Regulatory Capital and Asset Risk Transfer*

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Abstract

We investigate whether and how life insurers use risk-transfer contracts to manage the regulatory capital requirements associated with their investment risk. We theoretically document how a specific type of reinsurance contract, a form of modified coinsurance, enables life insurers to reduce the regulatory capital requirements associated with their investments. We then empirically investigate how life insurers respond to exogenous increases in their regulatory capital costs -- corporate bond downgrades. We find that relative to life insurers without them, life insurers with modified coinsurance reinsurance contracts are less likely to sell downgraded bonds if the sale would result in large realized capital losses.

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1. Introduction

Life insurers play a major role as institutional investors in financial markets, and their investment behavior receives considerable attention from regulators and policyholders. An emerging strand of research suggests that life insurers manage their assets to avoid increases in their regulatory capital requirements, e.g. through gains trading (Ellul et al., 2015) or reaching for yield conditional on regulatory capital costs (Becker and Ivashina, 2015; Lenciauskaite, 2018). Life insurers also manage their liabilities, often using reinsurance (the transfer of their underlying product risk to another insurer) to avoid increases in their regulatory capital requirements (e.g., Koijen and Yogo, 2016). In this paper, we explore whether and how life insurers use reinsurance to manage the regulatory capital requirements associated with their investments (assets).

We undertake this exploration by first presenting the basic operations of reinsurance contracts, then theoretically documenting how a specific type of reinsurance contract, a form of modified coinsurance,[1] enables life insurers to reduce the regulatory capital requirements associated with their investments. A reinsurance contract is an insurance policy purchased by one insurance company, the ceding company, from another, the reinsurer. A modified coinsurance contract is a type of reinsurance that allows life insurers to transfer the "risk" of their reserves and assets to a reinsurer while maintaining the underlying reserves and assets on their book. Modified coinsurance contracts are similar to interest rate swaps in operation, as the underlying liability risks are the insurer's life insurance or annuity products, which are highly correlated with interest rate risk. As a result, we posit that the life insurers that use modified coinsurance (henceforth "RBC-relief

[1] Modified coinsurance possesses particular qualities that are attractive in managing regulatory capital. We will describe the specific operations of this contract in the next section.

reinsurance") can bear higher investment risk than those that do not (see Section 2 for more details on modified coinsurance).

Next, we empirically examine whether life insurers with modified coinsurance manage their investments differently than those that do not. We use corporate bond credit rating downgrades to establish causality, given that these are exogenous events. A bond credit rating downgrade can increase the amount of capital that regulators require the life insurer to hold. Life insurers, like other financial institutions, are regulated by a risk-weighted capital adequacy metric. For life insurers it is the Risk-Based Capital Ratio (RBC ratio), the ratio of statutory capital to risk-based capital (RBC). A low RBC ratio indicates financial weakness. Depending on the magnitude of the bond downgrade, the required capital for a bond can increase from $0.30 to $19.5 per $100 in bond value which results in a lower RBC ratio. Bond downgrades, therefore, are undesired, yet insurers have no control over the bond market.

Because life insurers use historical cost accounting for their statutory assets, most downgraded bonds do not affect a life insurer's statutory balance sheet. Only realized capital gains (and losses) are recognized on a life insurer's statutory balance sheet.[2] Downgraded bonds, however, do affect a life insurer's regulatory capital requirements, which are based on the regulator's calculation of required capital. Selling a downgraded bond, therefore, has two opposing effects on a life insurer's Risk-Based Capital (RBC) Ratio. On the one hand, it reduces the insurer's regulatory risk-based capital, which improves the insurer's RBC ratio. On the other hand, it forces the insurer to recognize the price decline in the bond (i.e. the realized capital loss), which reduces the insurer's

[2] There is one exception. If a bond is downgraded to junk bond status (NAIC 6 designation) or considered to have been impaired, life insurers are required to use mark-to-market accounting (i.e. they need to mark the value of the bond at its market value). The percent of bonds held by life insurers that are downgraded to a junk bond status, however, is small.

capital and weakens the insurer's RBC ratio (Ellul, et al., 2015). Insurers weigh these opposing effects before selling downgraded bonds.

Life insurers with RBC-relief reinsurance, however, are insulated from the regulatory capital effects of downgraded bonds, so selling a downgraded bond does not improve their RBC ratio. Accordingly, we hypothesize that firms using RBC-relief reinsurance will be less likely to sell downgraded bonds than those not using RBC-relief reinsurance if the sales lead to capital losses and lower RBC ratios. Given that the majority of insurance companies acquire investment grade bonds and that bond downgrades occur after insurers acquire investment grade bonds (Khan, Ryan, and Varma 2019), we focus on investment grade bonds (NAIC designations 1 or 2) that are downgraded to speculative grades (NAIC designations 3, 4, or 5).

We find that life insurance companies with RBC-relief reinsurance are 4 percentage points less likely to sell downgraded bonds than those without RBC-relief reinsurance if the sale would have generated capital losses more than 7 times the increase in the regulatory capital requirement.[3] Since the average life insurer sells 42% of its downgraded bonds (mean estimate), the 4 percentage point difference is economically meaningful. The difference is not due to firms with and without RBC-relief reinsurance holding different investment portfolios, as the ex-ante likelihood of owning a downgraded bond is similar between the two groups. The difference is also not due to differences in the bond characteristics held by insurers with and without RBC-relief reinsurance, as we find consistent results using the subset of corporate bonds held by both insurers with and without RBC-relief reinsurance.

Our paper is related to two strands of literature. The first is the set of papers exploring the use of reinsurance by insurance companies. Existing studies focus on the use of reinsurance to manage

[3] We proxy the expected realized capital losses using the beginning of the year unrealized capital losses of each bond. See section 3 for details.

liability risks (e.g. Jean-Baptiste and Santomero, 2000; Cole and McCullough, 2006; Cummins and Weiss, 2014; Koijen and Yogo, 2016; Garven, Hilliard and Grace, 2014). To the best of our knowledge, we are the first to study whether and how life insurers use reinsurance to manage the regulatory capital requirements associated with their assets. We find that life insurance companies use reinsurance to alleviate asset risk and suppress the costs of regulatory capital.

Our paper also contributes to the broader literature on regulatory arbitrage. The use of regulatory arbitrage by financial institutions has been documented both theoretically (e.g. Acharya et al., 2016; Colliard, 2018; Iannotta, Pennacchi and Santos, 2019) and empirically. The focus of the empirical studies has been on the development and use of various financial instruments such as contingent convertible capital bonds or trust-preferred securities (e.g. Boyson Fahlenbrach, and Stulz, 2016; Begley, Purnanandam, and Zheng, 2017; Vallee 2019). These financial instruments alleviate banks of their regulatory capital burden by improving capital positions. Studies also explore the role that accounting rules play in allowing life insurers to boost their regulatory capital position (e.g. Ellul et al., 2015; Khan, Ryan and Varma, 2019). In this paper, we find that risk transfer mechanisms can help financial institutions to reduce regulatory capital costs. Solvency questions emerge, given that the counterparty accepting these regulatory capital costs typically reside outside of the U.S.

2. Institutional Background and Framework

2.1 Risk-based capital requirements

To protect policyholders from the potential of insurer insolvency, U.S. regulators require insurers to maintain adequate capital. One tool that insurance regulators use to monitor the capital adequacy of insurers is risk-based capital (RBC), which is conceptually similar to capital requirements in the banking industry. Intuitively, RBC is a minimum level of capital generated

from a regulatory formula established by the National Association of Insurance Commissioners (NAIC).

The RBC ratio measures the extent to which an insurer holds capital in excess of RBC. The numerator of the RBC ratio is the total adjusted capital (TAC), which is total capital and surplus (insurer profit) adjusted for the valuation of reserves. The denominator of the ratio is RBC. RBC is based on four risk components: insurance (i.e. product), interest rate (market), business, and investment. For life insurers, insurance risk is the face amount of insurance policies minus policy reserves (it is referred to as an insurer's net amount at risk). Interest rate risk accounts for the mismatch between an insurer's promised guarantees and the market rate. Business risk is a catch-all component for the insurer's residual operational risks. The final component, investment risk, is the weighted-average RBC charges of the insurer's assets.[4] Assets with higher credit risk are assessed higher RBC charges. The investment risk is the largest component of RBC for life insurers, accounting for approximately 65% of RBC for the industry (NAIC RBC Statistics Report 2016).

In addition to being a solvency measure, RBC serves as a market discipline mechanism and life insurers make investment decisions to manage their RBC. For example, life insurers may engage in fire sales to manage their regulatory capital requirements on investments (e.g. Ellul et al., 2011; Lu, Lai, and Ma, 2017), reaching-for-yield by purchasing a risky bond within a group of bonds with the same regulatory capital charges (Becker and Ivashina, 2015; Lenciauskaite, 2018), or "gains trade" by selling bonds that will improve insurers' capital positions to manage their risk-based capital ratios (Ellul et al., 2015). Becker, Opp, and Saidi (2019) find that insurers are more likely to hold risky assets when the regulatory capital requirements are reduced through a regulatory reform.

[4] Other investment characteristics, such as the asset concentration factor, also are considered when calculating the investment risk, but the RBC charges are the main and most significant factor for calculating the investment risk.

2.2 Modified coinsurance

A reinsurance transaction is one in which an insurer transfers (or "cedes") some of the risk it has accepted from policyholders to another insurer (a reinsurer). Reinsurance allows insurers to manage their capital. There are two broad types of reinsurance for life insurers: yearly-renewable term (YRT) and coinsurance. In a YRT transaction, the primary insurer transfers a block of mortality or morbidity risk to a reinsurer. In a coinsurance transaction, the primary insurer transfers a portion of its premiums (assets), liabilities (reserves), and expenses to the reinsurer. YRT transactions have little effect on an insurer's RBC, but coinsurance transactions can have a sizable effect on a life insurer's RBC.

Coinsurance arrangements can increase a primary insurer's RBC ratio in two ways. First, when an insurer transfers its reserves and assets to a reinsurer it no longer bears the regulatory capital requirements associated with the transferred reserves and assets. Second, the reinsurer pays the transferring insurer (i.e., the primary or ceding insurer) a ceding commission because the primary insurer incurred all the sales and underwriting expenses associated with obtaining the underlying insurance policies. The ceding commission increases the numerator of the RBC ratio, and thereby improves the RBC ratio.

One type of coinsurance arrangement in the life insurance industry is "modified coinsurance." Modified coinsurance differs from the traditional coinsurance arrangement in that the primary insurer, rather than the reinsurer, holds the reserves and assets associated with the reinsurance agreement. The primary insurer "holds" the modified coinsurance reserves and the commensurate amount of assets to support the reserves, yet the reinsurer is ultimately "responsible" for the risks of the modified coinsurance reserves and the supporting assets. This means that any increase in the modified coinsurance reserves or in the investment risk of the supporting assets are borne by

the reinsurer. Modified coinsurance is popular among life insurers that want to maintain control over their reinsured assets to reduce reinsurer counterparty risk.

Apart from where the reserves and assets reside, modified coinsurance works similar to a traditional coinsurance arrangement. As in a traditional coinsurance arrangement, the reinsurer pays a ceding commission to the primary insurer. Because the reinsurer is responsible for the changes in the modified coinsurance reserves, the reinsurer and the primary insurer periodically settle any increase or decrease in modified coinsurance reserves net of the ceding commission. Conceptually, the settlement is similar to the settlement of financial derivatives such as an interest rate swap. While the underlying risk is the interest rate for interest rate swaps, the underlying risk is the excess risk of the reserves on life insurance or annuities for modified coinsurance.[5] This settlement process, which minimizes the excessive liability risk for the party assuming risk, explains the supply of modified coinsurance arrangement from reinsurers in the market.

Modified coinsurance, has a differential effect on the primary insurer's balance sheet and RBC. Because reserves and assets are not transferred to the reinsurer, the total adjusted capital (TAC) of the life insurer is not proportionally reduced as in the case of a typical coinsurance transaction. Instead, TAC is affected only through the ceding commission. Even though the reserves and assets under a modified coinsurance arrangement are held on the primary insurer's balance sheet, the regulators recognize the reinsurer as the ultimate owner of the risks and thereby assign the RBC responsibility of these reserves and assets to the reinsurer. Thus, the modified coinsurance transaction lowers the RBC of the primary insurer.

Three components of RBC are reduced through the modified coinsurance: interest rate risk, net amount at risk, and asset risk. Both interest rate risk and asset risk components of RBC are

[5] For detailed illustration of the modified coinsurance reserves settlements, we direct readers to chapters 4 and 5 of Tiller and Tiller (2015).

proportionally reduced as the percent of reserves coinsured except for the insurance risk. The insurance risk, i.e. net amount at risk, component of RBC is often reduced more than the coinsured amount. The net amount at risk is the difference between the face value and the accumulated reserves of an insurance policy. The net amount at risk is a negative value under modified coinsurance because the face amount of policies under modified coinsurance is zero as they are transferred to the reinsurer yet the policy reserves remain with the insurer. The magnitude of this negative value of net amount at risk depends on the type of liability risk transferred to the reinsurer.

Below we illustrate the details of the effect of modified coinsurance arrangements on a life insurer's RBC ratio. We abstract away from any other factors that affect a primary insurer's RBC beyond these reinsurance arrangements and hold fixed the cost of reinsurance for the primary insurer. In addition, we center our attention on asset risk given that it is the largest component of RBC and it plays a crucial role in the primary life insurer's investment decisions.

We define the RBC ratio for a primary insurer prior to having any reinsurance as:

$$RBC\ ratio^{pr} = \frac{TAC_0}{RBC_0} = \frac{TAC_0}{I^{pr} + RBC_0^*}$$

where we define TAC_0 as the total adjusted capital and RBC_0 as the RBC before reinsurance. I^{pr} is the investment risk component of RBC prior to reinsurance and RBC_0^* is the RBC from operations other than investment activity. I^{pr} is a positive number if the primary insurer invests in any risky assets and is zero if the primary insurer does not invest in risky assets.

With modified coinsurance, the RBC ratio ($RBC\ ratio^{MC}$) becomes:

$$RBC\ ratio^{MC} \approx \frac{TAC_0 + CC}{I^{pr} + RBC_0^* - \theta(I^{pr} + RBC_0^*)}$$

$$= \frac{(1-\theta)TAC_0 + \theta \cdot TAC_0 + CC}{(1-\theta)(I^{pr} + RBC_0^*)}$$

$$= RBC\ ratio^{pr} + \frac{\theta \cdot TAC_0 + CC}{(1-\theta)(I^{pr} + RBC_0^*)} \quad (1)$$

where θ is the percent of reserves coinsured and CC is the ceding commissions paid by the reinsurer to the primary insurer. To make a conservative estimate of the effect of modified coinsurance on the RBC ratio due to asset risk, we assume a proportional reduction in RBC_0^*, ignoring the reduction in interest rate risk and insurance risk. We, therefore, do not explicitly consider any difference arising from insurance risk due to reductions in the net amount at risk and use the almost equality symbol ($\approx$) instead of the equality symbol.

In sum, modified coinsurance improves the RBC ratio because: (i) the ceding commission increases the level of capital; (ii) the investment risk component of RBC is decreased; and (iii) the insurance risk and the interest rate risk components of RBC are decreased. Even without any positive ceding commissions or the transfer of risk from operations other than investment, modified coinsurance provides RBC relief for life insurers with risky assets, $I > 0$, because life insurers reduce their RBC while still holding the risky assets.

In practice, life insurers can enjoy RBC relief if the reinsurer is an unaffiliated insurer or if the reinsurer is an affiliated foreign insurer not subject to U.S. regulation.[6] If the affiliated reinsurer is subject to the U.S. regulation then there is no RBC relief for the group, as any RBC relief for the primary insurer will become the burden of the affiliated U.S. reinsurer. We, therefore, label modified coinsurance through an unaffiliated reinsurer or affiliated foreign reinsurer as "RBC-

[6] By "foreign", we are referring to international reinsurers domiciled outside of the U.S. countries not subject to the RBC rules in the U.S.

relief reinsurance" and lay out our hypothesis on the insurer's responses given the RBC effects of this reinsurance method.[7]

Typically, assuming reinsurers are non-U.S. companies and are not subject to U.S. regulation. From 2002 to 2015, 70% of RBC-relief reinsurance transactions were arranged with foreign reinsurance companies. The lowest was 54% in 2004, and the highest was 80% in 2012. In all years, except 2002 and 2004, the share of RBC-relief reinsurance contracts arranged with foreign reinsurance companies was higher than 60%. From the U.S. policymakers' standpoint, this means that the regulatory capital costs vanish within the U.S.

2.3 Investment RBC relief

We analyze the impact of RBC-relief reinsurance on life insurers' investment RBC. We use a simple and conservative setting in which we assume no reinsurance benefits exist except for the reduction in investment RBC. We also assume that the amount of TAC is held constant. We define investment RBC prior to having modified coinsurance as I^{pr} and investment RBC after RBC-reducing reinsurance as I^{post}. We set RBC before reinsurance equal to RBC after RBC-relief reinsurance:

$$RBC_0^* + I^{pr} = RBC_0^* + (1-\theta)I^{post}$$

$$\rightarrow \frac{I^{post}}{I^{pr}} = \frac{1}{1-\theta}$$

$$= 1 + \frac{\Delta I}{I^{pr}} = 1 + \frac{\theta}{1-\theta} \quad (2)$$

[7] In addition to modified coinsurance, "coinsurance with funds withheld" reinsurance arrangements also provide similar RBC effect on life insurer investment risk (SoA 2003) although it does not have the similar effect on the net amount at risk. In this paper, we focus on the modified coinsurance arrangement because the coinsurance with funds withheld is seldom arranged for the RBC-relief purpose and its size is much smaller than modified coinsurance. The coinsurance with funds withheld is a popular method for affiliated reinsurance arrangements, i.e. captives.

Equation (2) shows that an insurer can increase its investment RBC ($\frac{\Delta I}{I^{pr}}$) up to $\frac{\theta}{1-\theta}$ with RBC-relief reinsurance and maintain the same overall RBC. For example, a life insurer with 20% of its reserves under RBC-relief reinsurance (θ=20%) can invest 25% more in risky assets. This is a lower bound estimate of how much additional risky assets a life insurer can invest in because it does not account for the other potential effects of reinsurance, e.g. the ceding commission that boost insurer's capital levels and net amount of risk effect that reduces the RBC from operations other than investments. Accordingly, our baseline hypothesis is that life insurers with RBC-relief reinsurance can hold more risky assets than insurers without RBC-relief reinsurance, everything else equal.

3. Empirical strategy and data

An ideal experiment to investigate whether and how RBC-relief reinsurance affects insurer investments would be to randomly assign the use of RBC-relief reinsurance to life insurers, but obviously this is not a possibility. Instead, we identify the causal relationship between RBC-relief reinsurance and insurer investment behavior by leveraging exogenous changes in the regulatory capital charges of bonds. Sixty-one percent of life insurer assets ($1.76 trillion of $2.87 trillion) are invested in corporate bonds (NAIC Capital Markets Special Report 2018) and a downgrade of a corporate bond increases RBC requirements. Our strategy exploits this institutional setting of regulatory costs of corporate bonds by studying whether life insurers that use RBC-relief reinsurance are less sensitive to corporate bond credit rating downgrades than other life insurers.

The regulatory risk-based capital charge is an increasing function of the National Association of Insurance Commissioners (NAIC) risk classification. Table 1 tabulates the before-tax required capital for each type of bonds. The capital charge for the least risky corporate bonds (AAA to A-; NAIC designation 1) is 0.3%. If a life insurer holds an NAIC designation 1 bond with a book value

of $100, it faces a capital requirement of $0.30. The capital charge for corporate bonds in NAIC designation 2 (bonds rated between BBB+ and BBB-) is 0.96%. These two groups (NAIC-1 and 2) are considered "investment grade" bonds. NAIC designations 3 to 6 are considered as speculative grade bonds, and the capital requirements associated with these bonds increase exponentially. The capital charge is 3.39% for NAIC designation 3, 7.38% for NAIC designation 4, 16.96% for NAIC designation 5, and 19.5% for NAIC designation 6. To put into perspective, when an investment grade bond is downgraded to speculative grade the smallest increase in regulated capital is when an NAIC designation 2 bond is downgraded to NAIC designation 3. In this case, an insurer's investment RBC increases by $2.43 per $100 value of the bond. The maximum increase is $19.2 when an NAIC designation 1 bond is downgraded to NAIC designation 6.

3.1 Insurer responses to bond downgrades

To manage the negative effect of a downgraded bond on RBC, the denominator of the RBC ratio, a life insurance company can sell the downgraded bond and avoid the increase in capital requirements. The decision to sell a bond to manage the insurer's regulatory capital costs, however, interacts with statutory accounting principles. When a bond is downgraded to NAIC designation 6, life insurance companies face the extreme increase in the capital requirement and are required to mark the value of the bond to the market value. Therefore, it is optimal for any insurer to sell a bond downgraded to NAIC designation 6. Except for bonds that are NAIC designation 6, life insurance companies follow historical cost accounting principles for bonds, thus selling downgraded bonds will only be beneficial if the insurer can realize capital gains, or if the realized

capital loss (that decreases the numerator of the RBC ratio) is expected to be less than the decrease in the regulatory capital requirement.[8]

The optimal reaction for a life insurance company, in the event of a bond downgrade (except for NAIC designation 6), is to sell a downgraded bond with capital losses smaller than the increased capital requirements. We denote the increase in capital requirement with σ. The RBC ratio after the bond downgrade is as follows:

$$RBC\ ratio^{down} = \frac{TAC_0}{RBC_0^* + I + \sigma \cdot I}$$

If a downgraded bond is sold, i.e. the bond is converted into cash, the RBC ratio changes to:

$$RBC\ ratio^{down,sell} = \frac{TAC_0 + \gamma I}{RBC_0^* + I + \sigma \cdot I - (\sigma \cdot I)} = \frac{TAC_0 + \gamma I}{RBC_0^* + I}$$

where γ is realized capital gains or losses as a percent of the investment, the denominator is reduced by the magnitude of the capital requirements σ and the numerator is affected by the magnitude of the realized capital γ.

i) If the sales lead to capital gains, $\gamma > 0$:

$$RBC\ ratio^{down,sell} = \frac{TAC_0 + \gamma I}{RBC_0^* + I} > RBC\ ratio^{down} = \frac{TAC_0}{RBC_0^* + I + \sigma \cdot I}$$

Selling the downgraded bond is the optimal reaction since the RBC ratio is improved.

ii) If the sales lead to capital losses, $-1 < \gamma < 0$,

[8] See discussions of the historical cost accounting principle and bond downgrades in Ellul et al., 2015

the benefit of selling the downgraded bond depends on the magnitude of the realized capital losses and the amount of reduction in the capital requirement. If the sales lead to capital losses smaller than the reduction in the capital requirement, $|\gamma| < \sigma$:

$$RBC\ ratio^{down,sell} > RBC\ ratio^{down}$$

It is beneficial for the insurer to sell the downgraded bond from the RBC ratio perspective.

iii) If the sales lead to capital losses larger than or equal to the reduction in the capital requirement, $|\gamma| \geq \sigma$:

$$RBC\ ratio^{down,sell} \leq RBC\ ratio^{down}$$

It is not beneficial for the insurer to sell the downgraded bond from the RBC ratio perspective.

For life insurers with RBC-relief reinsurance, however, the story is different. If a bond that is backed up with RBC-relief reinsurance experiences a downgrade, the life insurance company has little incentive to sell the bond because the regulatory bond investment risk does not increase.[9]

As shown in equation (2), a life insurer with RBC-relief reinsurance with θ of its reserves ceded only faces $(1-\theta)$ of the increased capital requirement when a bond it holds is downgraded:

$$RBC\ ratio^{down,RBC-relief} = \frac{TAC_0}{RBC_0^* + I + \sigma \cdot (1-\theta) \cdot I}$$

[9] While there are variations in the investment management arrangements on assets supporting the RBC-relief reinsurance arrangements, most reinsurance companies require life insurance companies to designate a segregated portfolio of assets primarily consisted of bonds to achieve the highest yield possible and match the liability duration of the reserves under the RBC-relief reinsurance agreement. To the best of our knowledge, the segregated portfolio of asset under RBC-relief reinsurance is communicated between the reinsurance company and the primary insurance company, and assets in the portfolio can be replaced by the primary insurance company with similar assets, but the detailed mandates are not disclosed to the public.

When the bond is sold, the RBC ratio effect is the same as a life insurer without RBC-relief reinsurance if we assume the bonds lead to the same amount of realized capital gains or losses:

$$RBC\ ratio^{down,RBC-relief,sell} = \frac{TAC_0 + \gamma I}{RBC_0^* + I + \sigma \cdot (1-\theta) \cdot I - (\sigma \cdot (1-\theta) \cdot I)} = \frac{TAC_0 + \gamma I}{RBC_0^* + I}$$

If a bond is downgraded to NAIC 6 designation or incur positive capital gains, the optimal decision for a life insurer with RBC-relief reinsurance is also to sell the bond. If the sale lead to capital losses, however, the life insurer with RBC-relief reinsurance needs to compare the magnitude between the realized capital losses γ and the effective increase in capital requirements, $\sigma \cdot (1-\theta)$. From the RBC ratio perspective, if the sale of the bond lead to realized capital losses smaller than the effective capital requirement, $|\gamma| < \sigma \cdot (1-\theta)$, it is beneficial for the insurer with RBC-relief reinsurance to sell the downgraded bond. If the sale lead to capital losses larger than or equal to the reduction in the capital requirement, $|\gamma| \geq \sigma \cdot (1-\theta)$, it is not beneficial for the insurer with RBC-relief reinsurance to sell the downgraded bond, considering the transaction costs.

3.2 Simulating the effect of RBC-relief reinsurance

We provide a simulation of 10,000 bonds to illustrate the theoretical prediction before our analyses using sample insurer data. We draw a random bond downgrade for each investment grade bond (NAIC 1 and 2 designations) uniformly over the range of NAIC 3 designation to NAIC 5 (inclusive) designation, and a random amount of potential capital losses for each bond uniformly over the range of 0% to -20%. We focus our attention on investment grade bonds that are downgraded with potential capital losses given that the majority of insurance companies acquire investment grade bonds (Khan, Ryan, and Varma, 2019).

The potential capital losses are capped at -20% to focus our attention on the tension between realized capital losses and the capital requirements associated with bond downgrades, which

ranges between 0.66% and 19.2%. We create a measure of the ratio between potential capital losses and the increase in capital requirements due to bond downgrades, which we label as **"*Delta*"**. *Delta* represents a measure of the overall RBC "ratio" costs of selling a bond due to expected capital losses when a life insurer decides to sell a bond with increased regulatory capital requirements. We then simulate the effect of RBC-relief reinsurance for a life insurer with 0%, 5%, and 20% of reserves in RBC-relief reinsurance.

Figure 1 shows the key theoretical prediction of the bond selling decision that life insurers with RBC-relief reinsurance on average are less like to sell a bond given the same level of *Delta*. The figure plots the average probability of selling a bond when the bond is downgraded from investment grades (NAIC designation 1 or 2) to speculative grades (NAIC designation 3 to 5). The X-axis represents each bin of *Deltas* with 0.1 percentage point intervals. For each bin, the circles plot the average probability for firms without RBC-relief reinsurance, the squares plot the probability for firms with 5% of their reserves under RBC-relief reinsurance, and the triangles plot the probability for firms with 20% of their reserves under RBC-relief reinsurance. Generally, the probability of selling a bond is zero when *Delta* exceeds 1. As *Delta* approaches 1, meaning that the costs of selling a bond for regulatory capital management exceed the benefit from RBC reduction due to bond sales, life insurers without RBC-relief reinsurance will not sell a downgraded bond due to negative overall effects on the RBC ratio.

The probability of selling a bond goes to zero even when *Delta* is less than 1 for life insurers with RBC-relief reinsurance because these life insurers are partly insulated from the regulatory capital costs. The graph predicts that even for a slight amount of RBC-relief, e.g. 5%, life insurers with RBC relief reinsurance will be less likely to sell a bond than those without RBC-relief reinsurance if *Delta* is larger than 0.8. Life insurers with 20% of its reserves under RBC-relief

reinsurance will be less likely to sell a downgraded bond than those without RBC-relief reinsurance if *Delta* is larger than 0.7. The decline in the probability of selling a bond for life insurers with RBC-relief reinsurance is due to the multiplicative regulatory capital requirement increase associated with different notches of bond downgrades.

3.3 Empirical model

Motivated by our theoretical prediction shown in Figure 1, we estimate the probability of a life insurer selling an investment grade bond that is downgraded to speculative grade as follows:

$$Sell_{i,j,t} = \beta rbc\_re\_ind_{i,j,t} + \varphi Delta_{i,j,t} + \vartheta rbc\_re\_ind_{i,j,t} \times Delta_{i,j,t} + \mathbf{\Gamma} \boldsymbol{X}_{i,t} + \mathbf{\Lambda} \mathbf{H}_{i,j,t} + \lambda_i + \theta_t + \varepsilon_{i,j,t}, \quad (3)$$

where $Sell_{i,j,t}$ is an indicator set equal to 1 if bond *j* owned by insurer *i* is sold at time *t* and 0 otherwise. $rbc\_re\_ind_{i,j,t}$ is an indicator equal to 1 if firm *i* that owns bond *j* uses RBC-relief reinsurance in year *t* and 0 if it does not. $Delta_{i,j,t}$ is the ratio of the potential capital losses to the increased capital requirement for a downgraded bond *j* held by insurer *i* at time *t*. $\boldsymbol{X}_{i,t}$ is the set of time-varying firm-level control variables. $\mathbf{H}_{j,t}$ is a set of bond level control variables. λ_i and θ_t are firm and year fixed effects, and $\varepsilon_{i,t}$ is the error term.

We consider a bond as sold if by the end of the year, December 31st, all or part of the bonds have been sold. Partial sales of a downgraded bond will also be beneficial for the insurance company from an RBC ratio perspective. December 31st is the effective deadline for statutory filings of insurance companies thus insurance companies only need to sell a downgraded bond by the end of the year to enjoy the RBC effect.

β captures the difference in the probability of selling downgraded bonds between firms using and not using RBC-relief reinsurance. A negative coefficient on ϑ tells us that firms with RBC-

relief reinsurance sold downgraded bonds less than firms without RBC-relief reinsurance. It implies that life insurance companies using RBC-relief reinsurance are more likely to hold bonds with higher regulatory capital costs (and not sell the bond) than those not using any RBC-relief reinsurance.

φ captures the differences in the probability of selling downgraded bonds conditional on *Delta*, the measure of the sensitivity of the RBC ratio of the downgraded bond when a bond is sold with potential capital losses. The interaction term tells us whether firms with RBC-relief reinsurance are much less likely to sell downgraded bonds than those without RBC-relief reinsurance depending on the magnitude of *Delta*.

The life insurer's decision to purchase or sell bonds will also be associated with the underlying characteristics of the bond, including the liquidity and the duration (Becker and Ivashina 2015; Ellul et al., 2011; Ellul et al., 2015). $\mathbf{H}_{j,t}$ controls for the following characteristics: the issue size, maturity, coupon rate, and whether a bond is callable. The issue size (offering amount) controls for the liquidity of the bond. The maturity, coupon rate, and callable bond indicator allow us to proxy for the duration of the bond. Lastly, we control for the size of the bond relative to the holding insurer's asset to account for the relative magnitude of a downgraded bond to the firms' available for sale assets.

Our time-varying firm-level control variables, $\boldsymbol{X}_{i,t}$, include factors that affect the amount of regulatory investment risk an insurer can take in a given year. The firm-level controls include the insurer's organizational structure, asset size, profitability, capital, and business mix (i.e. liability structure). In addition, we include the percent of investment bonds downgraded to speculative grades per each firm, measured as the carrying value of the bonds held by the insurer at the beginning of the year, to control for the compositional effect of a downgraded bond's size.

3.4 Data and sample

Life insurance company data

Our data come from the annual statutory statements reported by individual life insurance companies to the NAIC from 2003 – 2015. Reinsurance transaction data come from Schedule S Part 3 Section 1 "Reinsurance ceded life insurance, annuities, deposit funds and other liabilities", which includes detailed information on the reinsurance company, starting date of the reinsurance, the type of reinsurance, the amount of transferred risk (reserve credit taken), and the amount of modified coinsurance reserves (this is separately reported from the reserve credit taken for other reinsurance contracts). We focus on life and annuity reinsurance.

The use of RBC-relief reinsurance on life and annuity business is measured as the amount of RBC-relief reserves divided by total gross reserves.[10] Total gross reserves are used because life insurer's modified coinsurance reserves are not considered as reinsured reserves. In addition, a life insurer's gross reserves before reinsurance are reported. By compiling a panel of financial statements from 2003 to 2015, we track each life insurers' annual end-of-year RBC-relief reinsurance activity. In calculating the amount of RBC-relief reinsurance reserves, we only include modified coinsurance reserves if the reinsurance counterparty is an unaffiliated insurance company or an affiliated foreign insurance company. We also exclude variable life or variable annuity reinsurance reserves as there is no relief of investment risk, given that variable insurance policies' investment risk is borne by the insurance policyholders.[11]

[10] We use reserves, instead of premiums, because of the long-term nature of life and annuity business. For example, the reserves of life and annuity policies can be large even if their premiums are zero, if the policies are beyond the accumulation period or if the premiums are paid up front as a "single" payment.

[11] Among all life insurers reporting to the NAIC for their annual statutory statements, 30 firms (190 firm-year observations) had RBC-relief reinsurance set up only for variable life or variable annuity products. This is only one tenth of the life insurer observations that had any type of RBC-relief reinsurance (224 firms' 1,794 firm-year observations).

Figure 2 presents the industry's use of RBC-relief reinsurance based on the Schedule S information. Figure 2a shows the number of new RBC-relief reinsurance contracts initiated each year. There is a high take-up rate in 2008 during the financial crisis when 38 new contracts were initiated. The average number of new contracts over the sample period is 22.5. RBC-relief reinsurance contracts, or any modified coinsurance contracts, are multi-year treaty contracts. In Figure 2b, we show the volume of RBC-relief reinsurance separately for newly initiated contracts and existing contracts measured by the reserves under RBC-relief reinsurance contracts. The figure depicts a jump in the volume of existing contracts in 2010, most likely driven by the new contracts initiated during the financial crisis.

In Figure 3, we show the distribution of reserves under RBC-relief reinsurance for life insurers during our sample period. Given that more than 86% of our firm-year observations are identified as not using RBC-relief reinsurance, we show the distribution for firm-year observations with positive amount of RBC-relief reinsurance. We find that the amount of reserves under RBC-relief reinsurance is skewed in the life insurance industry, with more than half of the firms using RBC-relief reinsurance transferring less than 1% of their reserves. The other half firms, however, show a uniform distribution between 1% and 20%.

Bonds data

We utilize detailed bond holdings data reported by life insurance companies on Schedule D Part 1 "Long-term bonds owned" and Schedule D Part 4 "Long-term bonds sold, redeemed or otherwise disposed of" of their annual statutory statements. The data show year-end holdings of long-term bonds, within year sales of long-term bonds, and rich information on the bond identifier (CUSIP ID), adjusted carrying value (book value), fair value (market value), maturity, date of sales, sales value (consideration), adjusted carrying value at the time of sales, and the NAIC designation

of bond credit ratings. In most cases, the book adjusted carrying value of bonds is the amortized cost of bonds because life insurers are not required to mark long-term bonds to their market values unless they are downgraded to junk bond status.[12] The NAIC data are merged with the Mergent Fixed Income Securities Database (FISD) to identify bond characteristics including the issue size, maturity, coupon rate, callable bonds, and the bond credit ratings.

We utilize the universe of life insurers reporting statutory annual statements and the credit ratings information of Mergent FISD data to impute bonds with missing NAIC designation information. Given that multiple bond downgrades within a year do not affect annual regulatory capital calculation, we use the latest credit rating information from Mergent FISD in any given year to impute annual NAIC designation information when missing.

The potential capital loss from bond sales is an important aspect for an insurer's bond selling decision, given that insurance companies facing regulatory capital requirements are less likely to sell a downgraded bond if the anticipated capital losses from selling the bond will further decrease their capital levels. Because we only observe capital losses for bonds sold, and we want to compute the bond sales probability for bonds that are both sold and not sold, we create a proxy measure of potential capital losses for both type of bonds measured ex-ante of the bond sales. We calculate the beginning of the year potential capital losses for a downgraded bond held by an individual insurer, where the difference between the fair market value and the book value of the bond is considered as the beginning of the year unrealized capital losses. The potential capital losses are normalized as a percent of the book value of the bond beginning of the year.

[12] Life insurers are not required to mark their bonds/preferred stocks/mortgage loans to market value (fair value) unless the bond is categorized as NAIC designation 6 or becomes NAIC designation 6 or are deemed to be impaired. Other assets are marked to market, except for affiliated stocks, cash, and contract loans (policy loans).

Study Sample

Our sample excludes life insurers that are inactive, without RBC information, have an organizational form other than stock or mutual, or have non-positive values of gross reserves in life and annuity business. As these criteria likely influence any one year's investment decision, we exclude a life insurer if it does not meet the sample firm criteria in any given year.

Our sample bonds include investment grade bonds (NAIC designations 1 and 2) that are downgraded to speculative grades (NAIC designations 3 to 5), held by sample life insurance companies at least in the year immediately before (bonds acquired and sold in the same year do not have any RBC effect as the statutory filing deadline is December 31st), not matured by the end of the year, with valid bond identifier (CUSIP ID), merged with Mergent FISD data, and with potential capital losses. Because bonds issued by the U.S. federal government and U.S. government agencies are exempt from regulatory investment RBC charges, we exclude these bonds in our sample. We also exclude bonds issued by affiliated companies within the insurance holding group because they are exempt from regulatory investment RBC charges.

Out of a total of 1,166 life insurers who filed their statutory annual statements through the NAIC, 864 (74%) meet our sample selection criteria. In our NAIC dataset, a total of 6,489 corporate bonds (83,401 bond-year observations) held by life insurance companies are matched with the Mergent FISD data and experienced credit rating downgrades. Among these, 6,412 corporate bonds (79,507 bond-year observations) were held by sample life insurers. Our final sample of 1,368 corporate bonds (12,239 bond-year observations) are downgraded from an investment grade to a speculative grade, involve potential capital losses, have Mergent FISD information, and are held by sample life insurers; this is approximately 15% of total corporate bonds in the NAIC dataset. Thirty-six percent of the corporate bond downgrades are within

investment grade, i.e. NAIC designation 1 to 2 downgrade (28,773 out of 79,507 bond-year observations), which implies that our sample bonds represent around one quarter of the corporate bond downgrades, excluding within investment grade downgrades.

4. Results

4.1 Summary statistics

Table 2 provides summary statistics for the sample bonds held by life insurers in our sample. The first column shows the means and standard deviations of key variables for the full sample of 23,847 bonds with potential capital losses held by life insurers during the years 2003 – 2015, and the second and third columns show those for life insurers with and without RBC-relief reinsurance, respectively.

The bonds held by life insurers with RBC-relief reinsurance are, on average, expected to result in larger capital losses (test of significant difference at *p-value* = 0.01), are more sensitive to regulatory capital ratios with *Delta* being 0.26 larger (*p-value* < 0.01), have longer years left till maturity (*p-value* = 0.08), and earn higher coupon payments (*p-value* = 0.07) than those held by life insurers without RBC-relief reinsurance. The increased RBC requirement, the size of the bonds at issuance, the average NAIC ratings, and the percent of callable bonds are not statistically different between life insurers with and without RBC-relief reinsurance (*p-value* > 0.10). In addition, the carrying value of the downgraded bonds is smaller relative to the size of the firm (*p-value* < 0.01), for those held by life insurers with RBC-relief reinsurance than those without RBC-relief reinsurance.

In Figure 4, we show that our measure of potential capital loss closely approximates the realized capital losses when bonds are sold. The x-axis shows the bins of potential capital losses (or unrealized capital losses) and the y-axis displays the average realized capital losses in each bin,

with the 45 degrees reference line drawn for easy comparison. The interval for each bin is 1%, with the lowest bin of unrealized capital losses including all bonds with unrealized capital losses less than or equal to -20% of the beginning of the year's carrying value of the bond. We see a general upward trend with a spiky pattern in the lower-left corner where we have fewer observations than other bins. The average realized capital losses are lower than the potential capital losses, suggesting that while the measure is a good proxy it may well act as a lower bound for the true realized capital losses. Therefore, our measure of potential capital losses is a conservative proxy in estimating the RBC ratio effects.

We tabulate firm-level differences between life insurers with and without RBC-relief reinsurance in Table 3. Table 3 provides summary statistics for the time-varying firm characteristics among the sample life insurers with at least one bond downgraded from an investment grade to a speculative grade, i.e. sample firms included in our equation (3). There are 3,293 firm-year observations for this sample life insurers, with 916 of them being life insurers with RBC-relief reinsurance (28%). Compared to life insurers without RBC-relief reinsurance, life insurers with RBC-relief are more likely to be affiliated with an insurance holding group, more likely to be a mutual insurer, are larger, more likely to have an affiliated stock company, have lower profitability (*ROA),* less likely to have RBC ratio lower than 200%, lower total adjusted capital, less active capital transaction within the insurance group (*ICM*), and have disproportionately more life and annuity business than health or other non-traditional life business. The unconditional probability of selling a downgraded bond, however, is not statistically different between life insurers with and without RBC-relief reinsurance. Test of difference results are significant at 1% level for all variables except for *Pr(Sell|Downgrade), Life business,* and *Guaranteed Variable Annuities*.

In estimating equation (3), it is important to understand if the decision to sell a downgraded bond is driven by firm-level experience of a bond downgrade. To investigate the average probability of a bond held by a life insurer being downgraded, we calculate the percent of bonds downgraded from an investment grade to a speculative grade.[13] The descriptive statistics in Table 3 shows that, on average, the annual probability of an investment grade bond being downgraded (as low as to NAIC 5 designation) is 1 percentage point lower for firms with RBC-relief reinsurance than for firms without RBC-relief reinsurance. We take a closer look at this firm-level bond downgrade probability by visually examining the distribution and run estimated differences after controlling for various firm and bond characteristics.

Figure 5 shows the distribution of the probability of a bond being downgraded from investment to speculative grade, excluding bonds downgraded to NAIC 6. The gray bars indicate firms without RBC-relief reinsurance and the blue bars denote firms with RBC-relief reinsurance. The figure shows that the point estimate of the average difference can be misleading, as the distribution for life insurers with RBC-relief reinsurance is more skewed, i.e. the tails affect the average differences. In addition, more life insurers with RBC-relief reinsurance experience a smaller percent of bond downgrades (less than 1 percent of bonds held) than those without RBC-relief reinsurance.

Next, we estimate conditional differences in the probability of a bond downgrade by estimating bond level linear probability regressions among bonds that are investment grades at the beginning of the year. The dependent variable is 1 if a bond is downgraded in the next year and 0, otherwise. The main variable of interest, *RBC-relief* indicator, is equal to 1 if a life insurer has any positive reserves under RBC-relief reinsurance.

[13] To calculate the weighted percent, we use the carrying value of the bonds at the beginning of the year when calculating the percent of bonds being downgraded.

Table 4 shows the regression results. Column 1 is the baseline OLS model which controls for the NAIC designation beginning of the year, NAIC designation end of the year, and year fixed-effects. Column 2 includes firm fixed-effects and Column 3 adds firm-level and bond-level time-varying control variables. We then explore whether the pattern is different among firms that are more susceptible to regulatory capital requirements or during the financial crisis. Column 4 of Table 4 shows the firm fixed-effects regression results for firms with RBC ratios below 200% and Column 5 includes financial crisis years which is from years 2008 to 2010. All models estimate robust standard errors by adjusting for firm-level correlations.

While the baseline model shows statistically significant and negative effect of having RBC-relief reinsurance, the effect size is small. Further, the difference is not statistically significant once we control for firm fixed-effects in Column 2 and add control variables in Column 3. Bonds with larger issue size, smaller coupon rates, and not callable are more likely to have been downgraded, although the size of these effects are not economically meaningful. Both Columns 4 and 5 show that there is no difference in the bond downgrade probability for firms with and without RBC-relief reinsurance during the financial crisis years. We, therefore, argue that the probability of an investment bond downgrade to a speculative grade is not significantly different between firms with and without RBC-relief reinsurance.

4.2 Regression results

Figure 6 shows the relationship between the probability of selling a downgraded bond and *Delta* (the expected effect on RBC) for life insurers with and without RBC-relief reinsurance. Motivated by our theoretical prediction in Figure 1, we focus in Figure 6a on the subset of bonds whose *Delta* ranges between 0 and 2. In this figure, the average probability of selling a downgraded bond is plotted for each 0.1 interval of *Delta*. The first bin includes bonds with a *Delta* larger than

or equal to 0 and less than 0.1. The last bin includes bonds with a *Delta* larger than or equal to 2. In contrast to our theoretical prediction in Figure 1, the probability of a bond sale does not approach 0 when *Delta* exceeds 1.

The summary statistics in Table 2 show that the average *Delta* for our sample of bonds is well above 4. Accordingly, in Figure 6b we extend the range of the x-axis and show the average probability of selling a downgraded bond for each 1 increment of *Delta* ranging from 0 to 20, i.e., the last bin includes bonds with a *Delta* larger than or equal to 20. When *Delta* is less than 7, the probability of selling a downgraded bond does not differ between firms with and without RBC-relief reinsurance (the average difference is -0.1 percentage points; *p-value* = 0.565). A significant difference, however, emerges when *Delta* rises above 7.[14] When *Delta* is greater than or equal to 7 and less than 10, life insurers with RBC-relief reinsurance are 6.3 percentage points less likely to sell a bond than insurers without RBC-relief reinsurance (*p-value*=0.037). The difference is slightly larger when *Delta* exceeds 10 (the average difference is -6.90 percentage points; *p-value* = 0.007). Our theoretical prediction is that insurers are sensitive to increases in their regulatory capital requirements. The figure, however, shows that life insurers are substantially more sensitive to capital losses than they are to regulatory capital requirements. RBC-relief reinsurance seems to be reducing insurers' sensitivity to capital losses, but we do not see the predicted response when *Delta* is less than 1.

A majority of bond downgrades have little impact on a life insurer's regulatory capital requirements. In Table 5, we tabulate the NAIC designation of the bonds in our sample the year before the bond downgrade ("Before") and the year of the downgrade ("After"). More than 80% (10,101 out of 12,239) of the bond downgrades are from NAIC designation 2 to NAIC designation

[14] We do not have an economic rationale for why we observe these effects, and recommend further study to understand this dynamic better.

3, with a regulatory capital requirement increase of just 2.43 percentage points. In addition, 11% (1,354 out of 12,239) of the bond downgrades are from NAIC designation 2 to NAIC designation 4, which leads to a regulatory capital requirement increase of 6.42 percentage points. In Figure 7, we replicate Figure 6b using only the bonds that were downgraded from NAIC designation 2 to NAIC designation 3. The pattern in Figure 7 is similar to that in Figure 6b. This evidence suggests that most bond downgrades generate only small increases in regulatory capital and life insurers are more likely to respond to capital losses rather than changes in their regulatory capital costs.

Table 6 provides the linear probability regression results from estimating equation (3).[15] We interact the *RBC-relief* indicator variable with an indicator variable of *Delta* larger than or equal to 7. The omitted baseline category is bonds held by life insurers without RBC-relief reinsurance when *Delta* is less than 7. Column 1 is the baseline OLS model, Column 2 includes firm fixed-effects, and Column 3 includes firm-level and bond-level time-varying control variables. Column 4 shows the firm fixed-effects regression results for firms with RBC ratios below 200% in the previous year and Column 5 includes financial crisis years which is from years 2008 to 2010. All models estimate robust standard errors by adjusting for firm-level correlations.

The indicator of RBC-relief is not statistically significant in columns 1 to 5, indicating that for small *Delta* (less than 7) the RBC-relief reinsurance does not affect the decision to sell bonds. Our main interest variable, the interaction of the RBC-relief reinsurance indicator with an indicator of a large *Delta* (larger than or equal to 7), however, is statistically significant (*p-value* < 0.096) and negative even after controlling for various firm-level and bond-level control variables for our full sample bonds (Columns 3). This implies that life insurers with RBC-relief reinsurance are 4 percentage points less likely to sell downgraded bonds with large *Delta* (>=7) than those without

[15] To limit the effect of outliers arising from potential reporting errors, the regression sample excludes bonds with potential capital losses greater than or equal to the 99th percentile.

RBC-relief reinsurance. The unconditional probability of selling a downgraded bond is 42% (Table 3, *Pr(Sell|downgrade)*). Thus, the magnitude of the difference between insurers with and without RBC-relief reinsurance is 9 percent of the unconditional probability of selling a downgraded bond. The effect size is economically meaningful. The estimated effect is also conservative, considering that our indicator of RBC-relief reinsurance includes life insurers with less than 1% of their gross reserves in RBC-relief reinsurance (Figure 3), and we do not include RBC-relief reinsurance arranged for variable life or annuity products.

We do not find a significant difference in the probability of selling downgraded bonds for life insurers with and without RBC-relief reinsurance when life insurers are more susceptible to changes in regulatory capital (Column 4: life insurers with a RBC ratio less than 200% in the previous year) or when they experience an abnormal quantity of bonds being downgraded (Column 5: the financial crisis years, 2008 – 2010). This evidence provides additional support that life insurers' decision to sell bonds is more driven by capital losses than by regulatory capital requirements.

We further investigate whether the differences between life insurers with and without RBC-relief are driven by the types of bonds held across the two types of life insurers. To test this we re-estimate the regressions using the subset of bonds that are held by at least one life insurer with RBC-relief reinsurer as well as at least one life insurer without RBC-relief reinsurer, i.e. matching bonds held by both type of life insurers. Since life insurers tend to hold similar bonds (Chiang and Niehaus, 2019), the subsample represents 98% of the observations in our full sample. The regression results for the subsample are reported in Table 7. The results are consistent with those reported in Table 6, indicating underlying differences in the bond characteristics held by insurers with and without RBC-relief reinsurance do not affect our results.

We perform several additional tests to validate our regulatory arbitrage hypothesis. We investigate the observations that are least likely to respond to the regulatory capital costs. We first test whether or not insurers with high RBC ratios act differently from those with low RBC ratios. The expectation is that insurers with high RBC ratios will be less likely to sell downgraded bonds than other insurers with lower RBC ratios because the effect of downgrade bonds on regulatory capital is smaller than those with low RBC ratios. Yet we further expect that insurers with high RBC ratios that hold RBC-relief reinsurance will be even less likely to sell downgraded bonds.

We next take advantage of the fact that when a bond is not downgraded, there is no increase in regulatory capital requirements. In addition, there is no overall RBC ratio effect unless a bond is downgraded to an NAIC 6 designation. This fact allows us to run the same set of regressions among bonds with potential capital losses that do not change NAIC designation. To make comparison with the downgraded bond estimation reported in Table 6, we estimate the model among speculative bonds that remain within their NAIC designation: bonds with NAIC designations 3, 4, or 5. Instead of *Delta*, we use the size of potential *Capital Losses* to create an indicator variable of potential capital losses larger than 7%, i.e. bonds with the magnitude (absolute value) of capital losses larger than 7%. The prediction here is that the difference in the bond selling probability between life insurers with and without RBC-relief reinsurance is smaller than when a bond incurs increased regulatory capital requirements due to a credit rating downgrade.

The results are shown in Table 8. Column 1 shows the results from the subsample of insurers with RBC ratios higher than 400% (in the previous year). Among these life insurers, the probability of selling a bond does not differ between firms with and without RBC-relief reinsurance. This suggests that the effect of RBC-relief reinsurance does not exist among life insurers with sufficient capital relative to the regulatory capital requirement (RBC ratio > 400%). Column 2 shows the

regression results for the subset of downgraded speculative bonds that do not generate changes in regulatory capital costs, i.e. bonds that remain within their NAIC designation. Among these bonds, we find that the bond selling probability does not differ due to RBC-relief reinsurance. This suggests that the effect of RBC-relief reinsurance on the bond selling decision is not present when a bond does not increase the insurer's regulatory capital costs. The results in Table 8 support that the regulatory arbitrage of RBC-relief reinsurance for downgraded bonds is the driver for the bond selling probability differences observed in Table 6 columns 1 - 3.

5. Conclusion

In this paper, we illustrate the use of a reinsurance contract that relieves life insurance companies of their regulatory investment risk burden. Our theoretical prediction is that life insurers with RBC-relief reinsurance are less likely to sell a downgraded bond than those without RBC-relief reinsurance, but that any life insurer would not sell a downgraded bond if the sales could lead to lower RBC ratio because of the large capital losses associated with downgraded bonds.

We find empirical evidence that life insurers with RBC-relief reinsurance are less likely than those without RBC-relief reinsurance to sell downgraded bonds if capital losses are much larger than the increase in regulatory capital costs. When the capital losses are expected to be larger, but not substantially larger than the increase in regulatory capital costs, both types of life insurers sell downgraded bonds at the same rate as if the capital losses were smaller than the increase in regulatory capital costs. This implies that life insurers shed downgraded bonds despite the potential capital losses that lead to overall lower RBC ratios than if the bonds were not sold. We provide support for the small magnitude of the regulatory capital cost as a cause, with most of the downgrades being those from an NAIC designation 2 (S&P credit rating of BBB+ to BBB- bonds) to an NAIC designation 3 (S&P credit rating of BB+ to BB- bonds). Our findings suggest that

having RBC-relief reinsurance enables life insurers to avoid potentially large capital losses, conditional on the regulatory capital costs of downgraded bonds.

This blurring of the regulatory capital metric (the RBC ratio) through the use of RBC-relief reinsurance yields relevant solvency questions, challenging regulator and consumer ability to assess a life insurer's capital adequacy. Life insurers with RBC-relief reinsurance may appear to have little regulatory investment risk when in fact it may be large. This might call for a close investigation to accurately understand a life insurer's true investment risk, including tracking where the regulatory investment risk is transferred when RBC-relief reinsurance is used because these reinsurance contracts are typically arranged with insurance companies residing outside of the U.S. Since RBC-relief reinsurance enables pooling of regulatory investment risk, there may be a broader risk sharing implication in the insurance industry (including reinsurers). Future research should explore whether the investment risk of life insurers using RBC-relief reinsurance is advantageous to the insurance companies and the policyholders in the long-run.

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Figure 1: Theortical prediction on bond selling probability

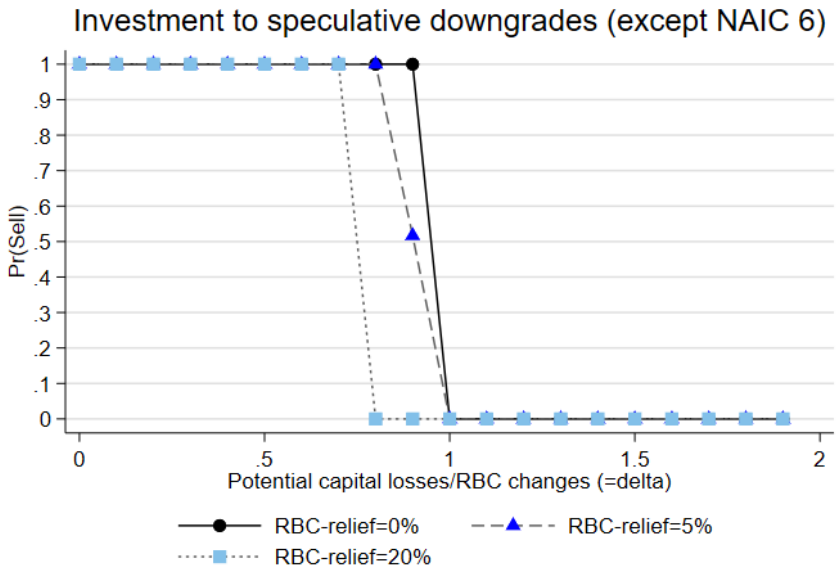
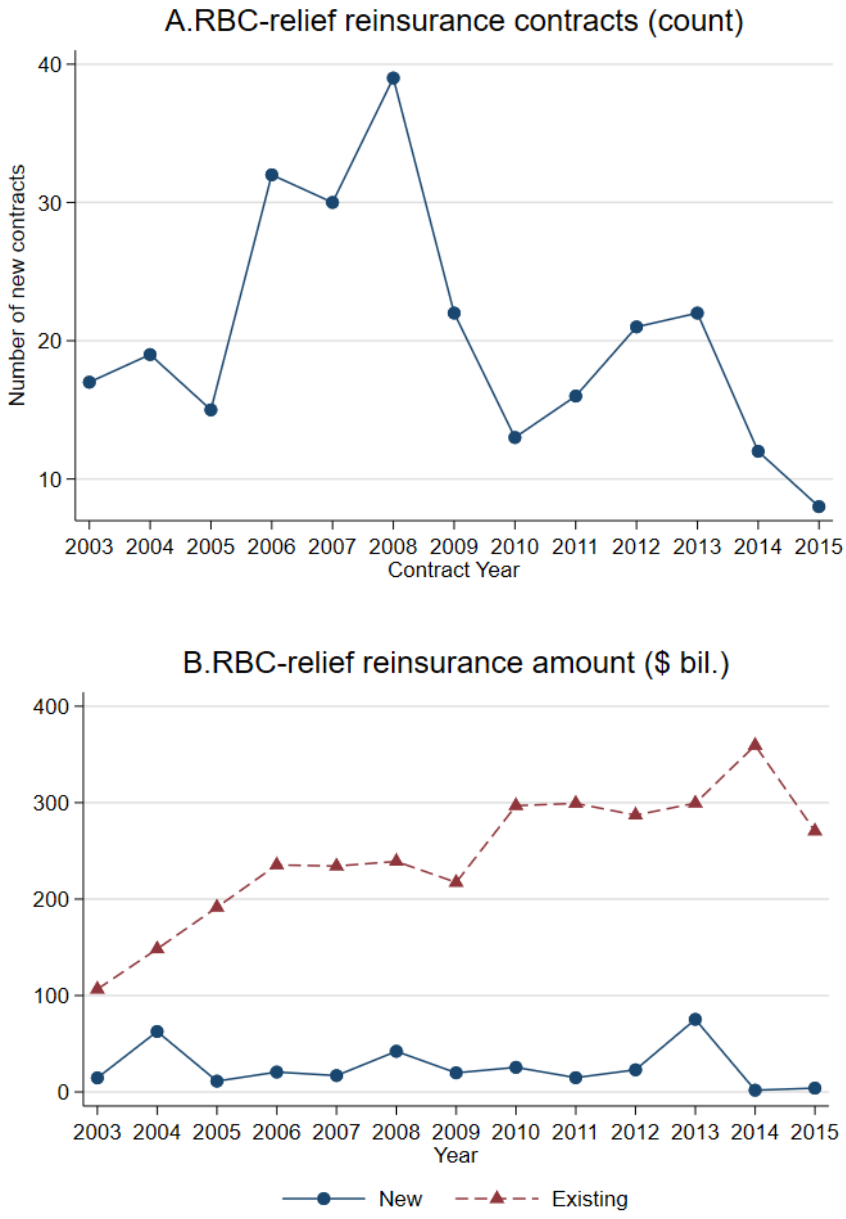
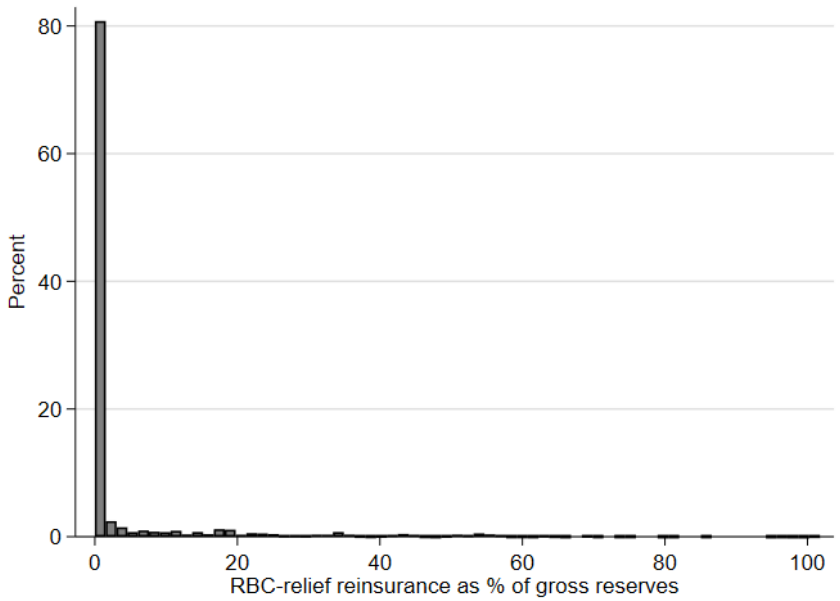


Figure 2: RBC-relief reinsurance contracts



Note: The figures show RBC-relief reinsurance contracts arranged by life insurance companies for their general account insurance policies (non-variable products) in each year. Modified coinsurance contracts of life and annuity products arranged with an unaffiliated insurer or a foreign affiliated insurer have RBC-relief effect, while those arranged with an affiliated insurance company does not have any RBC effect.

Figure 3: Share of RBC-relief reinsurance



Note: This figure depicts the distributions of RBC-relief reinsurance amount as a percent of total gross reserves of a firm. Given that more than 86% of our firm-year observations are identified as not using RBC-relief reinsurance, we show the distribution among those with any amount of RBC-relief reinsurance.

Figure 4: Potential capital losses

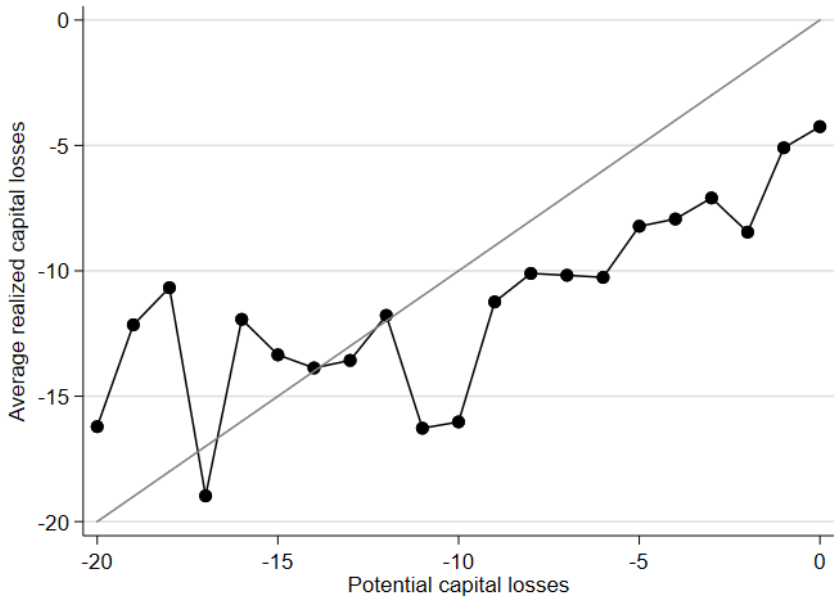
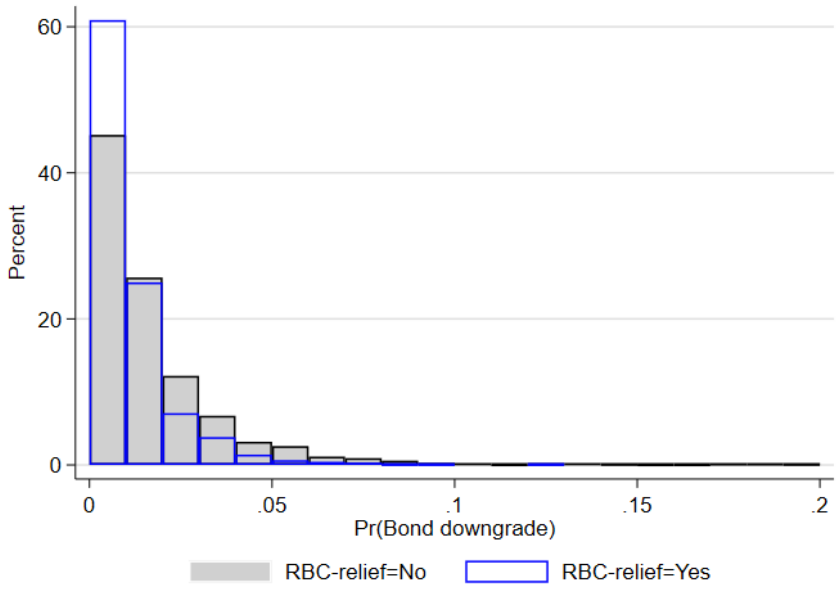
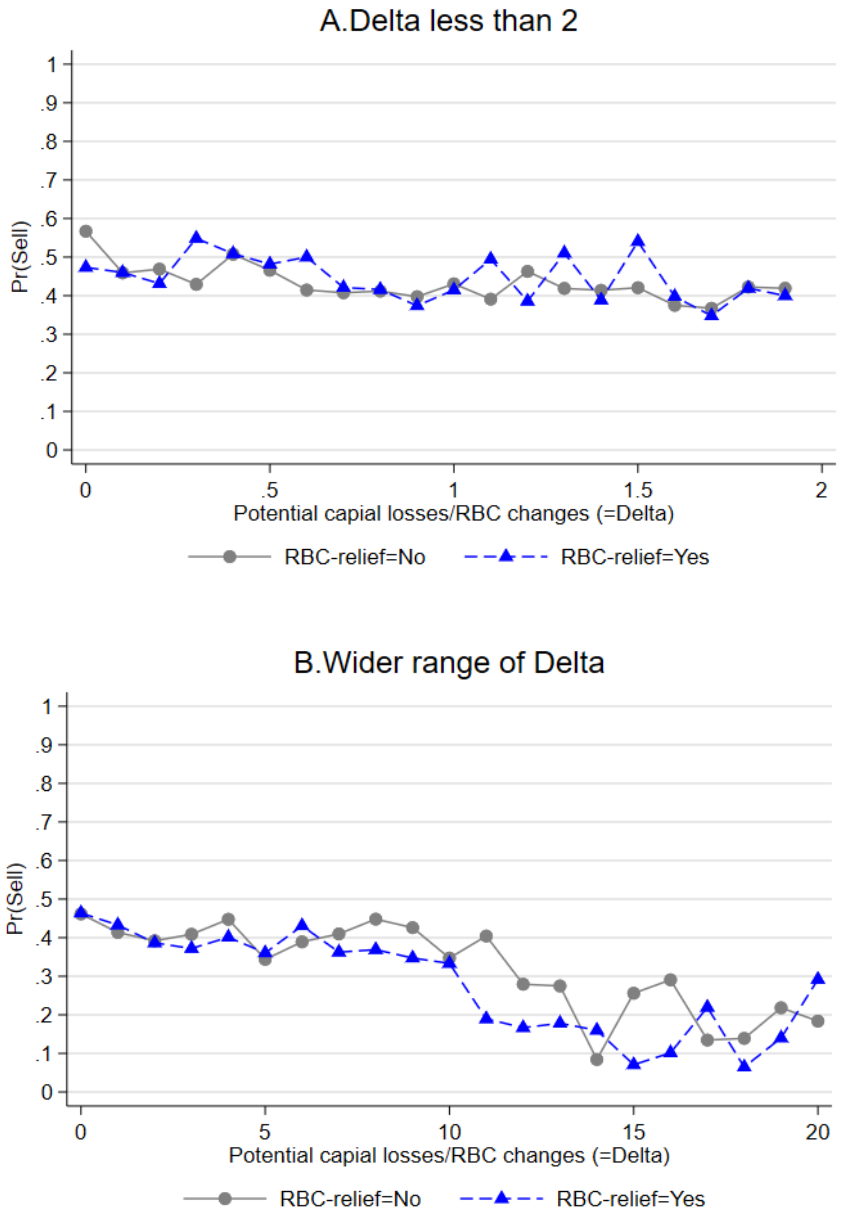


Figure 5: Probability of bond downgrades - per firm



Note: This figure depicts the distributions of the probability of bond downgrades (weighted by the adjusted carrying value of the bonds) separately for sample firm-year observations using and not using RBC-relief reinsurance. Bond downgrades include investment grade bonds (NAIC designations 1-2) downgraded to speculative bonds, excluding junk bonds (NAIC designations 3 -5).

Figure 6: Average bond selling probability



Note: The figures show unconditional probability of bond sales when a bond is downgraded from an investment grade to a speculative grade in our sample, per each bin of Delta (i.e. the ratio of potential capital losses to the increased regulatory capital requirements). The probability of bond sales is shown separately for bonds held by insurers using and not using RBC-relief reinsurance. The top figure is for bonds with Delta less than 2 to match with the theoretical prediction graph in Figure 1, with each bin showing a 0.1 increment of Delta. The bottom figure extends the x-axis to include all bond observation in our sample, with the last bin (20) including all observations with Delta larger than 20. Each bin is an increment of 1 delta in the bottome figure.

Figure 7: Average bond selling probability

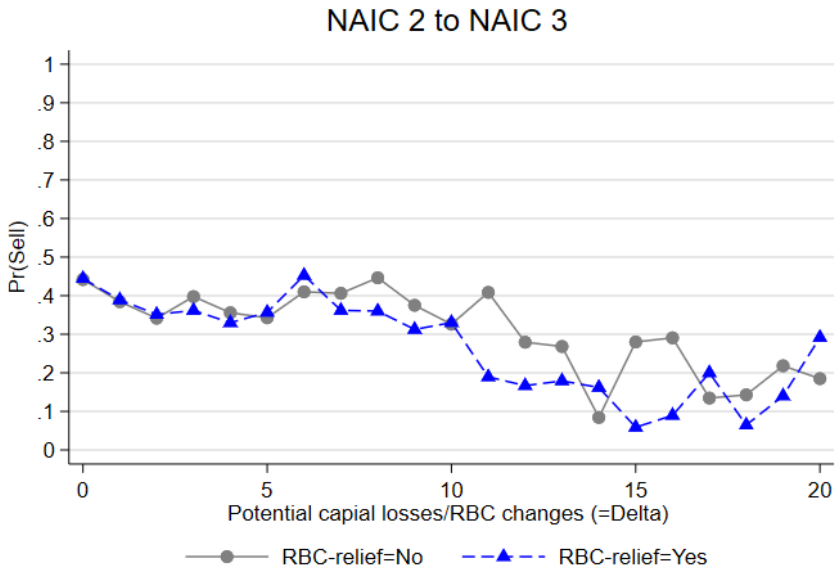


Table 1: RBC Charges for corporate bonds

	NAIC Designation	RBC Charges
Investment grade	1	0.30%
	2	0.96%
Speculative grade	3	3.39%
	4	7.38%
	5	16.96%
Junk	6	19.50%

Table 2: Summary statistics (bond-level)

	Full		RBC-relief=No		RBC-relief=Yes	
	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev
Potential capital loss	12.54	13.94	12.28	13.94	12.90	13.95
NAIC designation	3.18	0.45	3.18	0.46	3.17	0.45
Increased RBC	3.33	2.63	3.35	2.64	3.31	2.61
Delta	4.66	5.49	4.55	5.47	4.81	5.52
Bond size	0.12	0.29	0.18	0.36	0.05	0.13
Issue size	613.51	569.90	617.80	584.55	607.47	548.61
Years till maturity	14.59	191.04	11.80	133.72	18.52	250.38
Coupon rate	6.27	1.47	6.25	1.47	6.30	1.48
Callable bond (Yes)	0.75	0.43	0.75	0.43	0.75	0.43
Observations	12,239		7,156		5,083	

Note: Based on sample bonds downgraded from an investment grade to a speculative grade with potential capital losses, yet excluding bonds that are downgraded to NAIC 6 designation.

Table 3: Summary statistics (firm-level)

	Full		RBC-relief=No		RBC-relief=Yes	
	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev
Group	0.87	0.33	0.84	0.37	0.96	0.19
Stock	0.90	0.30	0.92	0.28	0.87	0.34
Size	16.76	40.73	8.97	26.02	36.97	60.36
Stock group	0.87	0.34	0.84	0.37	0.96	0.19
ROA	1.09	4.63	1.23	5.26	0.75	2.29
RBC ratio <200%	0.05	0.22	0.06	0.23	0.03	0.17
TAC	16.14	16.53	18.27	18.02	10.62	9.91
Pr(Bond downgrade)	0.02	0.04	0.02	0.05	0.01	0.01
Pr(Sell | Bond downgrade)	0.42	0.43	0.41	0.43	0.43	0.40
ICM	32.57	176.51	41.59	206.32	9.18	28.22
Life business	42.57	33.39	41.92	34.52	44.28	30.18
Annuity business	39.08	34.90	37.10	35.82	44.22	31.85
Health business	13.45	26.40	15.83	29.15	7.24	15.71
Other business	4.46	10.09	4.55	10.63	4.21	8.52
Guaranteed Variable Annuities	0.29	3.23	0.31	3.68	0.24	1.42
Observations	3,293		2,377		916	

Note: Based on sample firms with at least one bond downgraded from an investment grade to a speculative grade. Pr(Bond downgrade) and Pr(Sell|Bond downgrade) are both calculated by excluding bonds that are downgraded to NAIC 6 designation.

Table 4: Probability of an investment grade bond downgrade

	(1) OLS	(2) FE	(3) FE Controls	(4) Low RBC	(5) Crisis
RBC-Relief	-0.00**	-0.00	-0.00	0.00	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
NAIC (before) 2	-0.27***	-0.27***	-0.27***	-0.28***	
	(0.00)	(0.00)	(0.00)	(0.01)	
NAIC 2	0.27***	0.27***	0.27***	0.29***	0.06***
	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)
NAIC 3	1.23***	1.23***	1.23***	1.24***	1.00***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
NAIC 4	1.22***	1.22***	1.22***	1.24***	0.98***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
NAIC 5	1.15***	1.15***	1.15***	1.19***	1.01***
	(0.01)	(0.01)	(0.01)	(0.03)	(0.00)
Issue size			0.00***	0.00***	0.00***
			(0.00)	(0.00)	(0.00)
Coupon rate			-0.00***	-0.00**	-0.01***
			(0.00)	(0.00)	(0.00)
Callable bond			-0.00***	-0.01***	-0.03***
			(0.00)	(0.00)	(0.00)
Controls	No	No	Yes	Yes	Yes
Firm FE	No	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
R-sq	0.61	0.61	0.61	0.63	0.46
Observation	1,534,145	1,534,140	1,484,000	42,121	319,640

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table presents linear probability model of a corporate bond downgrade. The dependent variable is an indicator of 1 if an investment grade bond held by an insurer beginning of the year is downgraded during year t and 0 otherwise. RBC-relief reinsurance use is 1 when a firm has modified coinsurance reserves of life and annuity products arranged with an unaffiliated insurer or a foreign affiliated insurer. Standard errors are adjusted for within firm correlations.

Table 5: Rating downgrade matrix

	NAIC After			
NAIC Before	NAIC 3	NAIC 4	NAIC 5	Total
NAIC 1	368	38	124	530
NAIC 2	10,101	1,354	254	11,709
Total	10,469	1,392	378	12,239

Table 6: Probability of selling downgraded bonds

	(1) OLS	(2) FE	(3) FE Controls	(4) RBC<200	(5) Crisis
RBC-Relief	-0.00	0.01	0.02	0.06	0.01
	(0.010)	(0.032)	(0.031)	(0.097)	(0.110)
Delta >=7	-0.09***	-0.09***	-0.08***	-0.24**	-0.05*
	(0.018)	(0.020)	(0.019)	(0.091)	(0.028)
X RBC-Relief	-0.06***	-0.05*	-0.04*	0.01	-0.02
	(0.022)	(0.028)	(0.027)	(0.097)	(0.032)
NAIC 4	0.18***	0.18***	0.19***	0.25**	0.43***
	(0.015)	(0.016)	(0.016)	(0.107)	(0.031)
NAIC 5	0.09***	0.11***	0.13***	0.27**	0.02
	(0.026)	(0.027)	(0.027)	(0.113)	(0.037)
Bond size			0.10***	-0.04	0.12**
			(0.028)	(0.055)	(0.055)
Issue size			0.00***	0.00***	0.00***
			(0.000)	(0.000)	(0.000)
Coupon rate			-0.02***	-0.03*	-0.01*
			(0.004)	(0.016)	(0.006)
Callable bond			0.02	0.01	-0.00
			(0.012)	(0.046)	(0.016)
Controls	No	No	Yes	Yes	Yes
Firm FE	No	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
R-sq	0.06	0.24	0.26	0.51	0.32
Observation	11,548	11,548	11,548	371	4,295

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table presents linear probability model of downgraded corporate bond sales. We only include sample bonds that are downgraded from an investment grade to a speculative grade with potential capital losses. The dependent variable is an indicator of 1 if a downgraded bond held by an insurer is sold during year t and 0 otherwise. Delta is the ratio between potential capital losses and the increase in regulatory capital requirement induced by credit rating downgrade; Delta >= 7 is an indicator for bonds with Delta larger than or equal to 7. The omitted category for RBC-relief variable is those without RBC-relief reinsurance and Delta less than 7. Standard errors are adjusted for within firm correlations.

Table 7: Matching bonds

	(1) OLS	(2) FE	(3) FE Controls	(4) RBC<200	(5) Crisis
RBC-Relief	-0.00	0.01	0.02	0.03	0.01
	(0.010)	(0.031)	(0.031)	(0.090)	(0.110)
Delta >=7	-0.09***	-0.09***	-0.08***	-0.25***	-0.05*
	(0.018)	(0.020)	(0.020)	(0.087)	(0.028)
X RBC-Relief	-0.06***	-0.05*	-0.04*	0.01	-0.02
	(0.022)	(0.028)	(0.027)	(0.094)	(0.032)
NAIC 4	0.18***	0.19***	0.19***	0.19*	0.44***
	(0.015)	(0.016)	(0.016)	(0.113)	(0.032)
NAIC 5	0.10***	0.12***	0.14***	0.28**	0.02
	(0.027)	(0.028)	(0.027)	(0.111)	(0.040)
Bond size			0.10***	-0.03	0.13**
			(0.028)	(0.047)	(0.053)
Issue size			0.00***	0.00***	0.00***
			(0.000)	(0.000)	(0.000)
Coupon rate			-0.02***	-0.02	-0.01**
			(0.004)	(0.017)	(0.006)
Callable bond			0.02	0.04	-0.00
			(0.012)	(0.047)	(0.016)
Controls	No	No	Yes	Yes	Yes
Firm FE	No	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
R-sq	0.06	0.24	0.26	0.52	0.32
Observation	11,346	11,346	11,346	365	4,210

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table presents linear probability model of downgraded corporate bond sales. We only include sample bonds that are downgraded from an investment grade to a speculative grade with potential capital losses, which are held by at least one life insurer with RBC-relief reinsurance and at least one life insurer without RBC-relief reinsurance. The dependent variable is an indicator of 1 if a downgraded bond held by an insurer is sold during year t and 0 otherwise. Delta is the ratio between potential capital losses and the increase in regulatory capital requirement induced by credit rating downgrade; Delta >= 7 is an indicator for bonds with Delta larger than or equal to 7. The omitted category for RBC-relief variable is those without RBC-relief reinsurance and Delta less than 7. Standard errors are adjusted for within firm correlations.

Table 8: Falsification tests

	(1) RBC>400	(2) Same NAIC
RBC-Relief	0.01	-0.01
	(0.045)	(0.022)
Delta >=7	-0.09***	
	(0.030)	
X RBC-Relief	-0.03	
	(0.040)	
Capital loss >=7		-0.02***
		(0.008)
X RBC-Relief		0.01
		(0.014)
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
R-sq	0.32	0.14
Observation	5,830	63,240

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table presents linear probability model of corporate bond sales. The dependent variable is an indicator of 1 if a bond held by an insurer is sold during year t and 0 otherwise. Delta is the ratio between potential capital losses and the increase in regulatory capital requirement induced by credit rating downgrade. Capital losses are potential capital losses of a bond in absolute values, i.e. Capital loss >= 7 is an indicator for bonds with the magnitude (absolute value) of capital losses larger than or equal to 7%. The omitted category for RBC-relief variable is those without RBC-relief reinsurance and Delta less than 7 for column (1) and it is those without RBC-relief reinsurance and capital losses less than 7%, i.e. between 0% and -7% for column (2). Standard errors are adjusted for within firm correlations.