contrast, if only a few insurers hold unrealized losses on the relevant positions, there are still many other insurers that are unconstrained and can respond to flow-induced mispricing, so the observed price impact in equilibrium should be small. In summary:

Hypothesis 2: Bonds where insurance companies have accumulated larger unrealized losses on the relevant positions have larger price sensitivity to liquidity shocks such as mutual fund flows-induced trading. For bonds experiencing inflow-induced purchases, the relevant positions are the bonds themselves. For bonds experiencing outflow-induced sales, the relevant positions are peer bonds with similar characteristics.

If the effect of unrealized losses on insurer trading is due to held-to-maturity accounting, then such effect should be absent for investors where held-to-maturity accounting does not apply. In particular, when some mutual funds initiate liquidity trades due to flow shocks, other mutual funds can provide liquidity, and unrealized losses should not affect their trading decisions in the same way as insurers. In other words, the response of mutual funds to other mutual funds' flow-induced trading provides a placebo test:

Hypothesis 1A: The response to mutual funds to other mutual funds' flow-induced trading is not affected by unrealized losses in the same way as insurance companies.

Hypothesis 2A: The sensitivity of bond prices to mutual fund flow-induced liquidity shocks is not affected by aggregate unrealized losses across mutual funds in the same way as aggregate unrealized losses across insurance companies.

2.3 Sample selection

I focus on the crisis periods during December 2007 to June 2009 (the Great Financial Crisis (GFC)) and February 2020 to April 2020 (the COVID). These crisis periods are when insurers' regulatory capital is particularly constrained, due to large drops in asset value (which decrease capital), widespread rating downgrades (which increase required capital), and large increases in the moneyness of variable annuity guarantees (which decrease capital). Figure A3 shows aggregate changes in regulatory capital due to underwriting income and investment income, as described in Equation 1, but excluding realized gains and losses. This graph shows large negative capital losses during crisis periods, which create strong incentives (disincentives) for insurers to realize gains (losses).

The crisis periods also coincide with the largest mutual fund flow-induced trading activities, shown in Figure A4. At the start of crises, bond mutual funds tend to experience large outflows, as liquidity shocks emerge and get amplified by strategic complementarity (Goldstein et al., 2017; Falato et al., 2021; Fang and Goldstein, 2025). Announcements of policies such as QE and PMCCF/SMCCF tend to quickly restore market liquidity and lead to large mutual fund inflows. During crises, there tends to be a sharp contraction of arbitrage capital – for example, dealers take less inventory risk due to tighter regulatory constraints during crisis periods (Dick-Nielsen and Rossi, 2018). These stylized facts – that there are more mutual fund flow-induced liquidity shocks and there is less arbitrage capital – makes the elasticity of insurer capital particularly important during crises periods.

2.4 Data and variables

U.S. insurers report detailed security-level holdings under Schedule D Part 1 of annual filings to the National Association of Insurance Commissioners (NAIC). In particular, these reports contain book value and fair value for each security. The sum of security-level book values is required to match with the total book value on headline balance sheet pages, assuring data accuracy. Fair value is assessed by individual insurers, which can be manipulated (Sen and Sharma, 2022), so I will use month-end trading price from TRACE, defined as weighted average of trade prices across trades in the last 5 days of the month. Insurance companies also report transactions under Schedule D Part 3 (purchases) and Part 4 (sales), which I use to construct security-level holdings and book value at the monthly frequency.[5] Figure A2 shows a sample of these data reported by insurers.

The amount of unrealized loss that is not recognized under held-to-maturity accounting is defined as the difference between book value and market value:

$$UnrealizedLoss^{\$}_{i,b,t} = BookValue_{i,b,t} - MarketValue_{b,t} \tag{2}$$

I will compare the amount of unrealized loss to either the amount of holdings by individual insurers or the total amount of bond outstanding in the market. For placebo tests with bond mutual funds that are not subject to held-to-maturity accounting, book value is defined as the market value when the bond first appears in the investor's portfolio.

I focus on liquidity shocks coming from mutual fund flow-induced trading (Lou, 2012; Chaudhary et al., 2022). Mutual fund data (e.g. holdings) are from Morningstar Direct. I filter for mutual funds that focus on U.S. fixed income assets through Base Currency and Global Broad Category Group. Mutual fund flow-induced trading is measured at the bond issuer level:

$$FIT_{j,t} = \frac{\sum_i AmountHeld_{i,j,t-1} Flow^{\%}_{i,t}}{AmountOutstanding_{j,t-1}} \tag{3}$$

where $AmountHeld_{i,j,t-1}$ denotes amount of issuer j's bonds held by fund i in the previous month, $AmountOutstanding_{j,t}$ total amount of issuer j's bonds outstanding, and $Flow^{\%}_{i,t}$ net

[5] For bonds that are traded during the year, their book values are reported in the transaction filings. Bonds that are not traded are not reported in the transaction filings, and I infer their book value by interpolating the book values over the previous and the subsequent annual filings on holdings.

flows to fund i in the current period (relative to lagged fund size). Intuitively, FIT measures the amount of net purchase of issuer j's bonds if its existing fund holders simply scale up or down their portfolios in response to flows. This proportional scaling behavior has been documented in Choi et al. (2020); Ma et al. (2022); Fang (2023). I focus on FIT at the issuer level, because funds tend to buy bonds from the same issuers, even though not necessarily the exact same bonds (Fang, 2023).

An important assumption is that FIT represents liquidity trades, not informed trades driven by bond fundamentals. First, Fang and Goldstein (2025) show that more than half of the bond mutual fund outflows during COVID are attributable to rebalancing trades by target allocation funds in response to equity market declines, unrelated to bond fundamentals. Second, FIT is akin to a shift-share instrument (Goldsmith-Pinkham et al., 2020). In the canonical setting, there are several industries, different counties are differentially exposed to these industries, and shocks to an industry disproportionately affect the counties that have higher ex ante exposure to that industry. In my setting, there are many bond funds, different firms are differentially exposed to these bond funds, and flows to a bond fund disproportionately affect the firms that have higher ex ante exposure to that fund, i.e. higher ex ante ownership by that fund.

Data on corporate bonds are from FISD (for characteristics) and TRACE (for prices). I focus on straight senior unsecured U.S.dollar bonds issued by non-financial U.S. firms.[6] I focus on investment-grade bonds, as this market is where insurance companies primarily invest and face relatively fewer regulatory restrictions. I use the bond-Compustat link by Fang (2023) to map bonds to ultimate issuing entities. Cleaning of TRACE data follows Dick-Nielsen (2014).

Data on CDS are from Markit and linked to Compustat firms through issuer CUSIP and

[6] A bond is commonly defined as straight if it has fixed coupon, bullet maturity, not convertible, not exchangeable, not fixed callable, not puttable.

ticker. For a given bond, the CDS basis is:

$$CDSBasis = YieldSpread - CDSSpread \tag{4}$$

where yield spread is spread over duration-matched Treasury yield and CDS spread is par spread on 5-year CDS contract. To ensure the comparability of tenor, I restrict to bonds that are within 3 to 7 years to maturity, following Bai and Collin-Dufresne (2019).

3 Unrealized Loss and Insurer Elasticity

In this section, I show evidence in support of Hypothesis 1: during crisis periods, insurers trade less against liquidity shocks when the positions carry larger unrealized losses. A key advantage of looking at insurer-level trading is that I can compare the actions by different insurers with different unrealized losses on the same bond CUSIP at the same time. This would rule out any unobserved effects at the bond level, such as correlated buying or selling by all insurers due to momentum or reversal (Jostova et al., 2013), and therefore more convincingly attribute any differences in trading behavior to differences in unrealized losses.

I run the following regression on a three-dimensional panel data, where each observation corresponds to insurer i's trading of investment-grade bond b in month t:

$$\Delta Holding_{i,b,t} = \beta FIT_{b,t} \times UnrealizedLoss_{i,b,t-1} + \gamma Controls + FE + \epsilon_{i,b,t} \tag{5}$$

$\Delta Holding_{i,b,t}$ denotes change in insurer i's par amount held of bond b over month t, scaled by lagged par amount held. Mutual fund flow-induced trading is defined in Equation 3 and serves as a proxy for liquidity shock. $UnrealizedLoss_{i,b,t-1}$ denotes insurer i's own (peer) unrealized loss (negative for unrealized gain) on bond b (bond b's peers) relative to par amount held, measured as of the previous month. To ease interpretation, $UnrealizedLoss$

is scaled to mean zero and unit standard deviation.

I control for bond characteristics, including credit rating (AAA = 0, CCC- = 19), years to maturity, coupon rate, log amount outstanding and bid-ask spread. This purges out common trading across insurers driven by observable bond characteristics (e.g. low credit rating). I include insurer by time fixed effects, which further purge out unobserved common trading across bonds by a given insurer at a given time (e.g. due to high insurance sales). In the baseline regression, I also include bond peer group by time fixed effects, where a bond peer group is identified by bonds with the same credit rating letter, same rounded years to maturity, same rounded coupon rate, and same Fama-French 12 industry. This purges out unobserved common trading across insurers by a given type of bond at a given time.

The results are given in Table 1. For illustration, Panel A first focuses on the *cross section* of insurers and their trading of different bonds in the single month of March 2020, when COVID started. As previously shown in Figure A4, FIT is negative for almost all bonds in March 2020 due to large outflows that were common across bond mutual funds (Falato et al., 2021). Column 1 shows a statistically significant negative relationship between insurer trading and FIT: 1% mutual fund flow-induced selling ($FIT = -1$) leads to net purchase by the average insurance company equal to 0.243% of original holdings. Together with the price impact results that will be shown in the next section, this implies that insurers' price elasticity of demand is around 0.08. The elasticity estimate is lower than those in Bretscher et al. (2021); Chaudhary et al. (2022); Fang and Xiao (2025) that include non-crisis periods, suggesting that elastic capital is particularly scarce during crisis periods Duffie (2010).

Column 2 adds interactions between flow-induced trading and unrealized losses. The interaction between FIT and *peer* unrealized loss is significant and positive. This means that, conditional on -1% flow-induced trading, purchases by insurers are 0.294% smaller if the bond's peers carry one-standard-deviation higher unrealized losses. This is consistent with the interpretation that, when there are large outflow-induced sales by mutual funds, insurers buy, but the buying is dampened if there is large unrealized loss on the peer bond. Note that controlling for the interaction with unrealized losses boosts the baseline effect of FIT on insurer trading from -0.243% to -0.373%. Importantly, the interaction between FIT and the bond's *own* realized losses is not significant, consistent with my hypothesis in Section 2.2.

Column 3 includes bond CUSIP fixed effects, so the regression is identified by different trading actions on the same bond by different insurers that face different unrealized losses. How can two insurers have different unrealized losses on the same bond at the same time? This is because of the different timing of their purchases. For example, one insurer may have purchased the bond at its issuance, whereas the other insurer may have purchased the bond on the secondary market several years after it has been issued, in response to large inflows of insurance premiums and lack of primary market issuances that month. The price of this bond might have decreased substantially during this gap (e.g. due to tightening monetary policy), leading to larger unrealized loss for the first insurer. The timing of these historical purchases is likely orthogonal to subsequent mutual fund flow-induced trading, providing exogenous variation in unrealized loss across insurers. The results show that my main results continue to hold: insurers are less likely to respond to mutual fund flow-induced fire sales if there are more unrealized losses on the bond's peers.

Panel B of Table 1 extends the analysis from the cross section in March 2020 to all crisis periods during 2007-2009 and 2020. I partition FIT into its negative part and its positive part: $NegativeFIT = min(FIT, 0)$ and $PositiveFIT = max(FIT, 0)$. Column 1 shows that there is a negative relationship between insurer trading and mutual fund flow-induced trading. When there are more outflow-induced sales (inflow-induced purchases) by mutual funds, insurers buy more (sell more). Specifically, -1% FIT (+1% FIT) leads to 0.169% increase (0.114% decrease) in holding. Perhaps surprisingly, insurers acted as liquidity providers during crisis periods (O'Hara et al., 2025).

Column 2 adds interactions between flow-induced trading and unrealized loss. The coefficient on the interaction between positive FIT and own unrealized loss is significantly positive, meaning that big unrealized loss dampens the positive relationship between insurer trading and positive FIT. When there are large inflow-induced purchases by mutual funds, insurers sell, but the selling is dampened if there is large unrealized loss on the bond. This dampening pattern is similarly observed for negative FIT and peer unrealized loss, as previously explained in Panel A. The fact that only own unrealized loss (peer unrealized loss) matters for positive FIT (negative FIT) is consistent with my hypothesis.

Column 3 adds bond-by-time fixed effects. As explained before, the regression is now identified by different unrealized losses on the same bond at the same time due to the timing of their purchases by different insurers in history, which are plausible exogenous to subsequent FIT and insurer trading. The regression results remain robust: higher peer (own) unrealized loss is associated with less buying (selling) against liquidity sales (purchases).

To further understand the underlying mechanism, I adds a triple interaction with an dummy variable that indicates whether the insurer has had large capital drawdown. Capital drawdown is defined as cumulative change in regulatory capital since the beginning of crisis (2007Q4 for GFC and 2019Q4 for COVID), excluding new issuance of capital and excluding realized gains and losses, which I have shown can be used to strategically replenish capital. A capital drawdown is defined large if it is more than -20%. Column 4 shows that the triple interaction terms are significant, whereas the double interaction terms decrease substantially in magnitude, suggesting that the effect of unrealized loss primarily comes from insurers with large capital drawdowns. This further confirms the interpretation that the disincentive to absorb liquidity shocks derives from concerns about loss of regulatory capital.

As described in Hypothesis 1A, if the effect of unrealized losses on trading is due to held-to-maturity accounting, then such effect should be absent for investors not subject to held-to-maturity accounting, such as mutual funds. In other words, the behavior of mutual funds and other investors not subject to held-to-maturity accounting should provide a placebo test.

To conduct this placebo test, I run the same Regression 5 on a dataset of bond mutual funds, where each observation corresponds to fund i's trading of investment-grade bond b in month t. To avoid the mechanical correlation between mutual fund trading on the left-hand side and mutual fund flow-induced trading on the right-hand side, I separate bond funds into two groups: a group whose net flows were above median during March 2020, and a group whose net flows were below median during March 2020. Flow-induced trading is measured using the second group, and Regression 5 is run on the second group.

Panel A of Table 3 shows the results. Column 1 shows that mutual funds respond elastically to flow-induced trading by other mutual funds. This elasticity is higher than insurance companies, consistent with existing evidence (Chaudhary et al., 2022). Column 2 and 3 show that unrealized losses do not play the same role in dampening elasticity as for insurers. The evidence provides further support that the effect of unrealized losses on trading is unique to held-to-maturity investors such as insurers.

4 Unrealized Loss and Market Elasticity

The previous section shows that insurers are less likely to absorb liquidity shocks on bonds associated with higher unrealized losses. Given the importance of insurers in the corporate bond market, it is natural to expect that this trading behavior should affect market prices, as described in Hypothesis 2.[7] Indeed, this section will show that, during crisis periods and across corporate bonds, those with larger unrealized losses across insurer holders are associated with larger price sensitivity to liquidity shocks, consistent with the lack of elastic insurer capital.

[7] According to Financial Accounts of the United States (L.213), insurance companies have always been the largest holders of corporate and foreign bonds, although the lead against the second biggest holders (mutual funds) has narrowed.

I run the following regression on a sample of investment-grade corporate bonds during crises periods:

$$\Delta YieldSpread_{b,t} = \beta FIT_{b,t} \times UnrealizedLoss_{b,t-1} + \gamma Controls + FE + \epsilon_{b,t} \quad (6)$$

$\Delta YieldSpread_{b,t}$ measures the change of bond b's yield spread (defined as the bond's yield over that of a duration-matched Treasury bond) over month t. Mutual fund flow-induced trading (FIT) are defined in Equation 3 and serve as proxy for liquidity shocks. $UnrealizedLoss$ is the sum of unrealized losses (negative for unrealized gains) across insurance companies that are not recognized under held-to-maturity accounting, scaled by bond amount outstanding. To ease interpretation, I standardize $UnrealizedLoss$ to mean zero and unit standard deviation.

I control for a large number of observable variables at $t-1$. I control for the level and the past trajectory of yields, as momentum and reversal can play a role. I also control for credit rating, duration, amount outstanding (log) and trading volume (log). These controls help to parametrically purge out characteristics-driven returns. For example, during crises, bonds with lower credit ratings tend to experience larger yield increases.

I include rating letter (e.g. BBB) by rounded duration (e.g. 8Y) by Fama-French 12 industry by time fixed effects. Effectively, I compare the prices of near-identical bonds with the same rating, same duration, issued by firms in the same industry at the same time.

The results are given in Table 2. For illustration, I start with the *cross section* of bonds during the onset of COVID crisis in March 2020, shown in Panel A. As previously shown in Figure A4, FIT is negative for almost all bonds in March 2020 due to large outflows that were common across bond mutual funds (Falato et al., 2021). Column 1 shows that the coefficient on FIT is significant and negative at -0.747, meaning that, for higher flow-induced selling at 1% of amount outstanding ($FIT = -1$), the bond's yield spread increases by 0.747

percentage point. These results echo the existing evidence that mutual fund flow-induced liquidity shocks have large price impacts (Lou, 2012; Chaudhary et al., 2022), particularly during crisis periods when arbitrage capital is scarce (Ma et al., 2022; Coppola, 2025).

Column 2 adds the interaction between FIT and unrealized losses. The baseline effect of FIT on bond yield is significantly dampened, from -0.747 in Column 1 to -0.406, which suggests that unrealized loss explains a large portion of the unconditional price impact. The coefficient on the interaction between FIT and peer unrealized loss is significant and negative, meaning that, when there are more unrealized losses on the bond's peers, the negative impact of FIT on bond yield is amplified. The coefficient is economically significant: one-standard-deviation higher peer unrealized loss increases the baseline effect of -0.406 by -0.420, or -103%.

The fact that the bond's own unrealized loss does not have statistically important effect confirms my hypothesis. When a bond is under-priced due to negative liquidity shocks, insurers can gain by selling other bonds – in particularly peer bonds that share similar exposure to future risks as the target bond – and buying the target bond, but they would be discouraged from doing so if there are large regulatory capital losses associated with recognizing the unrealized losses on those peer bonds.

Column 3 and 4 repeat the same analyses but using CDS basis, i.e. the deviation of yield spread from CDS spread (Equation 4). CDS basis is more likely to reflect mispricing, as the subtraction of CDS spread purges out differences in fundamental default risk. Despite the drop in number of observations, the two main results hold: FIT has price impact, which is amplified by the size of (peer) unrealized loss.

Panel B of Table 2 extends the analysis from the cross section in March 2020 to all crisis periods during 2007-2009 and 2020. Column 1 shows that the coefficients on both the positive part and the negative part of FIT are significant and negative, meaning that more inflow-induced purchases are associated with lower yield spreads and more outflow-induced sales (more negative the term is) are associated with higher yields. Measuring FIT at the issuer-level is important here, as mutual funds tend to buy bonds from the same firms in response to inflows, but not necessarily the exact same bonds they already hold (Fang, 2023).

Column 2 adds interactions between FIT and unrealized losses. Consistent with my hypotheses, own unrealized loss affects the price impact of positive FIT, while peer unrealized loss affects the price impact of negative FIT. When there is large own unrealized loss, insurers are reluctant to sell the bond, so inflow-induced purchases need to bid for higher prices (lower yields) in order for insurers to sell. When there is large peer unrealized loss, insurers are reluctant to sell peer bonds, so outflow-induced purchases need ask for lower prices (higher yields) in order for insurers to sell other bonds and buy the target bond. The effects are economically large, as one-standard-deviation higher own unrealized loss (peer unrealized loss) amplifies the baseline effect of negative FIT of -0.829 p.p. (positive FIT of -0.055 p.p.) by -0.280 p.p. (-0.121 p.p.), or -33% (-2200%).

Figure 2 shows the full trajectory of yield changes in response to FIT. The two red lines show yield changes in response to outflow-induced selling ($FIT = -1$), whereas the two blue lines show yield changes in response to inflow-induced buying ($FIT = +1$). The dark red (blue) dash line shows cumulative price impacts for the average bond, i.e. where unrealized loss is at its mean. The light red (blue) solid line shows price impact for bonds with one-standard-deviation higher peer unrealized loss (own unrealized loss), which are noticeably larger. Moreover, all yield impacts fully revert over the subsequent months, which confirms that the liquidity shocks are orthogonal to changes in firm fundamentals (e.g. default risk), which would have led to permanent yield changes.

If the effect of unrealized losses on pricing is due to the lack of arbitrage capital subject to held-to-maturity accounting, then such effect should be absent for unrealized losses for investors not subject to held-to-maturity, e.g. bond mutual funds. To conduct this placebo test (Hypothesis 2A), I run the same Regression 6 with bond mutual funds' unrealized losses as regressors. Panel B of Table 3 shows the results. Consistent with my previous placebo test that unrealized losses do not affect bond funds' response to trading opportunities (Panel A), unrealized losses carried by these placebo investors do not meaningfully affect price sensitivity to liquidity shocks.

5 The Shadow Cost of Regulatory Capital

I have shown the trade-off that insurers face between seizing gains from trading against mutual fund liquidity shocks and losing regulatory capital from marking to market unrealized losses. In this section, I demonstrate how to exploit this trade-off to reveal an insurer's valuation of a unit of its regulatory capital. For each given value of regulatory capital loss realization, there should be a threshold above which the economic gain from trading is more appealing. With sufficient variation in trading gains and regulatory capital losses in the cross section of bonds, we can identify this threshold from the insurer's actual trading decisions.

Panel B of Figure 1 illustrates this strategy. For a given insurer at a given time, each bond can be mapped to this two-dimensional space, with liquidity-shock-implied trading gains on the y-axis and unrealized-loss-implied regulatory capital losses on the x-axis. The top-left green cross should be worthy of trading, as the trading gain is really high and the regulatory capital loss is actually negative – the position has large unrealized gains and recognizing the gains would increase the insurer's capital. In contrast, the bottom-right red cross is not worthy of trading, as it has little trading gain and simultaneously large regulatory capital loss that would be realized upon trading.

Conditional on having sufficient number of bonds that span this two-dimensional space of trading gains and regulatory capital losses, we can observe which area is considered by the insurer to be profitable and which area is not, given by the green area and the red area, respectively. The curve that separates the green area and the red area tells us the positions where insurers are indifferent between the trading gains and the regulatory capital losses. The slope of this indifference line identifies the shadow cost of regulatory capital: how much dollar gain is required in order to keep the insurer indifferent to a unit of decrease in regulatory capital due to the recognition of unrealized loss.

I model this difference curve as a linear line:

$$TradingGain = \tilde{\alpha} + \tilde{\beta} RegulatoryCapitalLoss \tag{7}$$

Trading gain is measured as mispricing (in percentage point) due to mutual fund flow-induced trading:

$$TradingGain = 0.829 \times PositiveFIT \times Duration - 0.055 \times NegativeFIT \times Duration$$

where 0.829 and 0.055 are from Table 2. Regulatory capital loss is own (peer) unrealized loss, in percent of holding, in the case of inflow-induced over-pricing (outflow-induced under-pricing):

$$RegulatoryCapitalLoss = \begin{cases} OwnUnrealizedLoss & FIT > 0 \\ PeerUnrealizedLoss & FIT < 0 \end{cases}$$

Unrealized gain is simply the negative of unrealized loss. In other words, $TradingGain$ and $RegulatoryCapitalLoss$ respectively measure the arbitrage gains and the regulatory capital losses that the insurer would realize by executing a \$100 trade against FIT.

I want to find the linear classifier that best separates the insurer's bond positions into two groups, one group where the insurer trades and the other where the insurer does not trade, depending on the associated trading gains and regulatory capital losses. To this end, I use a machine learning method called Support Vector Machine (SVM). Standard SVM models the separating line as:

$$w_1 x + w_2 y - b = 0$$

where x and y denote regulatory capital loss and trading gain, respectively. $\tilde{\alpha}$ and $\tilde{\beta}$ can be recovered as $\tilde{\alpha} = \frac{b}{w_1}$ and $\tilde{\beta} = -\frac{w_1}{w_2}$. SVM solves the following minimization problem:

$$\min_{w_1, w_2, b} \frac{1}{N} \sum_{i=1}^{N} \max(0, 1 - z_i(w_1 x_i + w_2 y_i - b)) + \lambda \sqrt{w_1^2 + w_2^2} \tag{8}$$

z_i is an indicator variable of whether the insurer trades on the bond or not. The first term captures the number of misclassifications, the second term captures the width of the soft margin which affects the number of misclassifications, and λ controls the relative weight of these two quantities, both of which SVM seeks to minimize. Figure A5 gives a graphical illustration of the method.

This estimation is done using the cross section of bonds for each insurer at each month-end. Some small insurers do not hold enough bonds to cover sufficient range of trading gain or regulatory capital loss. Therefore, I group insurers by filer type (life vs P&C) and by size percentile.

Panel C of Table A1 shows the distributions of $\tilde{\alpha}$ and $\tilde{\beta}$. On average, $\tilde{\alpha}$ is estimated to be \$3.31. This means that, even when there is zero regulatory capital loss, the threshold at which insurers start responding to trading gains is \$3.31. This is much larger the average bid-ask spread of corporate bond (\$0.50 per \$100 of trading) and suggests that there are large trading frictions (e.g. inattention) that are not explained by transaction costs or unrealized loss.

On average, $\tilde{\beta}$ is estimated to be \$0.81. This means that, when there is one more unit of regulatory capital loss, the trading gain required is \$0.81. In other words, the shadow cost of one unit of regulatory capital is \$0.81. This number is lower than the shadow cost of capital identified in Koijen and Yogo (2015) at $0.96, partially because the trade-off arising from trading opportunities is less persistent than the trade-off from mispricing insurance products.

Figure 3 shows the distribution of shadow cost of capital over time. The estimate is slightly negative on average. This is because insurers are averse to realizing gains, as oppose to losses, in normal times due to tax reasons (Jin, 2006), so the sign flips. In contrast to normal times, the estimate turns significantly positive during crisis periods in 2008 and in 2020, when the aversion to realize regulatory capital losses outweighs the aversion to save capital gain taxes (Ellul et al., 2015). In other words, assuming that the tax incentive remains constant over time, the difference between normal times versus crisis periods comes from the valuation of regulatory capital.

What determines the shadow cost of regulatory capital? To answer this, I examine the variation in $\tilde{\beta}$ in a panel regression of insurers i over quarters t:

$$\tilde{\beta}_{i,t} = a + bInsurerCharacteristics_{i,t} + e_{i,t} \tag{9}$$

where X includes RBC ratio and log total assets. Table 4 shows the regression results. The coefficient on RBC ratio is significant and negative, meaning that -1 (-100 percentage point) RBC ratio is associated with $0.09-$0.11 increase in the price of regulatory capital. This is consistent with the theoretical models from Koijen and Yogo (2015): when insurers have lower RBC ratio and are closer to regulatory constraint, they put more value in the marginal unit capital.

6 Conclusion

This paper identifies the accounting treatment of unrealized investment gains and losses as a determinant of bond market efficiency. Due to the favorable treatment of unrealized losses under held-to-maturity accounting, insurers are disincentivized to respond to trading gains that would simultaneously incur the losses of regulatory capital. I use detailed portfolio data and granular fixed effects to confirm the causal relationship between unrealized loss and insurer elasticity, and I use this relationship to quantify the economic price at which insurers value each unit of regulatory capital.

Depending on the past trajectory of monetary policy and macroeconomic conditions, unrealized losses can be large or small over time, which, based on my results, can lead to fluctuations in the aggregate market elasticity. This also suggests that policies that can temporarily reduce unrealized loss (e.g. asset purchases) can increase investor elasticity and reduce market dislocations during stress periods such as COVID. Outside of insurance companies, banks also hold a significant portion of their securities holdings under held-to-maturity accounting, which increase the relevance of this channel for the aggregate market.

My findings also have implications for retail investors who provide capital to insurance companies or other intermediaries that are subject to held-to-maturity accounting. Because of accounting rules, held-to-maturity intermediaries may forgo trading opportunities that will yield more economic profits that ultimately benefit the returns or safety of retail capital. The results echo the message in Ellul et al. (2015) that held-to-maturity accounting is not a panacea and can sometimes harm the welfare of retail investors.

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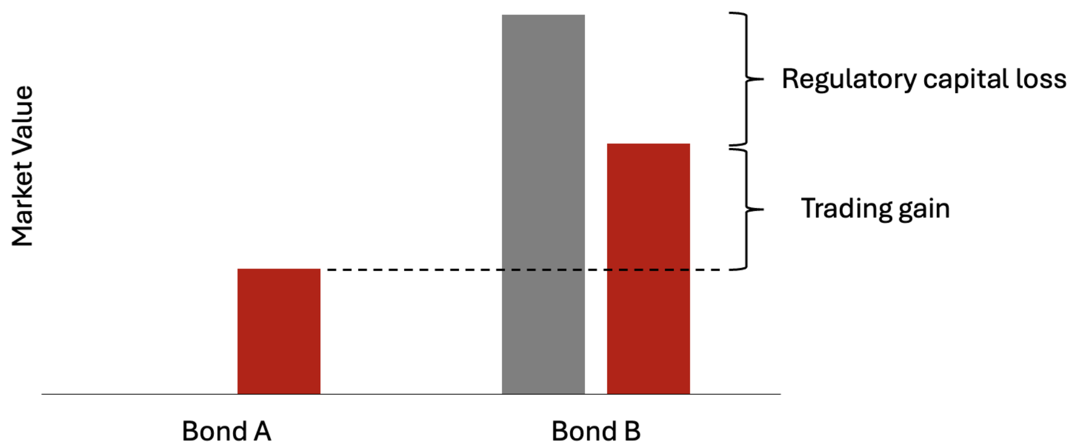
Figures

Figure 1: **Trade-off between Trading Gains and Regulatory Capital Losses.**

Panel A



Panel B

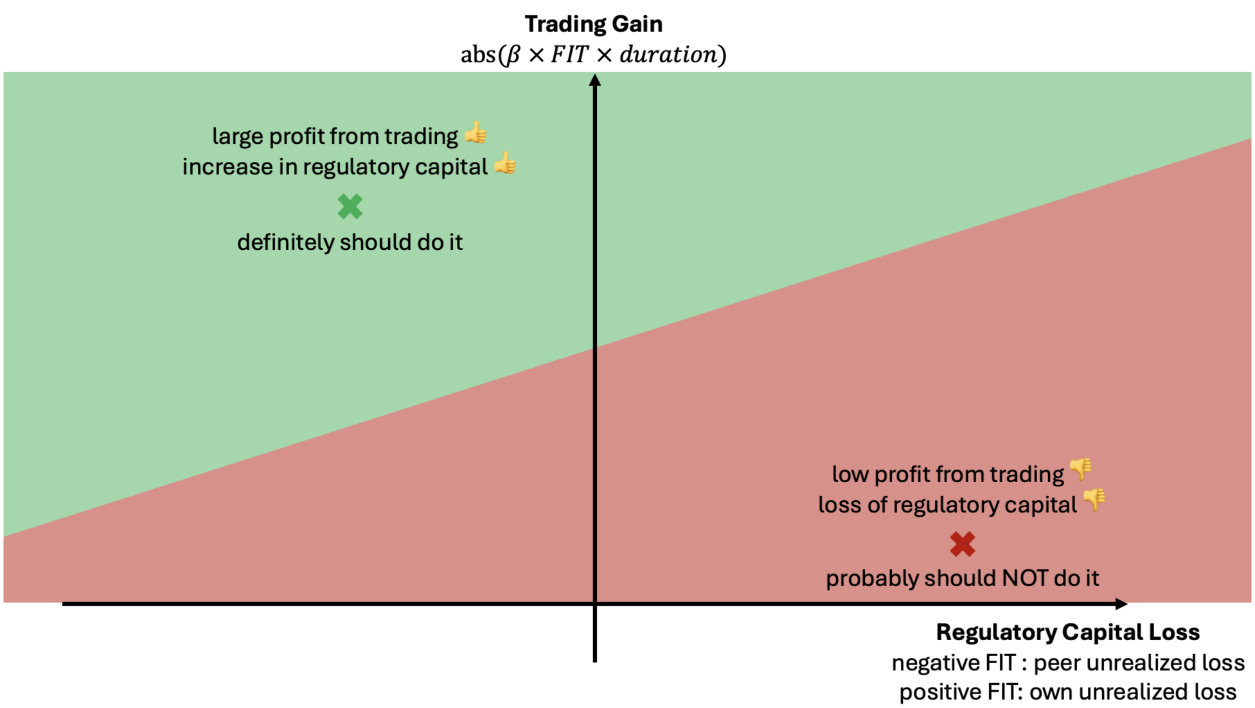


Figure 2: **Cumulative Yield Impact of Mutual Fund Flow-Induced Liquidity Shocks.** This figure plots cumulative yield spread changes in response to liquidity shocks coming from mutual fund flow-induced trading (FIT). The red lines (blue lines) plot yield response to -1% (+1%) FIT. The dark red / blue line plots yield impact for the average bond, and the bright red / blue line plots yield impact for bonds with one-standard-deviation higher unrealized losses across insurer holders (relative to amount outstanding). The solid lines show mean coefficients whereas the dash or dotted lines show 95% confidence intervals.

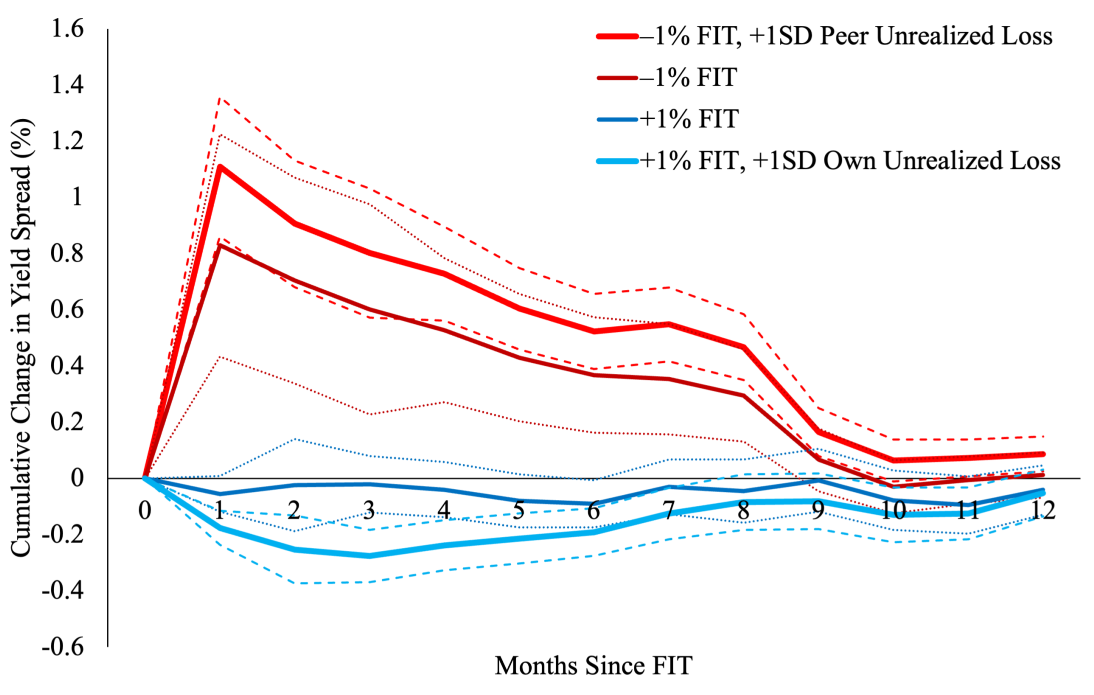
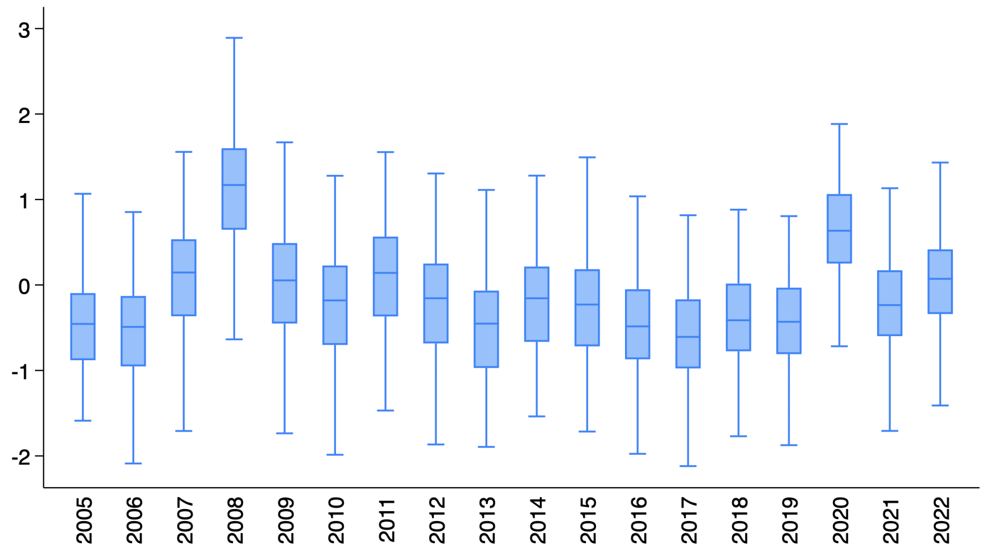


Figure 3: **Shadow Cost of Regulatory Capital over Time.** This figure plots the evolution of estimated shadow cost of regulatory capital according to Section 5. Each box plot shows the distribution of the estimates across insurance companies in that year.



Tables

Table 1: **Unrealized Loss and Insurer Elasticity.** These tables examine the response of insurer trading to mutual fund flow-induced liquidity shocks and the dependence of this response on unrealized losses, according to Regression 5:

$$\Delta Holding_{i,b,t} = \beta FIT_{b,t} \times UnrealizedLoss_{i,b,t-1} + \gamma Controls + FE + \epsilon_{i,b,t}$$

where $\Delta Holding$ denotes percent changes in par amount held, denotes mutual fund flow-induced trading according to Equation 3, and $UnrealizedLoss$ denotes unrealized losses on the bond or the bond's peers (i.e. those in the same rating, duration, and industry buckets) according to Equation 2. Panel A focuses on the cross section of bonds in March 2020. Panel B studies all crisis periods in 2007-2009 and in 2020. t-statistics are reported in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: March 2020

Dependent Variable	Change in Holding (%, t-1 to t)		
	(1)	(2)	(3)
Flow-Induced Trading (%, t-1 to t)	-0.243**	-0.373**	
	(-2.084)	(-2.323)	
× Own Unrealized Loss (standardized, t-1)		0.028	0.012
		(0.425)	(0.184)
× Peer Unrealized Loss (standardized, t-1)		0.294*	0.315**
		(1.788)	(1.994)
Controls	bond rating, bond duration, bond amount outstanding (log), bond trading volume (log)		
Insurer FE	Y	Y	Y
Bond Peer Group FE	Y	Y	
Bond FE			Y
Standard Errors	Clustered by Insurer		
Observations	96752	95856	83215
R2	0.046	0.049	0.113

Panel B: All Crisis Periods

Dependent Variable	Change in Holding (%, t-1 to t)			
	(1)	(2)	(3)	(4)
Negative Flow-Induced Trading (%, t-1 to t)	-0.169*	-0.207*		
	(-1.939)	(-1.905)		
× Own Unrealized Loss (standardized, t-1)		-0.083	0.007	0.009
		(-0.757)	(0.076)	(0.077)
× Peer Unrealized Loss (standardized, t-1)		0.199*	0.371**	0.157
		(1.952)	(2.073)	(1.038)
× Peer UL × Large Capital Drawdown (t)				0.321*
				(1.827)
Positive Flow-Induced Trading (%, t-1 to t)	-0.114*	-0.154*		
	(-1.665)	(-1.940)		
× Own Unrealized Loss (standardized, t-1)		0.129*	0.134	0.014
		(1.884)	(1.522)	(0.244)
× Peer Unrealized Loss (standardized, t-1)		-0.093	-0.047	-0.044
		(-1.383)	(-0.705)	(-0.664)
× Own UL × Large Capital Drawdown (t)				0.141*
				(1.832)
Controls	bond rating, bond duration, bond amount outstanding (log), bond trading volume (log)			
Insurer FE × Quarter FE	Y	Y	Y	Y
Bond Peer Group FE × Quarter FE	Y	Y		
Bond FE × Quarter FE			Y	Y
Standard Errors	Clustered by Insurer × Quarter			
Observations	867079	801679	799657	799657
R2	0.077	0.085	0.196	0.196

Table 2: **Unrealized Loss and Market Elasticity.** The tables examine the price impacts of mutual fund flow-induced liquidity shocks and their dependence on unrealized losses, according to Regression 6:

$$\Delta YieldSpread_{b,t} = \beta FIT_{b,t} \times UnrealizedLoss_{b,t-1} + \gamma Controls + FE + \epsilon_{b,t}$$

where $\Delta YieldSpread$ denotes changes in yield spread (over duration-matched Treasuries), FIT denotes mutual fund flow-induced trading according to Equation 3, and $UnrealizedLoss$ denotes unrealized losses on the bond or the bond's peers (i.e. those in the same rating, duration, and industry buckets) according to Equation 2. Panel A focuses on the cross section of bonds in March 2020. Panel B studies all crisis periods in 2007-2009 and in 2020. t-statistics are reported in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: March 2020

Dependent Variable	Change in Yield Spread (%, t-1 to t)		Change in CDS Basis (%, t-1 to t)	
	(1)	(2)	(3)	(4)
Flow-Induced Trading (%, t-1 to t)	-0.747***	-0.406***	-0.700***	-0.421
	(-4.375)	(-4.739)	(-3.004)	(-1.185)
Own Unrealized Loss (standardized, t-1)		-0.203**		0.134
		(-2.353)		(0.359)
FIT × Own Unrealized Loss		-0.105		0.588
		(-1.251)		(1.038)
Peer Unrealized Loss (standardized, t-1)		-0.143		0.596
		(-1.262)		(0.803)
FIT × Peer Unrealized Loss		-0.420***		-1.271*
		(-2.596)		(-1.705)
Controls	yield spread (CDS basis), lagged change in yield spread (CDS basis), rating, duration, amount outstanding (log), trading volume (log)			
Fixed Effects	Rating FE × Duration FE × Industry FE			
Standard Errors	Clustered by Rating FE × Duration FE × Industry FE			
Observations	3483	3417	630	608
R2	0.771	0.777	0.545	0.559

Panel B: All Crisis Periods

Dependent Variable	Change in Yield Spread (%, t-1 to t)		Change in CDS Basis (%, t-1 to t)	
	(1)	(2)	(3)	(4)
Negative Flow-Induced Trading (%, t-1 to t)	-1.128***	-0.829***	-0.365**	-0.308**
	(-7.397)	(-6.204)	(-2.102)	(-2.462)
× Own Unrealized Loss		-0.014		0.334
		(-0.145)		(1.363)
× Peer Unrealized Loss		-0.280***		-0.592*
		(-5.558)		(-1.857)
Positive Flow-Induced Trading (%, t-1 to t)	-0.087**	-0.055*	-0.143**	-0.017
	(-2.519)	(-1.691)	(-2.080)	(-0.231)
× Own Unrealized Loss		-0.121***		-0.407*
		(-4.280)		(-1.959)
× Peer Unrealized Loss		0.044		-0.079
		(1.399)		(-0.747)
Own Unrealized Loss (standardized, t-1)		-0.077***		-0.079*
		(-5.134)		(-1.755)
Peer Unrealized Loss (standardized, t-1)		-0.022		0.132
		(-0.829)		(1.394)
Controls	yield spread (CDS basis), lagged change in yield spread (CDS basis), rating, duration, amount outstanding (log), trading volume (log)			
Fixed Effects	Rating FE × Duration FE × Industry FE × Quarter FE			
Standard Errors	Clustered by Rating × Duration× Industry FE and by Quarter			
Observations	32767	30772	8023	7509
R2	0.809	0.812	0.679	0.685

Table 3: **Placebo Tests with Mutual Fund Unrealized Losses.** The tables examine whether bond mutual funds' unrealized losses have effects on their trading decisions (Panel A) and bond prices (Panel B) through Regression 5 and 6. t-statistics are reported in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: Trading Reaction to Flow-Induced Mispricing

Dependent Variable	Change in Holding (%)		
	(1)	(2)	(3)
Negative Flow-Induced Trading (%, t-1 to t)	-0.265* (-1.894)	-0.293* (-1.802)	
× Own Unrealized Loss (standardized, t-1)		0.094 (0.692)	0.098 (1.089)
× Peer Unrealized Loss (standardized, t-1)		-0.007 (-0.043)	0.002 (0.014)
Positive Flow-Induced Trading (%, t-1 to t)	-0.157 (-1.338)	-0.093 (-1.059)	
× Own Unrealized Loss (standardized, t-1)		-0.119* (-1.931)	-0.103* (-1.821)
× Peer Unrealized Loss (standardized, t-1)		0.026 (0.181)	0.011 (0.079)
Controls	bond rating, bond duration, bond amount outstanding (log), bond trading volume (log)		
Fund FE × Quarter FE	Y	Y	Y
Bond Peer Group FE × Quarter FE	Y	Y	
Bond FE × Quarter FE			Y
Standard Errors	Clustered by Fund × Quarter		
Observations	235345	235345	230274
R2	0.034	0.039	0.198

Panel B: Price Reaction to Flow-Induced Trading

Dependent Variable	Change in Yield Spread (%, t-1 to t)		Change in CDS Basis (%, t-1 to t)	
	(1)	(2)	(3)	(4)
Negative Flow-Induced Trading (%, t-1 to t)	-1.128***	-1.204***	-0.365**	-0.394**
	(-7.397)	(-7.024)	(-2.102)	(-2.507)
× Own Unrealized Loss across Mutual Funds		0.023		0.012
		(0.202)		(0.156)
× Peer Unrealized Loss across Mutual Funds		-0.060		0.153
		(-0.985)		(0.824)
Positive Flow-Induced Trading (%, t-1 to t)	-0.087**	-0.072*	-0.143**	-0.199**
	(-2.519)	(-1.933)	(-2.080)	(-1.988)
× Own Unrealized Loss across Mutual Funds		0.137*		0.513*
		(1.902)		(1.746)
× Peer Unrealized Loss across Mutual Funds		-0.013		-0.098
		(-0.184)		(-0.829)
Own Unrealized Loss across MFs (standardized, t-1)		-0.102***		0.024
		(-4.285)		(0.823)
Peer Unrealized Loss across MFs (standardized, t-1)		-0.081		0.004
		(-1.390)		(0.086)
Controls	yield spread (CDS basis), lagged change in yield spread (CDS basis), rating, duration, amount outstanding (log), trading volume (log)			
Fixed Effects	Bond Peer Group FE × Quarter FE			
Standard Errors	Clustered by Bond Peer Group and by Quarter			
Observations	32767	31463	8023	7002
R2	0.809	0.810	0.679	0.687

Table 4: **Determinants of Estimated Shadow Cost of Regulatory Capital.** The table examines determinants of the estimated shadow cost of regulatory capital according to Section 5, based on Regression 9:

$$\tilde{\beta}_{i,t} = a + bInsurerCharacteristics_{i,t} + e_{i,t}$$

t-statistics are reported in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Dependent Variable	Estimated Price of Regulatory Capital ($, t)		
	(1)	(2)	(3)
RBC Ratio (t-1)	-0.11***	-0.09*	-0.09*
	(-2.74)	(-1.71)	(-1.60)
Total Assets (Log, t-1)	0.03	0.02*	0.02
	(1.62)	(1.73)	(0.64)
Life Insurer	-0.13*	-0.13	
	(-1.66)	(-1.61)	
Quarter FE		Y	Y
Insurer FE			Y
Observations	7987	7987	7985
R2	0.13	0.13	0.14

Appendix A Additional Figures

Figure A1: **Mark-to-Market vs Held-to-Maturity Accounting.** This figure illustrates, for a bond whose price evolution is given by the black bars, the trajectory of its book value under mark-to-market accounting (blue bars), held-to-maturity accounting (red bars), and held-to-maturity accounting when trading occurs at T2 (pink bars).

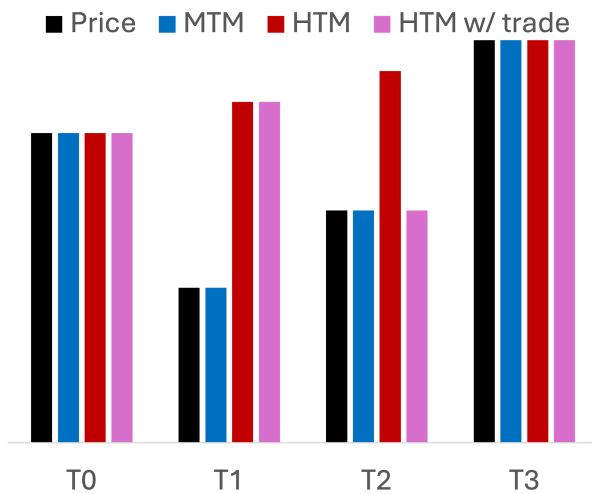


Figure A2: **Example of Insurance Regulatory Filing.** The figures show regulatory filings made by Security Benefit Life Insurance Company in 2016.

Capital Accounting

ANNUAL STATEMENT FOR THE YEAR 2016 OF THE Security Benefit Life Insurance Company

SUMMARY OF OPERATIONS

	1 Current Year	2 Prior Year
1. Premiums and annuity considerations for life and accident and health contracts (Exhibit 1, Part 1, Line 20.4, Col. 1, less Col. 11)	3,665,498,482	2,270,676,839
2. Considerations for supplementary contracts with life contingencies	41,049	2,242
3. Net investment income (Exhibit of Net Investment Income, Line 17)	1,026,225,718	743,442,804
4. Amortization of Interest Maintenance Reserve (IMR, Line 5)	11,546,136	4,074,029
5. Separate Accounts net gain from operations excluding unrealized gains or losses	0	0
6. Commissions and expense allowances on reinsurance ceded (Exhibit 1, Part 2, Line 26.1, Col. 1)	5,179,903	17,737,474
7. Reserve adjustments on reinsurance ceded		0
8. Miscellaneous Income:		
8.1 Income from fees associated with investment management, administration and contract guarantees from Separate Accounts	55,161,182	59,501,930
8.2 Charges and fees for deposit-type contracts	0	0
8.3 Aggregate write-ins for miscellaneous income	188,096,778	174,478,335
9. Totals (Lines 1 to 8.3)	4,951,749,248	3,269,913,653
10. Death benefits	354,120	1,353,648
11. Matured endowments (excluding guaranteed annual pure endowments)	0	0
12. Annuity benefits (Exhibit 8, Part 2, Line 6.4, Cols. 4 + 8)	216,769,303	201,740,818
13. Disability benefits and benefits under accident and health contracts	1,347	4,831
14. Coupons, guaranteed annual pure endowments and similar benefits		0
15. Surrender benefits and withdrawals for life contracts	1,253,570,169	1,242,848,559
16. Group conversions		0
17. Interest and adjustments on contract or deposit-type contract funds	24,520,285	19,172,821
18. Payments on supplementary contracts with life contingencies		0
19. Increase in aggregate reserves for life and accident and health contracts	3,248,199,567	1,684,973,113
20. Totals (Lines 10 to 19)	4,743,414,791	3,150,093,790
21. Commissions on premiums, annuity considerations and deposit-type contract funds (direct business only) (Exhibit 1, Part 2, Line 31, Col. 1)	371,402,374	370,016,161
22. Commissions and expense allowances on reinsurance assumed (Exhibit 1, Part 2, Line 26.2, Col. 1)	2,236,007	1,995,167
23. General insurance expenses (Exhibit 2, Line 10, Columns 1, 2, 3 and 4)	196,227,061	104,408,043
24. Insurance taxes, licenses and fees, excluding federal income taxes (Exhibit 3, Line 7, Cols. 1 + 2 + 3)	2,862,126	2,508,239
25. Increase in loading on deferred and uncollected premiums	(6)	(8)
26. Net transfers to or (from) Separate Accounts net of reinsurance	(378,392,096)	(421,798,570)
27. Aggregate write-ins for deductions	139,451,930	5,603,948
28. Totals (Lines 20 to 27)	5,077,202,187	3,212,826,770
29. Net gain from operations before dividends to policyholders and federal income taxes (Line 9 minus Line 28)	(125,452,939)	57,086,883
30. Dividends to policyholders	58	66
31. Net gain from operations after dividends to policyholders and before federal income taxes (Line 29 minus Line 30)	(125,452,997)	57,086,817
32. Federal and foreign income taxes incurred (excluding tax on capital gains)	(32,843,553)	(13,783,945)
33. Net gain from operations after dividends to policyholders and federal income taxes and before realized capital gains or (losses) (Line 31 minus Line 32)	(92,609,444)	70,870,762
34. Net realized capital gains (losses) (excluding gains (losses) transferred to the IMR) less capital gains tax of $ 11,243,556 (excluding taxes of $ 31,230,071 transferred to the IMR)	11,564,194	4,554,892
35. Net income (Line 33 plus Line 34)	(81,045,250)	75,425,654
CAPITAL AND SURPLUS ACCOUNT		
36. Capital and surplus, December 31, prior year (Page 3, Line 38, Col. 2)	1,286,369,374	1,301,456,083
37. Net income (Line 35)	(81,045,250)	75,425,654
38. Change in net unrealized capital gains (losses) less capital gains tax of $ (15,023,750)	(2,033,478)	(2,181,588)
39. Change in net unrealized foreign exchange capital gain (loss)	(8,831,813)	(8,440,880)
40. Change in net deferred income tax	19,541,998	(9,946,666)
41. Change in nonadmitted assets	6,751,436	(2,962,258)
42. Change in liability for reinsurance in unauthorized and certified companies	0	0
43. Change in reserve on account of change in valuation basis, (increase) or decrease	0	0
44. Change in asset valuation reserve	(58,075,111)	(53,494,580)
45. Change in treasury stock (Page 3, Lines 36.1 and 36.2 Col. 2 minus Col. 1)	0	0
46. Surplus (contributed to) withdrawn from Separate Accounts during period		0
47. Other changes in surplus in Separate Accounts statement	0	0
48. Change in surplus notes	(49,987,779)	20,033
49. Cumulative effect of changes in accounting principles		0
50. Capital changes:		
50.1 Paid in		0
50.2 Transferred from surplus (Stock Dividend)		0
50.3 Transferred to surplus		0
51. Surplus adjustment:		
51.1 Paid in	289,366,509	0
51.2 Transferred to capital (Stock Dividend)		0
51.3 Transferred from capital		0
51.4 Change in surplus as a result of reinsurance	(1,021,854)	(13,506,424)
52. Dividends to stockholders		0
53. Aggregate write-ins for gains and losses in surplus	160,633,491	0
54. Net change in capital and surplus for the year (Lines 37 through 53)	275,298,149	(15,086,709)
55. Capital and surplus, December 31, current year (Lines 36 + 54) (Page 3, Line 38)	1,561,667,523	1,286,369,374

Bond Holdings

ANNUAL STATEMENT FOR THE YEAR 2016 OF THE Security Benefit Life Insurance Company

SCHEDULE D - PART 1

Showing All Long-Term **BONDS** Owned December 31 of Current Year

E10.15

1	2	Codes			6	7	Fair Value		10	11	Change in Book / Adjusted Carrying Value				Interest					Dates	
		3	4	5			8	9			12	13	14	15	16	17	18	19	20	21	22
CUSIP Identification	Description	Code	Foreign	Bond CHAR	NAIC Designation	Actual Cost	Rate Used to Obtain Fair Value	Fair Value	Par Value	Book/ Adjusted Carrying Value	Unrealized Valuation Increase/ (Decrease)	Current Year's (Amortization)/ Accretion	Current Year's Other Than Temporary Impairment Recognized	Total Foreign Exchange Change In B./A.C.V.	Rate of	Effective Rate of	When Paid	Admitted Amount Due & Accrued	Amount Rec. During Year	Acquired	Stated Contractual Maturity Date
12515A-BB-5	CD COMMERCIAL MORTGAGE TRUST 2016-CD2 A2			4	1FE	5,149,959	102.3630	5,118,168	5,000,000	5,148,089	0	(1,870)	0	0	3.037	2.393	MON	6,749	0	11/18/2016	11/10/2049
12531W-BC-5	CFCRE COMMERCIAL MORTGAGE TRUS 2016-C3 X			4,6	1FE	1,489,653	7.3040	1,378,030	0	1,364,103	0	(125,550)	0	0	1.089	5.319	MON	17,151	189,432	03/23/2016	01/10/2048
12531W-BF-8	CFCRE COMMERCIAL MORTGAGE TRUS 2016-C3 A			4	1FM	2,832,455	103.7490	2,853,109	2,750,000	2,825,735	0	(6,720)	0	0	4.147	3.800	MON	9,504	104,539	01/22/2016	01/10/2048
12531W-BH-4	CFCRE COMMERCIAL MORTGAGE TRUS 2016-C3 C	C		4	1FM	6,859,816	99.2990	7,298,471	7,350,000	6,894,130	0	34,314	0	0	4.758	5.683	MON	29,142	325,444	01/22/2016	01/10/2048
12531Y-AN-8	CFCRE COMMERCIAL MORTGAGE TRUS 2016-C4 A			4	1FM	3,089,753	99.0700	2,972,085	3,000,000	3,084,628	0	(5,125)	0	0	3.283	2.937	MON	8,208	57,453	05/04/2016	05/10/2058
12531Y-AU-2	CFCRE COMMERCIAL MORTGAGE TRUS 2016-C4 A	C		4	1FM	526,719	99.8130	499,064	500,000	525,478	0	(1,241)	0	0	3.691	3.063	MON	1,538	9,228	06/22/2016	05/10/2058
12531Y-AV-0	CFCRE COMMERCIAL MORTGAGE TRUS 2016-C4 B			4	1FM	3,089,995	100.3340	3,010,029	3,000,000	3,085,128	0	(4,867)	0	0	4.147	3.800	MON	10,368	72,573	05/04/2016	05/10/2058
12532L-BA-2	CGGS COMMERCIAL MORTGAGE TRUST 2016-RND8			4	1FM	2,654,388	100.5380	2,668,656	2,654,388	2,654,388	0	0	0	0	5.454	5.515	MON	6,836	100,337	03/21/2016	02/15/2033
125354-AJ-9	CGRBS COMMERCIAL MORTGAGE TRUS 2013-VN05	C		4	1FM	2,395,418	96.1510	2,403,784	2,500,000	2,428,931	0	9,570	0	0	3.584	4.117	MON	7,467	91,093	03/15/2013	03/13/2035
12591Q-AR-3	COMM MORTGAGE TRUST 2014-UBS4 A5			4	1FM	3,145,078	103.4790	3,104,357	3,000,000	3,131,761	0	(13,318)	0	0	3.694	3.046	MON	9,235	92,350	02/23/2016	08/10/2047
12591T-AG-1	COMM MORTGAGE TRUST 2014-LC15 AM			4	1FM	2,496,129	105.0820	2,416,895	2,300,000	2,482,410	0	(13,719)	0	0	4.198	2.975	MON	8,046	56,323	05/20/2016	04/10/2047
12591V-AF-8	COMM MORTGAGE TRUST 2014-CR16 XA	C		4,6	1FE	1,442,661	5.4950	1,120,010	0	1,134,701	0	(180,352)	0	0	1.218	4.109	MON	20,730	238,165	04/06/2016	04/10/2047
12591V-AG-6	COMM MORTGAGE TRUST 2014-CR16 AM			4	1FM	2,513,199	105.4090	2,424,399	2,300,000	2,498,467	0	(14,732)	0	0	4.278	2.961	MON	8,200	57,397	05/20/2016	04/10/2047
12592X-BD-7	COMM MORTGAGE TRUST 2015-CR22 A5	C		4	1FM	4,014,715	101.2080	3,947,113	3,900,000	4,007,954	0	(6,761)	0	0	3.309	2.929	MON	10,754	92,652	08/25/2016	03/10/2048
12592X-BG-0	COMM MORTGAGE TRUST 2015-CR22 B			4	1FM	410,969	100.7520	403,009	400,000	410,234	0	(735)	0	0	3.926	3.578	MON	1,309	9,161	04/27/2016	03/10/2048
12593A-BB-0	COMM MORTGAGE TRUST 2015-CR23 XA	C		4,6	1FE	989,103	5.3560	767,211	0	812,343	0	(114,284)	0	0	0.999	3.472	MON	11,926	154,351	05/08/2015	05/10/2048
12593A-BC-8	COMM MORTGAGE TRUST 2015-CR23 AM			4	1FM	2,643,420	101.8900	2,547,238	2,500,000	2,634,757	0	(8,663)	0	0	3.801	3.070	MON	7,919	55,431	05/20/2016	05/10/2048
12593A-BD-6	COMM MORTGAGE TRUST 2015-CR23 B			4	1FM	4,055,370	96.4610	3,858,452	4,000,000	4,051,764	0	(3,606)	0	0	4.183	4.018	MON	13,943	97,603	05/04/2016	05/10/2048
12593J-BF-2	COMM MORTGAGE TRUST 2015-CR24 A5	C		4	1FM	4,028,953	103.8040	3,840,760	3,700,000	4,011,718	0	(17,235)	0	0	3.696	2.596	MON	11,396	68,376	06/17/2016	08/10/2048
12593J-BJ-4	COMM MORTGAGE TRUST 2015-CR24 B			4	1FM	1,875,484	104.0380	1,820,672	1,750,000	1,868,745	0	(6,739)	0	0	4.374	3.465	MON	6,379	38,907	06/03/2016	08/10/2048
12593J-BK-1	COMM MORTGAGE TRUST 2015-CR24 C			4	1FM	1,492,617	97.7360	1,466,037	1,500,000	1,492,942	0	325	0	0	4.374	4.466	MON	5,468	38,997	05/05/2016	08/10/2048
12593Q-BE-9	COMM MORTGAGE TRUST 2015-CR26 A4			4	1FM	3,114,375	102.9290	3,087,861	3,000,000	3,105,403	0	(8,972)	0	0	3.630	3.172	MON	9,075	81,675	02/26/2016	10/10/2048
12593Q-BF-6	COMM MORTGAGE TRUST 2015-CR26 XA			4,6	1FE	1,555,185	6.4190	1,401,786	0	1,350,289	0	(204,896)	0	0	1.055	1.034	MON	19,225	206,741	01/28/2016	10/10/2048
12593Q-BJ-8	COMM MORTGAGE TRUST 2015-CR26 C	C		4	1FM	2,422,641	94.9490	2,468,677	2,600,000	2,435,817	0	13,177	0	0	4.495	5.450	MON	9,738	106,881	02/09/2016	10/10/2048
12625C-AL-7	COMM MORTGAGE TRUST 2013-WWP C	C		4	1FM	1,979,743	99.9760	1,999,520	2,000,000	1,985,935	0	1,739	0	0	3.544	3.683	MON	5,907	70,884	03/25/2013	03/10/2031
12625C-AN-3	COMM MORTGAGE TRUST 2013-WWP D	C		4	1FM	967,099	99.2080	992,079	1,000,000	977,571	0	2,963	0	0	3.898	4.331	MON	3,248	38,979	03/25/2013	03/10/2031
12625K-AL-9	COMM MORTGAGE TRUST 2013-CR8 AM			4	1FM	3,186,328	103.5250	3,105,762	3,000,000	3,171,313	0	(15,015)	0	0	3.826	2.844	MON	9,566	68,293	05/18/2016	06/10/2046
12626B-AF-1	COMM MORTGAGE TRUST 2013-CR10 XA	C		4,6	1FE	450,150	3.7970	339,159	0	450,150	0	0	0	0	0.927	0.000	MON	6,907	91,853	05/13/2015	08/10/2046

Bond Transactions (Purchases)

ANNUAL STATEMENT FOR THE YEAR 2016 OF THE Security Benefit Life Insurance Company

SCHEDULE D - PART 3

Showing All Long-Term Bonds and Stocks **ACQUIRED** During Current Year

1	2	3	4	5	6	7	8	9
CUSIP Identification	Description	Foreign	Date Acquired	Name of Vendor	Number of Shares of Stock	Actual Cost	Par Value	Paid for Accrued Interest and Dividends
70469Q-AA-7	PEAKS CLO LTD 2014-1A A	D	12/30/2016	SBL - FIA AG33 LD Client	XXX	66,698,229	67,150,000	363,020
74737E-AA-2	QBE INSURANCE GROUP LTD	D	11/17/2016	MORGAN STANLEY	XXX	167,252	150,000	0
74966W-AA-4	RFT ISSUER LTD 2015-FL1 A	D	12/09/2016	JPMORGAN SECURITIES INC	XXX	191,369	192,090	354
76121V-AJ-4	RESOURCE CAPITAL CORP LTD 2015-CRE3 D	D	12/14/2016	BAY CREST PARTNERS, LLC	XXX	499,375	500,000	211
774262-AC-3	ROCKWALL CDO 2006-1A A2L	D	12/30/2016	SBL-SUR CLIENT	XXX	3,388,262	3,512,404	8,842
77426N-AB-9	ROCKWALL CDO 2007-1A A1LB	D	12/30/2016	SBL-FO CLIENT	XXX	956,023	1,000,000	2,353
780097-BA-8	ROYAL BK SCOTLND GRP PLC	D	03/30/2016	MORGAN STANLEY	XXX	5,190,588	5,200,000	0
78467M-AA-1	SRERS FUNDING LTD 2011-RS A1B1	D	10/28/2016	Various	XXX	799,583	811,011	338
78467M-AB-9	SRERS FUNDING LTD 2011-RS A1B2	D	12/20/2016	CITIGROUP GLOBAL MARKETS	XXX	968,438	1,500,000	527
79411M-AA-6	SALEM FIELDS CLO SECURED NOTE	D	10/28/2016	CITIGROUP GLOBAL MARKETS	XXX	73,932,000	73,932,000	0
80281L-AD-7	SANTANDER UK GROUP HLDGS	D	01/05/2016	BARCLAYS CAPITAL INC	XXX	7,692,223	7,700,000	0
80283L-AL-7	SANTANDER UK PLC 2.439% 03/14/19	D	06/01/2016	No Broker	XXX	3,250,000	3,250,000	15,065
81254U-20-5	SEASPAN CORP 6.375% 04/30/19	D	11/25/2016	DIRECT	XXX	25,000,000	1,000,000	0
817176-AC-4	SENECA PARK CLO LTD 2014-1A B1	D	10/21/2016	JEFFERIES & COMPANY INC	XXX	952,375	950,000	672
81880R-BH-7	SHACKLETON CLO LTD 2012-1A B1R	D	10/25/2016	NATIXIS CAPITAL MARKETS	XXX	750,000	750,000	0
818813-AT-4	SHACKLETON CLO LTD 2012-2A CR	D	10/04/2016	NATIXIS CAPITAL MARKETS	XXX	750,000	750,000	0
818813-AU-1	SHACKLETON CLO LTD 2012-2A DR	D	10/04/2016	NATIXIS CAPITAL MARKETS	XXX	1,000,000	1,000,000	0
81882B-AN-8	SHACKLETON CLO LTD 2015-7A CR	D	12/16/2016	CREDIT SUISSE FIRST BOSTON	XXX	1,249,625	1,250,000	0
83367T-BR-9	SOCIETE GENERALE 4.750% 11/24/25	D	04/25/2016	SANTANDER INVESTMENT SECURITIE	XXX	377,601	377,586	7,672
83368J-KF-6	SOCIETE GENERALE 4.250% 08/19/26	D	08/16/2016	SG AMERICAS SECURITIES LLC	XXX	1,640,562	1,650,000	0
86562M-AE-0	SUMITOMO MITSUI FINL GRP	D	07/07/2016	GOLDMAN SACHS & CO	XXX	7,500,000	7,500,000	0
87230A-AD-8	TCI-FLATIRON CLO LTD 2016-1A D	D	06/02/2016	BANK OF AMERICA	XXX	4,826,000	5,000,000	0
87233G-AG-5	TCP WATERMAN CLO LLC 2016-1A A2	D	11/22/2016	NATIXIS CAPITAL MARKETS	XXX	1,000,000	1,000,000	0
88167A-AD-3	TEVA PHARMACEUTICALS NE	D	07/18/2016	BARCLAYS CAPITAL INC	XXX	4,484,970	4,500,000	0
88432L-AA-4	THL CREDIT WIND RIVER 2016-2 C SECURED N	D	11/01/2016	No Broker	XXX	110,900,000	110,900,000	0
88433A-AG-4	WIND RIVER CLO LTD 2016-1A D	D	05/18/2016	RBC CAPITAL MARKETS LLC	XXX	3,829,600	4,000,000	0
89300A-AW-7	TRALEE CDO LTD 2014-3A CR	D	11/02/2016	DEUTSCHE BANK SECURITIES INC	XXX	2,000,000	2,000,000	0
90351D-AE-7	UBS GROUP FUNDING 2.661% 04/14/21	D	03/29/2016	UBS SECURITIES LLC	XXX	7,000,000	7,000,000	0
92329L-AN-4	VENTURE CDO LTD 2012-10A CR	D	10/06/2016	JEFFERIES & COMPANY INC	XXX	500,000	500,000	0
92329L-AQ-7	VENTURE CDO LTD 2012-10A DR	D	10/06/2016	JEFFERIES & COMPANY INC	XXX	1,500,000	1,500,000	0
92330E-AL-1	VENTURE CDO LTD 2014-19A CR	D	12/15/2016	JEFFERIES & COMPANY INC	XXX	1,750,000	1,750,000	0
92912Q-AE-6	VOYA CLO LTD 2014-3A C	D	04/06/2016	MORGAN STANLEY	XXX	3,763,863	4,265,000	38,484
95736X-AB-4	WESTCHESTER CLO LTD 2007-1A A1B	D	12/30/2016	SBL-SUR CLIENT	XXX	3,027,679	3,250,000	6,530
96525Q-AG-1	WHITEHORSE LTD 2012-1A A3R	D	10/20/2016	NOMURA	XXX	2,000,000	2,000,000	0
98954R-AA-8	ZIGGURAT CLO LTD 2014-1A A1	D	12/30/2016	SBL - FIA AG33 LD Client	XXX	24,922,972	25,000,000	126,417
98954T-AA-4	ZIGGURAT CLO LTD 2014-1A E	D	01/06/2016	WELLS FARGO	XXX	390,000	500,000	6,207
000000-00-0	OCTAGON INVESTMENT PARTNERS 28 SECURED N	D	09/08/2016	MORGAN STANLEY	XXX	145,000,000	145,000,000	0
000000-00-0	VOYA CLO 2016-4 SECURED NOTE	D	11/17/2016	MORGAN STANLEY	XXX	112,600,000	112,600,000	0
000000-00-0	ARES CLO MANAGEMENT LLC VERTICAL STRIP	D	12/30/2016	SBL - FIA AG33 LD Client	XXX	35,282,171	35,250,000	143,393
000000-00-0	CARLYLE CLO MANAGEMENT TL A	D	04/27/2016	CITIGROUP GLOBAL MARKETS	XXX	20,550,000	20,550,000	0
000000-00-0	MARANON LOAN FUNDING LTD SECURED NOTE	D	12/02/2016	CITIGROUP GLOBAL MARKETS	XXX	113,200,000	113,200,000	0
33833P-AA-6	5180-2 SECURED NOTE 5.330% 11/25/27		08/29/2016	No Broker	XXX	325,605,626	335,873,977	179,156
48249N-AE-9	KHCN LLC SECURED NOTE 3.310% 04/17/27		10/19/2016	No Broker	XXX	144,482,442	144,665,143	26,602
794107-AN-2	SALEM FIELDS CLO LTD 2016-2A D2		10/28/2016	CITIGROUP GLOBAL MARKETS	XXX	12,311,373	12,900,000	0
000000-00-0	MPE HOTEL I LLC (NY) 1ST LIEN SECURED LO		07/01/2016	DIRECT	XXX	62,196,839	64,973,013	0
3899999 - Bonds - Industrial and Miscellaneous (Unaffiliated)						6,128,283,594	6,111,844,211	11,561,125
Bonds - Hybrid Securities								
020002-30-9	ALLSTATE CORP 5.100% 01/15/53		11/25/2016	DIRECT	XXX	4,096,160	164,000	0
064058-AF-7	BANK OF NY MELLON CORP		07/25/2016	MORGAN STANLEY	XXX	1,500,000	1,500,000	0
369604-BQ-5	GENERAL ELECTRIC CO 5.000% 12/15/49		01/19/2016	No Broker	XXX	7,388,760	7,352,000	0
759351-70-3	REINSURANCE GRP OF AMER		11/25/2016	DIRECT	XXX	5,000,000	200,000	0
808513-AP-0	CHARLES SCHWAB CORP 4.625% 12/31/49		10/24/2016	CREDIT SUISSE FIRST BOSTON	XXX	4,000,000	4,000,000	0
857477-AX-1	STATE STREET CORP 1.462% 05/15/28		12/21/2016	No Broker	XXX	2,935,445	3,000,000	4,386
902973-AY-2	US BANCORP 5.125% Perpet		02/22/2016	GOLDMAN SACHS & CO	XXX	1,997,500	2,000,000	11,389
978802-20-5	WOODBOURNE CAPITAL I FLEX COMMITTED CAPI		04/09/2008	DIRECT	XXX	750,000	1,250,000	0
978803-20-3	WOODBOURNE CAPITAL II FLEX COMMITTED CAP		04/09/2008	DIRECT	XXX	750,000	1,250,000	0
97880P-20-4	WOODBOURNE CAPITAL III FLEX COMMITTED CA		04/09/2008	DIRECT	XXX	750,000	1,250,000	0
97880Q-20-2	WOODBOURNE CAPITAL IV FLEX COMMITTED CAP		04/09/2008	DIRECT	XXX	750,000	1,250,000	0
055451-AX-6	BHP BILLITON FIN USA LTD	D	02/08/2016	CREDIT SUISSE FIRST BOSTON	XXX	932,500	1,000,000	21,000
4899999 - Bonds - Hybrid Securities						30,850,365	24,216,000	36,775
Bonds - Parent, Subsidiaries, and Affiliates								
000000-00-0	HEMPSTEAD CLO LP CLO 2013-1A COMB		10/19/2016	No Broker	XXX	97,122,704	97,122,704	0

Figure A3: **Aggregate Changes in Regulatory Capital.** This figure plots aggregate changes in regulatory capital coming from underwriting income and investment income (the first two terms in Equation 1), separately for life insurers and P&C insurers. Realized gains and losses are excluded, as they can be endogenously chosen by the firm to offset other capital losses. The shaded areas indicate NBER recessions.

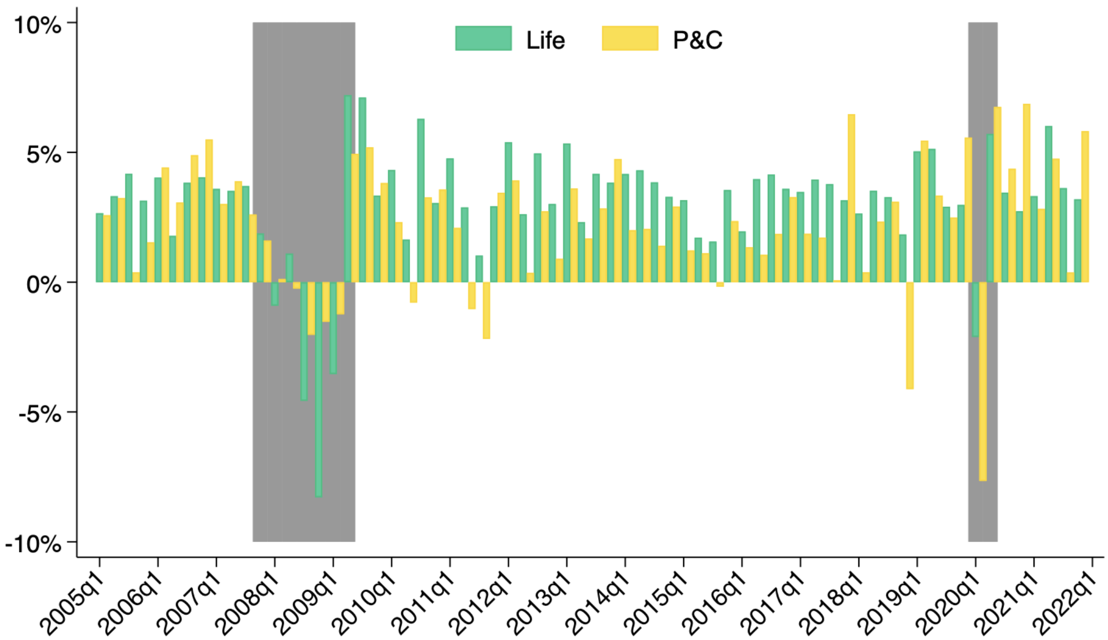
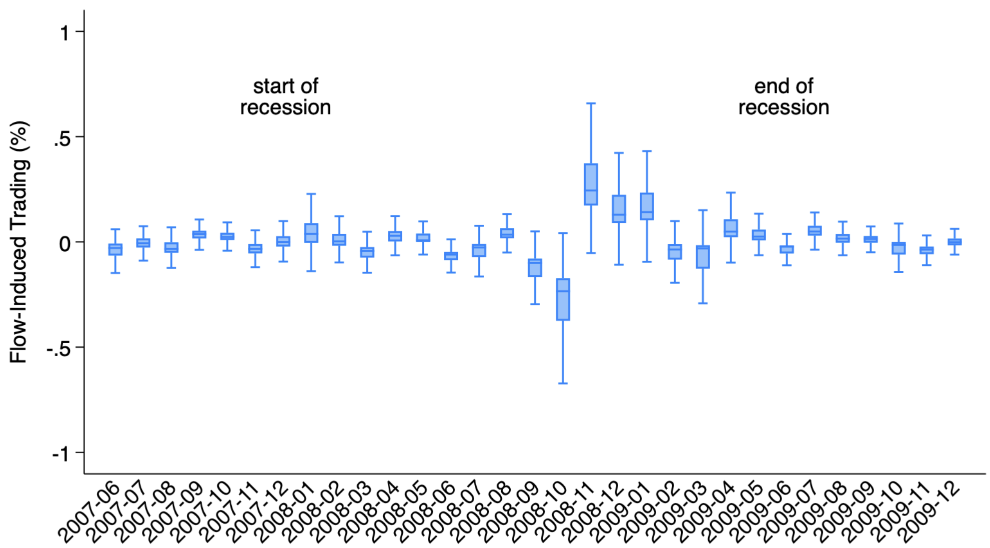


Figure A4: **Mutual Fund Flow-Induced Trading During Crisis Periods.** The figures plot mutual fund flow-induced trading (FIT) during the 2007-2009 Great Financial Crisis (Panel A) and the 2020 COVID crisis (Panel B).

Panel A: 2007-2009 Great Financial Crisis



Panel B: 2020 COVID Crisis

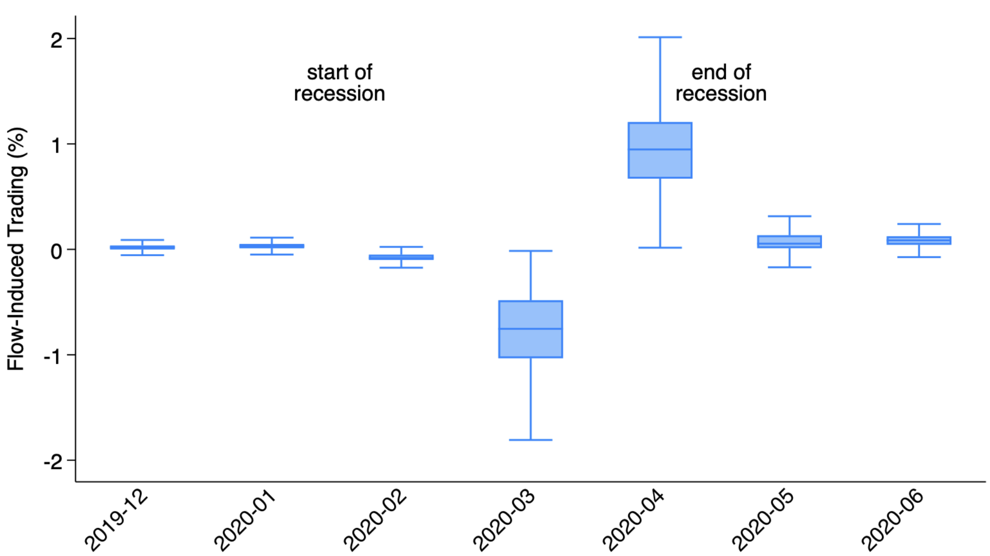
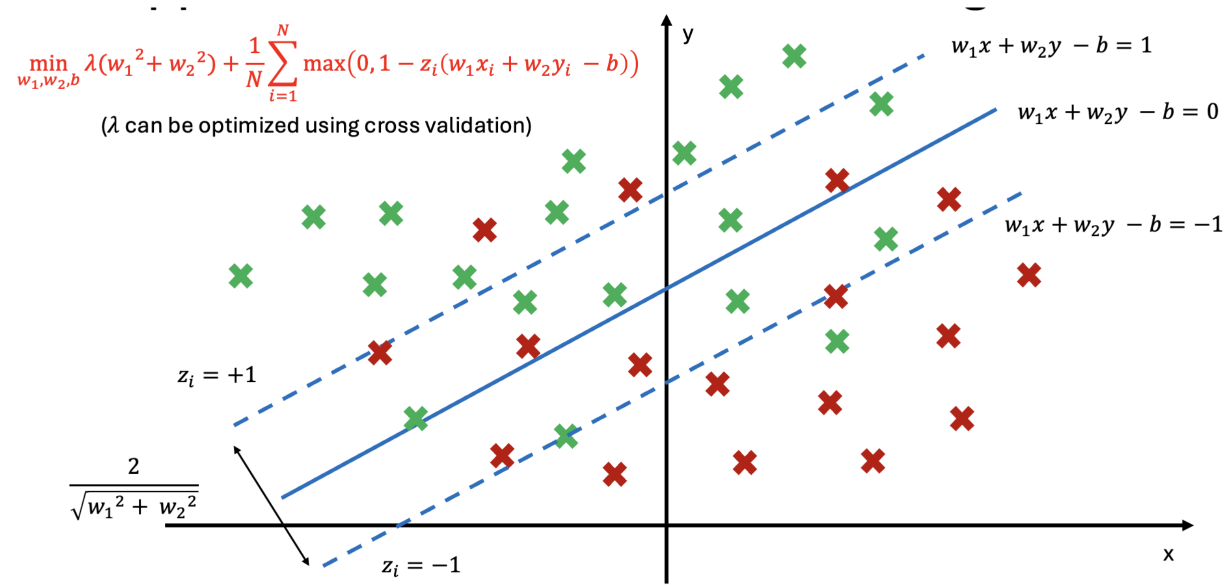


Figure A5: **Illustration of Support Vector Machine (SVM).** This figure illustrates mechanics of Support Vector Machine (Equation 8), which is used to find the indifference line separating trades versus non-trades.



Appendix B Additional Tables

Table A1: **Summary Statistics.** Panel A shows summary statistics for the two-dimensional bond-month data used for the bond pricing analyses in Section 4. Panel B shows summary statistics for the three-dimensional insurer-bond-month data used for the insurer trading analyses in Section 3.

Panel A: Bond-Month Statistics

	N	Mean	SD	P5	P50	P95
Credit Rating (AAA = 1, BBB- = 10)	46196	7.06	2.23	3.00	7.00	10.00
Coupon Rate (%)	46196	5.70	1.48	3.15	5.75	8.13
Years to Maturity	46196	8.29	5.89	1.57	6.61	19.85
Amount Outstanding (million $)	46196	453	515	3	300	1499
Yield Spread (%)	46196	2.82	1.83	0.87	2.38	6.20
Change in Yield Spread (%)	35915	0.17	1.23	-1.24	0.10	1.94
CDS Basis (%)	11141	1.67	1.18	0.14	1.50	4.08
Change in CDS Basis (%)	8707	0.05	0.84	-1.12	0.02	1.47
Flow-Induced Trading (%)	46196	0.00	0.40	-0.54	0.00	0.67
Own Unrealized Loss (%)	46196	-0.31	4.78	-6.91	-0.31	6.62
Peer Unrealized Loss (%)	46196	-0.33	2.86	-4.74	-0.33	4.14

Panel B: Insurer-Bond-Month Statistics

	N	Mean	SD	P5	P50	P95
Holding (million $)	906092	4.27	7.66	0.10	1.50	18.00
Change in Holding (%)	906092	-0.95	11.64	0.00	0.00	0.00
Own Unrealized Loss (%)	906092	-2.98	10.27	-21.59	-2.22	12.43
Peer Unrealized Loss (%)	803123	-3.07	8.84	-19.38	-1.87	8.85

Table A2: **Unrealized Loss and Insurer Trading, Replication of Ellul et al. (2015).** This table examines how insurance companies' selling decisions depend on unrealized gains and losses during crisis periods. The regression specification is copied from Table VI of Ellul et al. (2015), except that the fixed effects are more string (insurer-by-time fixed effects and bond-by-time fixed effects) and the sample includes the recent COVID crisis.

Dependent Variable	1(Sell)			
Sample	Life Insurers		P&C Insurers	
	(1)	(2)	(3)	(4)
Unrealized Loss (standardized, t-1)	-0.023**	-0.007	-0.014***	-0.012**
	(-1.998)	(-1.036)	(-2.863)	(-2.423)
× Large Capital Drawdown (t)		-0.058**		-0.010*
		(-2.303)		(-1.814)
Insurer FE × Quarter FE	Y	Y	Y	Y
Bond FE × Quarter FE	Y	Y	Y	Y
Standard Errors	Clustered by Insurer × Quarter			
Observations	317452	317452	408229	408229
R2	0.106	0.106	0.177	0.177