Regulatory Forbearance in the U.S. Insurance Industry: The Effects of Eliminating Capital Requirements*

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Abstract

This paper documents the long-run effects of an important reform of capital regulation for U.S. insurance companies in 2009. We show that its design effectively eliminates capital requirements for non-agency MBS, implying an aggregate capital relief of over $18bn at the time of the reform. By 2015, 40% of all high-yield assets in the overall fixed-income portfolio are MBS investments. This result is primarily driven by insurers' reduced propensity to sell poorly-rated legacy assets. Using a regression discontinuity framework, we can attribute this behavior to capital requirements. We also provide evidence that the insurance industry, driven by large life insurers, crowds out other investors in the new issuance of (high-yield) MBS post reform.

Keywords: insurance industry, capital regulation, regulatory reform, NAIC, risk-based capital requirements

JEL classification: G20, G22, G23, G28

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1 Introduction

The insurance industry is one of the pillars of the modern U.S. financial system, with a 30% share of all financial intermediation in terms of value added (Greenwood and Scharfstein, 2013) and invested assets in excess of $3.6tn in 2015. While it was historically considered safe and unimportant from a systemic perspective, this began to change in the early 2000s when insurance companies, in particular life insurers, have started to offer riskier products (Koijen and Yogo, 2016a), invest in riskier assets (Becker and Ivashina, 2015), and exploit state-level law changes permitting captive reinsurance (Koijen and Yogo, 2016b). As a result, insurance companies' balance sheets have been heavily hit by the financial crisis, in particular due to their exposure to downgraded mortgage-backed securities (MBS), pushing several insurers into distress (Ellul et al., 2014, Koijen and Yogo, 2015).

We document the long-run effects of a far-reaching reform of capital regulation for MBS that was instituted in the aftermath of the financial crisis. This reform effectively eliminated capital requirements for non-agency MBS. By 2010, aggregate capital relief relative to the previous regime amounted to over $18bn, with large life insurers being the primary beneficiaries both in absolute and relative terms. We identify the effects of this reform in two ways. First, since other fixed-income assets (corporate bonds, municipal bonds, asset-backed securities other than MBS, agency debt, etc.) were not affected by the reform, we are able to separate the impact of reduced capital requirements on insurance companies' portfolios from overall time trends in their risk appetite. Following the reform, insurance companies are much less likely to sell downgraded MBS, but not other downgraded asset-backed securities or corporate bonds. Second, exploiting (multiple) discontinuities in the reform, we can attribute this response to capital requirements. While the main effect on insurers' portfolios is driven by the (lack of) adjustments to legacy assets, we also find evidence that insurance companies crowd out other investors in the new issuance of MBS and, in particular, high-yield MBS, with life insurers and larger insurers being the key force behind this effect.

Figure 1 goes a long way in summarizing our main results. In the 2005 – 2008 period, the high-yield share in the U.S. insurance industry's MBS portfolio increased from an average of 2.6% to 22% in 2009 (see Panel A in Figure 1), largely driven by unprecedented downgrades of MBS due to reassessments of their riskiness. Naturally, as the reform was imposed right after the global financial crisis, the crisis itself may have changed the desired portfolio composition. For instance, insurers may have aimed for safer portfolios, but with slow adjustment in order to reduce or spread out losses. However, by 2015 the high-yield share within insurers' MBS holdings increases to 34%. The high-yield share for non-MBS

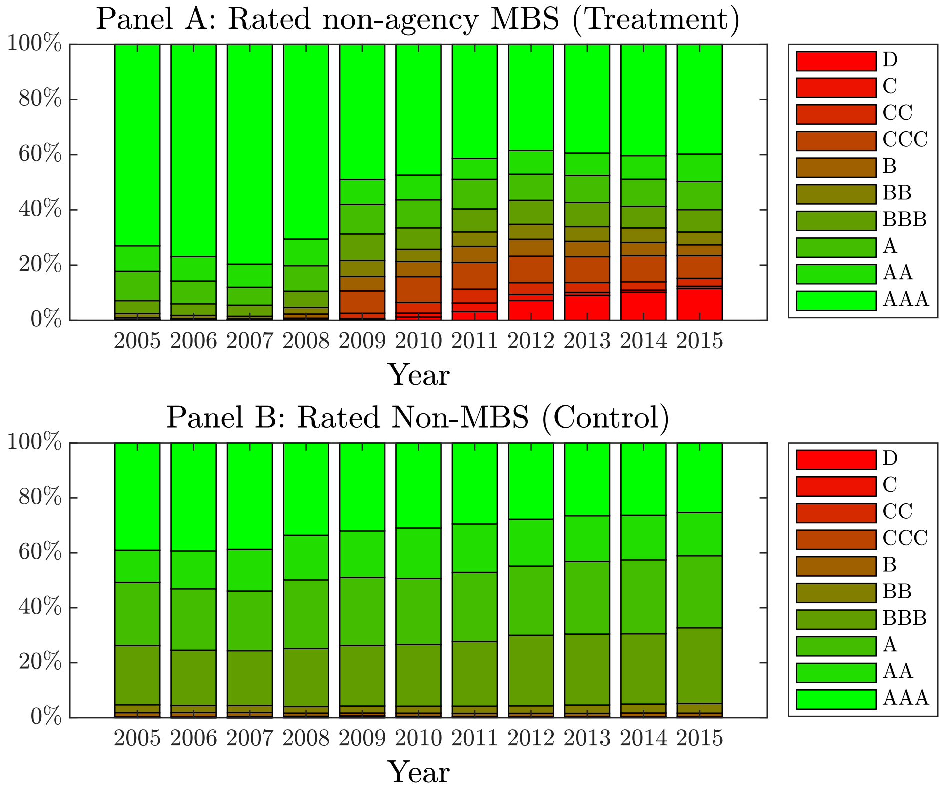

Figure 1. Ratings Distribution MBS vs. Non-MBS Over Time. For each year-end from 2005 to 2015, this graph plots the ratings distribution of MBS holdings (Panel A) and non-MBS holdings (Panel B). This graph conditions on the availability of at least one rating. If multiple ratings are available for a given security, we create a comprehensive rating equal to the lowest rating (for two ratings) and the median (for three ratings).

assets (see Panel B in Figure 1) remains stable at almost exactly 5% throughout the entire 2005 – 2015 period, including the global financial crisis. The stability of the high-yield share outside MBS is maintained through selling of downgraded assets (consistent with Ellul et al., 2011) and new purchases of highly-rated assets. As a result of these divergent trends, by 2015, 40% of all high-yield assets in the overall fixed-income portfolio are MBS investments. Taken together, this suggests that capital requirements rather than market conditions or taste shifts are the key driver.

We corroborate these industry-level findings at a more disaggregate level using comprehensive data on (i) U.S. insurers' holdings and trades of fixed-income assets in the period between 2005 and 2015, (ii) insurer characteristics from A.M. Best Company, (iii) a virtually complete panel of credit ratings by Moody's, S&P, and Fitch for all fixed-income securities ever issued, and finally (iv) a proprietary dataset on novel risk metrics of MBS between 2009 and 2015 used by the National Association of Insurance Commissioners (NAIC) for the purpose of regulation. Exploiting these rich data, our main empirical approach is to examine the trading behavior of insurance companies in an annual panel of their holdings of fixed-income securities, with a particular emphasis on the comparison between the pre-period ($2005 - 2009$) and the post-period ($2010 - 2015$).

In 2009, the coordinating body of insurance regulators (NAIC) motivated the reform by concerns about the accuracy of credit ratings (see Appendix A for a memo explaining the reform) and removed references to credit ratings in the calculation of capital requirements for MBS. Given the unprecedented downgrades of these assets during the financial crisis,[1] the previous regulatory system would have implied a quadrupling of 2009 capital requirements for MBS compared to 2008 (and further increases in 2010). In turn, the considered 2009 reform prevented this massive increase of capital requirements from occurring.

Instead of ratings, capital requirements for individual securities are now based on expected-loss estimates ("ELOSS"), provided by PIMCO (for RMBS) and BlackRock (for CMBS). Given this new input, capital requirements are calculated as follows. Suppose PIMCO assigns ELOSS of 12% to a particular MBS, and MetLife's book value for this security is 90% of par value, implying a "book discount" of 10%. Then the approximate capital requirement under the new system is the difference between ELOSS and the book discount, i.e., 2%. (We use the term "approximate" as we ignore discontinuities in the implementation of capital requirements.) However, due to marking-to-market requirements, book values of most MBS are below par after the financial crisis, implying large book discounts, in particular for riskier MBS.[2] Since this "book discount" is of similar magnitude as ELOSS for the typical MBS position, the associated capital requirements become approximately zero. Hence, capital buffers now do not provide any cushion against unexpected losses in bad states, as reflected by an industry observer's reaction: "*They take one class of securities and change the rules [to give] insurers capital relief. Let's just hope they aren't picking something out that results in inadequate capital.*" (Wall Street Journal, January 2010)

As insurance companies are, under normal circumstances, buy-and-hold investors, they typically do not trade much in the secondary market. However, as Ellul et al. (2011) point out, trading does occur in response to rating downgrades, at least in a system where capital requirements are hardwired to ratings. As a result of the reform, a rating downgrade for an MBS only captures variation in credit quality, but does not automatically trigger increases in capital requirements (in contrast to non-MBS, and in contrast to the previous system

[1] In 2008, S&P downgraded over 30% of structured securities, in 2009 50%, and in 2010 again over 30%. There were virtually no upgrades.

[2] Marking-to-market requirements imply that both life and P&C insurers need to mark most of their MBS to market (see Section 4.2 and Appendix C).

for MBS under which capital requirements used to be based on ratings). Against this background, we initially analyze the trading behavior in legacy assets on the balance sheets of insurers, in particular their selling decisions in response to downgrades. In line with our hypothesis, we find that insurance companies, especially life insurers, are significantly less likely to sell downgraded MBS, both absolutely and relative to other asset classes. This result holds at the industry (see Figure 1), the insurance conglomerate (group), and the individual company level.

We improve on identification by employing a regression discontinuity design. This approach exploits two additional institutional features. First, while the book discount is close to ELOSS for the typical MBS, they are not perfectly correlated, so that the difference between ELOSS and the book discount is strictly positive for a smaller fraction of MBS holdings. Second, this difference does not map one-to-one to capital requirements, but discontinuously with different cutoffs across insurer types (life vs. P&C), and even differentially across insurers.[3] For example, any security position where the difference of ELOSS and the book discount is between 0.85% and 2.95% (such as the security mentioned above) would lead to a capital requirement of 1.3% for a life insurer, jumping to 4.6% as soon as the difference exceeds 2.95%.

Using a regression discontinuity framework with multiple cutoffs, we estimate the sales elasticity at these cutoffs separately for life and P&C insurers.[4] We find that insurance companies – and especially life insurers – (continue to) react quite strongly in their decision to sell a mortgage-backed security if it is assigned a higher capital-requirement bucket, but with different intensities at the five cutoffs. Across all risk categories, life insurers are 1.2 to 6.3 percentage points more likely to sell any fraction of their legacy MBS, whereas P&C insurers' propensity to sell MBS does not respond to four out of five increases in capital requirements.

While the discontinuity-based approach identifies the responsiveness of insurers' selling behavior with respect to capital requirements, it is possible that the portfolio relevance of capital requirements is not symmetric for buying and selling decisions. To investigate insurers' purchasing behavior, we exploit the fact that the reform for MBS capital requirements applies not only to legacy assets, but also to any MBS issued post reform. To investigate the effect of the reform on purchases in the primary market, we assemble a comprehensive dataset of over 1.5 million newly issued securities between 2005 and 2015.

[3] Different insurers may hold the same security (with the same par amount) at different book values if the timing of the purchase (and, thus, the purchase price) differs across insurers.

[4] Here, identification is obtained from the smaller set of MBS that do not fall into the most preferential risk bucket NAIC-1.

While the issuance of private residential mortgage-backed securities (RMBS) has not recovered after the financial crisis, the market for commercial mortgage-backed securities (CMBS) started to revive in 2012. In these markets, we show that following the reform, the insurance industry crowds out other investors (such as pension funds, bond funds, etc.) in the issuance of MBS and, in particular, high-yield MBS. The latter type of securities would have been associated with (much) higher capital requirements in the absence of the regulatory reform. This response is entirely driven by life insurers, consistent with the idea that the business model of these insurers is under greater reaching-for-yield pressure in times of low interest rates (see Koijen and Yogo, 2016a). In sum, our results suggest that the response to the reform extends above and beyond legacy assets, although the contribution of new (high-yield) MBS to the overall riskiness of the insurance industry is modest due to the low total volume of new MBS issuances.

The reform we study addresses a commonly voiced concern of hardwiring institutional capital requirements to credit ratings.[5] However, it also introduces new flaws. First of all, by construction, the new risk measures focus on expected losses, not tail events, and are, thus, not substantially different from credit ratings. Second, the mapping of these new metrics to capital requirements is calibrated in such a way that the implied capital buffers cover expected losses, thus providing no protection against unexpected losses, the very losses capital requirements ought to protect against (Brunnermeier et al., 2009). This implies that after 2009, capital requirements in principle do not discourage insurers from holding, or investing in, high-risk MBS, while the penalty for other types of fixed-income assets remains in place.

What was the motivation for this reform? One potential explanation is the political-economy channel behind regulation going back to Olson (1965), Stigler (1971), and Peltzman (1976). Consistent with this view, we show that large life insurance companies are the biggest beneficiaries of this reform, i.e., companies that are presumably more influential in the regulatory process. This interpretation would also be consistent with prior experience: Kroszner and Strahan (1999) argue that industry interests were important to U.S. financial regulation in the 1970s and 1980s.

Another, not necessarily mutually exclusive, motivation is that insurance regulators may have wanted to relieve pressure on the industry so as to mitigate fire-sale discounts caused by industry-wide sales (see Shleifer and Vishny, 1992 or, within the insurance set-

[5] The optimistic ratings issued in the pre-crisis period were seen to reflect long-term weaknesses with the business model of rating agencies (Bolton et al., 2012; He et al., 2012; Griffin and Tang, 2012; Benmelech and Dlugosz, 2009; Becker and Milbourn, 2011; Baghai and Becker, 2018). These could be exacerbated by the regulatory use of ratings itself (Opp et al., 2013).

ting, Ellul et al., 2018), or to protect insurance clients from price movements (Chodorow-Reich et al., 2018). Indeed, the increase in capital requirements under the previous system would have occurred at a difficult time: many insurance companies simultaneously experienced market-value losses in their asset portfolios, and faced tight conditions for raising new equity. However, to avoid *temporary* fire sales of legacy assets, it does not seem necessary to grant capital relief to newly purchased securities.

This paper is related to recent work on the insurance industry, on capital requirements, and on the design and implementation of financial regulation.[6] Insurance companies are prominent institutional investors, and their demand is important for the pricing of traded assets (e.g., Koijen and Yogo, 2019; Harris et al., 2017; Becker and Ivashina, 2015; Ellul et al., 2011, 2015). We contribute to this literature by demonstrating a permanent asset-portfolio impact of capital regulation.

Prior work examining the reform (Becker and Opp, 2013; Hanley and Nikolova, 2015) presents results on trading of existing MBS directionally consistent with ours. Our paper brings three key improvements on this. First, using novel proprietary data, we exploit the non-linear nature of the new capital requirements to yield more precise identification, i.e., to better rule out that omitted variables related to the new risk measure for MBS are drivers of trading. Second, we include a long post-crisis period: if the initial responses were specific to crisis conditions, long-term effects might differ, but we show that they do not. Third, we examine the new-issues market, which requires considerable data collection and allows to investigate whether the response to the reform is confined to legacy assets or also applies to new issues.

Finally, our findings on the difficulty of implementing sound regulatory regimes are related to recent work on the constraints and impediments to effective regulation (Agarwal et al., 2014; Lucca et al., 2014). While there exists the possibility that insurers' lower propensity to sell MBS might have precluded costly fire sales, all the while relieving pressure on the U.S. insurance industry at a difficult time, we point out that this type of macroprudential policy on the fly comes at a steep price: a long-term increase in the high-yield share in insurers' MBS portfolios.

[6] In this thrust, our results chime with recent work showing that banks respond to increased capital requirements by aggregate risk reduction and less lending (Behn et al., 2016; Chen et al., 2017; Gropp et al., 2019). The consistency of this literature on the (generally) more gradual and predictable increases of bank requirements and our evidence from the rapid, large, and less foreseeable reduction of insurance capital requirements helps to formulate a set of conditions for effective capital requirements.

2 The 2009 Regulatory Reform

Since 1994, the NAIC has used a risk-based capital system to regulate insurance companies. This system imposes *annual* capital requirements and computes a solvency metric, the risk-based capital (RBC) ratio, for each insurer at the end of each year.[7] It aims to ensure a minimum level of solvency of insurance companies to protect policy holders, and, ultimately, the tax payer from losses originating from both the asset and liability side of their balance sheets. As for banks, fixed-income securities represent the most important asset class for insurance companies. As a result, their regulatory treatment is conceptually similar to bank capital requirements under Basel II.

In this paper, we focus on a change in capital regulation for a subcategory of fixed-income assets, namely for non-agency mortgage-backed securities, which we, henceforth, simply refer to as MBS. Precisely, the dollar capital requirement for a particular fixed-income security s (CR_s) is a product of the size of the insurer's position measured in book values (BV_s)[8] and a risk-based charge ($RBC\%_s$). The risk-based charge is an increasing function of the NAIC risk classification, which takes on discrete values from 1 to 6 (see Table 1). Here, NAIC-1 refers to the lowest risk category, and NAIC-6 represents the highest risk category.[9]

Table 1 illustrates that if a life insurance company holds an NAIC-4 bond with a book value of \$100, it faces a capital requirement of \$10.[10] The capital requirement (in \$) for the insurer's entire fixed-income portfolio (CR) with N bonds is given by:

$$CR = \sum_{s=1}^{N} CR_s = \sum_{s=1}^{N} RBC\%_s \times BV_s.^{11} \tag{1}$$

Prior to year-end 2009, the NAIC risk classifications for all fixed-income securities were hardwired to credit ratings issued by acceptable ratings organizations (AROs), as illustrated in the fourth column of Table 1.[12] That is, a AA-rated bond received a NAIC-1 designation, whereas a B-rated bond was considered NAIC-4. The capital requirements

[7] We refer the reader to Appendix B for a more detailed discussion of the overall system for capital requirements, for both the asset and the liability side.

[8] Formally, the NAIC refers to the book value as book-adjusted carrying value (BACV).

[9] Holdings of U.S. government debt (including agency MBS) are exempt from capital requirements.

[10] Since the risk-based charges for life and P&C insurers differ (see columns 2 and 3 in Table 1), the same bond would command a risk-based charge of 4.5% if held by a P&C insurer.

[11] The formula implies that the overall capital requirement does not account for the correlation structure of the securities within the fixed-income portfolio.

[12] In March 2013, AROs were Moody's, S&P, Fitch, DBRS, A.M. Best, RealPoint, and Kroll Bond Rating Agency, largely the same set of credit rating agencies as those designated nationally recognized statistical ratings organizations (NRSROs) by the SEC.

for corporate bonds, asset-backed securities, and municipal bonds still follow this ratings-based classification scheme.

Starting year-end 2009 for RMBS and year-end 2010 for CMBS, the NAIC made fundamental changes in how to classify the risk of MBS. This reform instituted changes both on the input dimension of capital regulation as well as its calibration of capital buffers.

New input to regulation. The official rationale behind the regulatory reform was to replace "flawed ratings" by traditional credit rating agencies as inputs to capital regulation. To achieve this, the NAIC purchased security-level expected-loss assessments by PIMCO (for RMBS) and BlackRock (for CMBS).[13] For each security (CUSIP), these providers estimate discounted expected losses of principal payments, which we refer to as $ELOSS$.

Since traditional ratings also reflect expected losses (Moody's), the most significant change on the input side is that $ELOSS \in [0, 1]$ is a continuous estimate of expected loss in contrast to a letter-grade rating. In particular, $ELOSS$ determines the regulator's notion of an "intrinsic price" (IP) for a security:

$$IP := 1 - ELOSS. \tag{2}$$

For example, the intrinsic price of a bond with 30% expected loss is given by 70% of par. The intrinsic prices provided by PIMCO and BlackRock are highly correlated with brokerage quotes of the market price (see Figure 2): the respective correlation coefficients are 0.82 and 0.81. Moreover, Figure 2 reveals that the intrinsic price, with a mean of 0.86, is typically above the market price (MP), with a mean of 0.81.

In Appendix D, we highlight two channels that imply $IP > MP$ for the typical structured security. First, $ELOSS$ disregards losses to coupons. Second, the discount rate used to estimate $ELOSS$, i.e., the coupon rate of the respective security, is inappropriate.[14]

New calibration of capital buffers. As under the previous system, securities with the best possible risk assessment ($ELOSS = 0$) automatically fall into the NAIC-1 category. However, for the majority of securities with $ELOSS > 0$ (see Figure 2), the regulatory treatment is changed substantially in that the risk-based charge is not only a function of the security-specific $ELOSS$ metric but also of the insurer-specific book discount for that security. Let $BP_{si} := \frac{BV_{si}}{PV_{si}}$ denote the book price of security s for insurer i, referring to the

[13] As of 2016, BlackRock replaced PIMCO as the provider of ELOSS for RMBS. We investigated potential conflicts of interests on the side of BlackRock and PIMCO by examining whether their risk assessments are related to their holdings/trading behavior, but we could not detect any unusual pattern.

[14] Since losses tend to be higher in bad aggregate states of the world (negative beta), standard insights from consumption-based asset pricing imply that the discounted market expectation of losses must be greater than the losses using a state-independent discount rate equal to the coupon rate. See Almeida and Philippon (2007) for a similar point in the context of estimating distress cost.

book value of the bond per unit of par, so that $1 - BP_{si}$ can be interpreted as the book discount.[15] Then, the approximate capital requirement under the new system (per unit of par holding) is equal to:

$$CR_{si} \approx ELOSS_s - (1 - BP_{si}) = BP_{si} - IP_s. \tag{3}$$

This approximation reveals that the regulatory capital reform targets first moments by netting the expected average loss of the security with book discount. If an insurer records a security at 60% of par on the books, i.e., $BP_{si} = 0.6$, an intrinsic price of 0.57 ($ELOSS_s = 0.43$) implies a 3% capital requirement per unit of par. By charging an amount equal to $\frac{BP_{si}-IP_s}{BP_{si}}$ on the book value (in this example, 5%), capital requirements for security s would be exactly given by (3) (see red line in Figure 3).

The reason for why (3) only holds approximately is that the regulator implements it in a discontinuous way by designing five cutoffs based on $\frac{BP_{si}-IP_s}{BP_{si}}$ (see black step function in Figure 3 and columns 5 and 6 in Table 1). The cutoffs are calibrated such that the new system still features six NAIC risk categories and associated capital charges ranging from 0.4% (NAIC-1) to 30% (NAIC-6) (for life insurers).[16] For example, for a life insurer, the just described bond would be considered NAIC-3 with an associated RBC% charge of 4.6% (rather than 5%). We will exploit the discontinuities implied by the new system in our regression discontinuity analysis (in Section 4.2).

3 Data

In this section, we first describe all data sources used for our analysis. We then present summary statistics and motivating evidence for the effect of the 2009 regulatory reform on insurance companies' asset allocation.

3.1 Data Description

Our main data cover the universe of insurer holdings and trades of fixed-income assets. For insurer holdings, the NAIC provides CUSIP-level end-of-year holdings for all insurance companies in the U.S. from 2005 to 2015. This dataset, NAIC Schedule D Part 1, covers

[15] The book price is beyond the control of the insurance company and determined by accounting rules (see Appendix C).

[16] To understand the magnitudes of the risk-based charges, observe that the cutoffs (in columns 5 and 6 of Table 1) are simply the average of the respective adjacent NAIC RBC% charges: for life insurers, the NAIC-1 cutoff is thus given by (0.4%+1.3%)/2=0.85%. These cutoffs ensure that the approximation in (3) holds.

holdings for all fixed-income securities (including treasury bonds, corporate bonds, MBS, agency-backed RMBS, etc.). It provides us with insurer-specific holdings (book value and par value for each security), the NAIC risk classification of each bond, as well as insurer characteristics (such as the state of incorporation and the business type). Our entire analysis is limited to the two most important types of insurers: life and property & casualty (P&C).

Since our empirical analysis focuses mainly on the examination of active portfolio adjustments (in the form of selling legacy assets or purchasing new securities), we complement the year-end holdings data from NAIC Schedule D Part 1 with data on sales from NAIC Schedule D Part 4. This dataset covers sales transactions for insurers' fixed-income positions from January 1, 2006 to December 31, 2015. We require this additional dataset since reductions in the year-end par value of a fixed-income security often do not reflect active selling, but are primarily due to (partial) prepayment or maturity of a security.

To identify active trades, we use information in the fields "name of purchaser" and "realized gain (loss) on disposal" in Schedule D Part 4. We consider a security as actively sold if the "name of purchaser" does not indicate any of the following categories: redemptions, maturity, or default. Moreover, we require that the transaction generate a non-zero realized gain or loss on disposal.[17] For example, if the "name of purchaser" lists a transaction with "Goldman Sachs," it is categorized as an active trade, while it would not be an active trade if it listed "MBS paydown," "called," or "maturity" (see Appendix E for a detailed description of our classification methodology and keywords). Our analysis indicates that only 25% of all fixed-income transactions listed in NAIC Schedule D Part 4 are due to active sales.

Unless noted otherwise, we consider insurance groups, whenever they deviate from the individual company level, as the relevant unit of observation. We zoom in on the individual company level in particular when we use insurer data at this level. We retrieve the respective data, annual financial statements and ratings information, from A.M. Best Company for fiscal years $2005 - 2015$.

We use a comprehensive set of ratings data. For structured securities, we obtain the universe of ratings directly from the three major credit rating agencies, i.e., Moody's, S&P, and Fitch. For all other issues, we rely on the comprehensive Mergent FISD corporate bond database as well as the Mergent FISD municipal bond database to obtain ratings from

[17] The idea behind this restriction is that transactions in secondary markets will unlikely take place exactly at book values and, thus, generate either realized gains or losses. In contrast, the data indicate that scheduled prepayments (almost) always lead to exactly zero gains or losses. Appendix E provides more details.

all three rating agencies.[18] For each security, when ratings from two rating agencies are available, we use the lower one. When ratings from all three rating agencies are available, we use the median rating.

In addition, we obtain the year-end NAIC ELOSS metrics calculated by PIMCO and BlackRock for all RMBS (2009 to 2015) and CMBS (2010 to 2015) held by at least one insurance company. These proprietary data are used to calculate capital requirements after the reform, and serve as an input to our regression discontinuity analysis.

When we move our analysis from existing securities to newly issued ones, we use data on all newly issued securities from January 1, 2005 to December 31, 2015. We define the issue date as the date of the first rating from any of our data sources.

Finally, all securities (CUSIPs) are matched with asset categories available from the CUSIP master file database, including mortgage-backed securities and private loans.[19] We use this information to build the following seven asset categories: corporate bonds and loans, asset-backed securities (excluding mortgage-backed securities), mortgage-backed securities (excluding agency mortgage-backed securities), agency mortgage-backed securities, government debt, municipal bonds, and other (including equity-like instruments).

3.2 Summary Statistics

In Figure 4, we plot the book values of all fixed-income assets held by the two most important business lines of insurers, namely life and P&C. (We present book values rather than the quantitatively similar market values to facilitate comparison with official NAIC numbers, which tend to be reported in book values.) By 2015, life insurers' total fixed-income holdings amount to $2,734bn whereas P&C insurers held in total $960bn, implying combined holdings of $3,694bn.

For our asset categorization, we distinguish between MBS, the treated group of securities, and agency MBS that are not treated. For life and P&C insurers combined, the share allocated to MBS has increased from 12.3% in year-end 2005 up to 14.7% at the onset of the crisis (year-end 2008). It then decreased sharply over the crisis period due to prepayments/redemptions, write-downs and a lack of new issues, and has remained stable at 8% since 2012. Interestingly, while corporate bonds are the most important category within the fixed-income portfolio for both life and P&C insurers, only P&C insurers allocate a

[18] If a security's rating shows up in multiple data sources, we rely on the respective credit rating agency as the source, e.g., if for a given CUSIP-year we have both an S&P rating directly from S&P and via Mergent FISD, we use S&P as the source.

[19] We wish to thank Brian Sweeney from CUSIP for helping us with identifying the asset classes of all assets held by U.S. insurance companies anytime from 2005 to 2015 according to the NAIC.

substantial share towards municipal bonds (of similar magnitude as corporate bonds).[20]

Table 2 presents summary statistics for the main variables used in our analysis. In Panel A, we summarize information on our security-insurer-year dataset (see Table 6). In Panel B, we present summary statistics for our dataset of newly issued securities (see Table 8) at the security level. While only 1.9% of all new issues are initially rated BB+ or lower, this fraction increases to 12.1% in the subsample of MBS.

In Table 3, we present summary statistics separately for life and P&C insurers, using A.M. Best data (at the individual company level) on financial statements and ratings for the last year available, 2015.[21] In doing so, we focus on a group of relevant insurers for our estimation, namely those with total assets in excess of $100m.

Following Koijen and Yogo (2015), we consider the size of their balance sheets, i.e., their total admitted assets, the ratio of MBS over total assets, return on equity (ROE), their leverage ratio, which is equal to one minus the ratio of equity to total admitted assets, and risk-based capital (RBC) ratio, which is equal to total adjusted capital over authorized control level risk-based capital. In addition, we include information on A.M. Best Financial Strength Ratings and Capital Adequacy Ratios (ranging from 1 to 999), which reflect whether an insurer will be able to meet its policy obligations.

There are some notable differences between life and P&C insurers, reflecting their different business models. Importantly, life insurers are relatively more likely to be held by their shareholders ("stock"), whereas P&C insurers are relatively more likely to be held by their policyholders ("mutual"). Life insurers are also much larger, and hold more mortgage-backed securities on average, 6.7% of their admitted assets as compared to 4.0% for P&C insurers. Life insurers have higher leverage ratios and are worse capitalized (as measured by their RBC ratios and A.M. Best Capital Adequacy Ratios), but their financial strength ratings are similar to those of their P&C counterparts.

3.3 Motivating Evidence

In the following, we present evidence that motivates our scrutiny of the role of capital requirements and the 2009 regulatory reform in shaping asset-allocation decisions by U.S. insurers. We use the detailed breakdown of insurers' asset portfolios in conjunction with our comprehensive ratings data to characterize the evolution of credit risk in the fixed-

[20] The preference for municipal bonds is largely due to tax benefits associated with this asset class. While life insurers are not excluded from these tax benefits, they tend to have lower taxable income and, thus, have less of a need to protect interest income. For a more extensive discussion of insurers' investment in municipal bonds, see http://www.naic.org/capital_markets_archive/130701.htm.

[21] All differences between life and P&C insurers are virtually invariant over our sample period.

income portfolio of the U.S. insurance industry.

In Figure 5, we plot the year-end ratings distribution of the combined fixed-income asset holdings of life and P&C insurers. To illustrate our continuously high ratings coverage, we also plot the stable share of assets without a rating (labeled "NR"). These 16% of assets include securities for which no credit rating exists (e.g., a private corporate loan) or securities for which ratings exist, but they are not covered by any of our datasets.

We observe two trends in the overall portfolio that are indicative of reaching-for-yield behavior. First, the fraction of high-yield investments (conditional on a rating) almost doubles from 4.4% to 7.4%. Second, even within the set of investment-grade securities, there is a granular trend towards lower-rated (but higher-yielding) assets. In particular, the super-safe AAA share (conditional on availability of a rating) dropped from 43.8% to 26.5% between 2005 and 2015. Our introductory Figure 1 indicates that holdings of MBS, the only set of securities treated by the regulation, go a long way of explaining these stylized facts.

We next zoom in on the importance of the regulatory reform. To assess the capital relief for insurers that may have contributed to their reaching-for-yield behavior (see Figure 1), we plot the actual required regulatory capital charge for MBS holdings, the counterfactual capital requirement for MBS under the previous ratings-based system (starting 2009), and the actual regulatory capital charge for non-MBS in Figure 6. Compared to the counterfactual capital requirements that would have been implied by ratings, we observe an extreme capital relief ($\approx$ 92% in 2015) for insurance companies holding MBS. Moreover, despite the significantly worse credit risk of MBS compared to non-MBS (see Figure 1), capital requirements for MBS drop even below those for non-MBS by 2015.

To shed light on the characteristics of insurers that are more affected by the reform, we distinguish between insurance companies that benefited from the reform, by incurring lower capital requirements than those that would have been implied by the counterfactual ratings-based system, and insurers that did not in the first year after the reform, 2010.[22] Naturally, these groups differ by the extent to which they were invested in MBS. We present the remaining summary statistics in Table 4.

Most notably, insurers that benefited from the reform are much more likely to be life, rather than P&C, insurers: on average, 40.0% of insurers that benefited from the reform are life insurers, in comparison to only 17.8% of insurers that did not (the difference is significant at the 1% level). Consistent with this, insurers that benefited from the reform are also much larger in terms of admitted assets, have higher leverage ratios, lower RBC

[22] Our summary statistics are similar for the last year of our sample, 2015, and RBC savings based on 2015 data.

ratios, and lower A.M. Best Capital Adequacy Ratios. Other differences, even if statistically significant, are of smaller economic magnitudes, e.g., the difference in ROE. While this cannot, and should not, be seen as a test of any particular model of the regulatory process and its political economy, these correlates indicate that the 2009 reform benefited insurers that were more likely to be large and potentially influential.

4 The Impact of the Reform on Asset Portfolios

In this section, we lay out our empirical approach for estimating the effects of capital requirements on insurers' asset portfolios. We then turn to the results. We start with the effect of the regulatory reform on insurers' portfolio decisions in legacy assets, and then move our focus to insurance companies' purchases of newly issued securities.

4.1 Hypotheses and Empirical Approach

It is conventional wisdom that capital buffers are meant to withstand unexpected, rather than expected, losses (see Brunnermeier et al. (2009)). Yet, the design of the new system of capital regulation violates this fundamental principle. It ensures risk buffers just enough to cover losses that are expected to occur and, thus, fails to provide buffers against adverse scenarios (unexpected losses). As such, the reform does not address a key criticism of using credit ratings for capital regulation, namely the lack of distinction between systematic and unsystematic risks.

Figure 6 illustrates that the new system implies large savings in aggregate capital requirements relative to the old ratings-based system. However, the new capital regulation not only reduces overall levels of capital, but also introduces distortions across asset classes since the favorable new system only applies to structured securities which are, by design, heavily exposed to systematic risk (Coval et al., 2009), much more so than corporate bonds with similar expected loss. If risk taking is a relevant concern for insurers, they can now reach for yield (Becker and Ivashina, 2014) and purchase the riskiest tranches of structured securities at (essentially) zero regulatory cost.

Therefore, we conjecture that the new system increases insurers' willingness to bear risk in structured securities, but will not alter their trades of asset classes the capital requirements of which are not affected, e.g., corporate bonds. To test this conjecture, we examine insurers' trading behavior for existing securities at the security-insurer-year level. We use downgrades of credit ratings to identify deterioration in credit quality. Since the regulatory reform removed the dependence of capital requirements on ratings, we expect insurers to respond less to changes in ratings after the reform. This is because such downgrades would have been associated with higher capital requirements before the reform, but not after the reform.

Because ratings may motivate trades for reasons not directly related to capital requirements, it is important to contrast insurers' trading behavior with that before the reform: the prediction is not that insurers' trades should be unrelated to ratings, but that they should respond less to ratings after the reform. It is also possible that ratings changes generally matter differently over the cycle. We therefore also include non-MBS securities in the dataset. Implicitly, we rely on these to capture how insurers' propensity to trade based on credit quality changes over time.

Our conjecture is that following a downgrade, insurers are less likely to sell MBS – in comparison to other types of fixed-income securities – after the 2009 regulatory reform. To test this, we run the following regression:

$$\begin{aligned} Sold_{sit} = {} & \beta_1 \max\left\{\Delta RBC_{sit-1}^{ratings}, 0\right\} \times MBS_s \times Post_t \\ & + \beta_2 \max\left\{\Delta RBC_{sit-1}^{ratings}, 0\right\} \times Post_t + \beta_3 \max\left\{\Delta RBC_{sit-1}^{ratings}, 0\right\} \times MBS_s \\ & + \beta_4 \max\left\{\Delta RBC_{sit-1}^{ratings}, 0\right\} + \mu_s + \psi_{kt} + \eta_{it} + \epsilon_{sit}, \end{aligned} \tag{4}$$

where $Sold_{sit}$ is an indicator variable for whether insurer i sold a non-zero fraction of security s in year t, $\max\{\Delta RBC_{sit-1}^{ratings}, 0\}$ is the absolute increase in risk-based charges (RBC, from 0 to 0.297) of security s as a function of the NAIC risk category according to credit ratings (also after the regulatory reform) for life and P&C insurers i in year-end $t-1$ (compared to the previous year), MBS_s is an indicator variable for whether security s is a mortgage-backed security, $Post_t$ is an indicator variable for the year 2010 and onwards, μ_s denotes security fixed effects, ψ_{kt} denotes asset-class-year fixed effects, and η_{it} denotes insurer-year fixed effects. Standard errors are clustered at the security level.

The coefficient of interest is β_1, which indicates whether insurers sold downgraded MBS with a different likelihood following the regulatory reform. We hypothesize $\beta_1 < 0$ because capital requirements are no longer based on credit ratings after the regulatory reform. Therefore, downgrade events that would have been associated with higher risk-based capital requirements under the old regime should be less likely to trigger sales of MBS by insurance companies after the reform.

We control for security fixed effects, μ_s, which capture time-invariant heterogeneity at the security level. In our most refined specification, we also include security-insurer fixed effects, which capture time-invariant heterogeneity at the security-insurer level, such as the general investment profile of insurance companies according to their business model (life vs. P&C). Throughout, we also control for (variants of) asset-class-year fixed effects so as to control for any different trajectories across security categories (e.g., MBS vs. other asset-backed securities). Last, we include insurer-year fixed effects η_{it} which control for time-varying unobserved heterogeneity at the insurer level, including but not limited to insurers' demand for fixed-income securities in general.

Our identification relies on the assumption that there is no (other) change over time in the response to downgrades by insurers, as opposed to other market participants, across asset categories. That is, one may be concerned about coincidental events that are correlated with downgrades of MBS in general. To mitigate this concern, we control for rating-year fixed effects for each asset class k as well as time-varying fixed effects for all kinds of rating changes (as measured in notches) for each asset class. The latter type of fixed effects would comprise any downgrade events that are not, or would not be, associated with higher risk-based capital requirements. In this manner, we control for time-varying unobserved heterogeneity that pertains to generally downgraded MBS and all other fixed-income assets.

4.2 Insurers' Trading Behavior for Legacy Assets

We now turn to scrutinizing insurers' trading behavior for legacy fixed-income securities. In particular, we test whether following the reform, insurers are less likely to sell downgraded MBS that would have been associated with higher capital requirements under the previous system, but are not any more.

We start by presenting industry-level evidence in favor of this conjecture, and consider the percent change of the total par value of a given security s held by the insurance industry in year t vs. $t-1$ as the dependent variable. We pool together all downgrade events, $Downgrade_{st-1}$, and estimate a separate interaction effect of downgrades by the previous year-end with an indicator for the post-reform period from 2010 to 2015.

In columns 1 and 2 of Table 5, we run separate regressions for MBS and all other fixed-income securities, and find that while insurance companies increase their holdings of downgraded MBS after the reform, the opposite is the case for all other downgraded securities. In column 3, we re-run our specification on the pooled sample of all fixed-income securities, and add asset class by year fixed effects. The coefficient of interest is that on $Downgrade_{st-1} \times MBS_s \times Post_t$, which is positive and significant. We find that following downgrades, insurers collectively reduce their holdings of a given security, and even more so after the reform, but this effect is entirely offset for MBS.

We then test whether this effect reflects insurers' reduced propensity to sell or heightened propensity to buy MBS. For this purpose, we use two different dependent variables in columns 4 and 5 for, respectively, non-positive and non-negative changes in par holdings. As such, the two coefficients add up to the respective coefficient in column 3. In this manner, we find that the positive coefficient on the triple interaction is entirely driven by insurers' reduced propensity to sell MBS (column 4). In columns 6 and 7, by re-defining the dependent variable to capture the percent change in holdings by, respectively, life and P&C insurers, we furthermore find that it is exclusively life insurers that respond to the reform by not reducing their MBS holdings.

In Table 6, we move to estimating our core specification (4) on our sample at the security-insurer(group)-year level sit.[23] In contrast to the previous table, we now consider active selling behavior (see definitions in Appendix E) to rule out that the results are driven by redemptions or defaults rather than active selling. As such, we use an indicator for whether insurer i active sold any non-zero fraction of security s in year t as our dependent variable. As explanatory variable, we use changes in risk-based charges as implied by credit ratings, $\max\{\Delta RBC^{ratings}_{sit-1}, 0\}$, which are factual in the pre-reform period but only hypothetical in the post-reform period when ratings are replaced as inputs in the calculation of risk-based charges.[24] Note also that by using actual risk-based charges, we can exploit within-security variation across insurers as risk-based charges vary by business line (see Table 1).

As in Table 5, we first focus on the MBS subsample. In column 1, we start with a raw estimate that does not account for any other source of variation but year fixed effects. While insurers are more likely to sell MBS that are downgraded so as to be associated with higher capital requirements (in line with Ellul et al., 2011), they do so with a significantly lower likelihood after the regulatory reform. This continues to hold in column 2 after adding not only security and insurer-year fixed effects, but also rating-(asset-class-)year and rating-change-(asset-class-)year fixed effects (the asset class is fixed in the first five columns as we consider only MBS).

In this manner, the coefficients on $\max\{\Delta RBC^{ratings}_{sit-1}, 0\}$ and $\max\{\Delta RBC^{ratings}_{sit-1}, 0\} \times Post_t$ are estimated off downgrades by any number of notches that are, or would have been, associated with higher capital requirements implied by the corresponding NAIC risk category, as opposed to those downgrades that are not. Whether any such downgrade is, or would have been, linked to the next NAIC risk category is not only a function of the

[23] While in Table 6 we focus on the insurance group level, the estimates are very similar in the somewhat larger sample when considering the individual company level (see Table Appendix F.1).

[24] All results are invariant to using an indicator for any increase in risk-based charges, i.e., $\mathbb{1}\{\Delta RBC^{ratings} > 0\}_{sit-1}$.

number of notches of the downgrade itself, but also of the previous rating. This allows us to separately estimate these coefficients after including rating-year and rating-change-year fixed effects.

After the reform, in comparison to any other downgrade events, insurers are significantly less likely to sell MBS following downgrades that would have been associated with higher capital requirements under the previous regime. The negative coefficient on $\max\{\Delta RBC_{sit-1}^{ratings}, 0\} \times Post_t$ is consistent with the hypothesis that the reform reduced insurers' incentives to sell poorly-rated assets, allowing them to retain downgraded assets.

Quantitatively speaking, a downgrade from NAIC 2 to 3, i.e., a non-investment-grade downgrade, is associated with an absolute increase in RBC of 0.033 for life insurers, namely from 1.3 to 4.6%. This translates into a ($0.033 \times 0.658 =$) 2.2-percentage-point lower likelihood of selling MBS after the regulatory reform (column 2), which corresponds to roughly one-sixth of the average value for the dependent variable (see Panel A in Table 2).

In column 3, we include security-insurer fixed effects, so we drop (few) observations that are associated with securities held by insurers in only one of the two periods around the regulatory reform. This leaves our estimates virtually unaltered. Finally, in columns 4 and 5, we split our sample by the type of insurers. We find that our effect is driven primarily by life insurers (column 4).

In columns 6 to 9 of Table 6, we run analogous regressions to those in columns 2 to 5 on the sample of all fixed-income securities. In column 6, we include (as is the case in column 2), rating-asset-class-year and rating-change-asset-class-year fixed effects, so we compare downgrade events that are, or would have been, associated with higher capital requirements to any other downgrades that are not associated with higher capital requirements (even before the reform).

Prior to the reform, higher capital requirements translate into greater propensity of insurers to sell downgraded fixed-income securities (as reflected by the positive coefficient on $\max\{\Delta RBC_{sit-1}^{ratings}, 0\}$), and even more so for MBS (positive coefficient on its interaction with MBS_s). This effect stays in place for all non-MBS fixed-income securities, as there is no post-reform reduction in insurers' propensity to sell them: the coefficient on $\max\{\Delta RBC_{sit-1}^{ratings}, 0\} \times Post_t$ is insignificant (and not always negative).

In contrast, this effect is reduced significantly after the reform for MBS: the coefficient on $\max\{\Delta RBC_{sit-1}^{ratings}, 0\} \times MBS_s \times Post_t$ is negative and significant at the 1% level throughout (except for P&C insurers). This remains to hold true after including security-insurer fixed effects in column 7. In the last two columns, we split the sample by business line, and we continue to find that our effect holds first and foremost for life insurers (column 8).

To account for the possibility that some of our identified sales may not be substantial portions of insurers' existing positions, we re-run all specifications, and use as an alternative dependent variable an indicator for whether an insurer sold more than 50% of a given asset. The results are in Table Appendix F.2, and are even stronger (in relative terms) than in Table 6. In fact, insurers' selling propensity is now entirely undone after the reform for MBS, as the sum of all four coefficients is not significantly different from zero ($p = 0.18$ and $p = 0.19$ in columns 6 and 7, respectively).

There are multiple potential reasons for why life insurers respond differently from P&C insurers. As already seen in Table 3, life insurers are much larger, allowing them to be more sophisticated in their portfolio decisions. They also have higher leverage, a larger deficit in risk-based capital and, thus, face a higher shadow cost of capital (Koijen and Yogo, 2015). In addition, their capital requirements tend to be driven by their asset portfolio, whereas those of P&C insurers are governed by underwriting risks. Finally, existing research has highlighted the difference in their accounting treatment (Ellul et al., 2015). Typically, life insurers are considered as exclusively using historical cost accounting (in contrast to P&C insurers).[25] However, due to the extreme credit deterioration for MBS, this conventional wisdom does not apply. The vast majority of MBS is marked to market even for life insurers (see Appendix C for details), so that there is no significant difference between life and P&C insurers in the accounting treatment for MBS, both before the reform (since virtually all assets are held at par) and after the reform (since most assets are marked to market).

Our results indicate that the reform enables insurers to hold on to downgraded MBS. We next provide evidence that insurers' lower propensity to sell downgraded MBS is due to the reform reducing the regulatory-capital cost, rather than a general reduction in the elasticity of insurers' desired portfolios with respect to capital requirements. To identify the short-run response to capital requirements, we exploit that the difference between ELOSS and the book discount maps discontinuously into capital requirements.

In particular, we make use of a regression discontinuity design around the five NAIC threshold values for the determination of capital requirements (see Table 1). For this purpose, we limit our security-insurer-year dataset to all RMBS held anytime from year-end 2009 to year-end 2014 and CMBS held anytime from year-end 2010 to year-end 2014.

Cutoffs, which vary for life and P&C insurers, are based on $\frac{BP_{sit}-IP_{st}}{BP_{sit}}$ (see Table 1). As the highest cutoff is at 0.265, and to remove outliers that are too far away from the highest and the lowest cutoffs, we limit the sample from $t = 2010$ (for RMBS) and $t = 2011$ (for

[25] This is because life insurers only need to mark assets in the (virtually nonexistent) NAIC-6 category to market, whereas P&C insurers need to mark anything below NAIC-2 to market.

CMBS) to 2015 to securities for which $-0.5 \leq \frac{BP_{sit-1}-IP_{st-1}}{BP_{sit-1}} \leq 0.5$, thereby removing a relatively small number of 13,946 out of 114,035 security-year observations. In addition, we drop all securities with zero expected loss, as these securities are automatically assigned the lowest capital requirement (NAIC-1) and, hence, the discontinuity does not apply. This restriction affects half of the remaining security-year observations (47,912 out of 100,089 security-year observations), contributing to the capital relief documented in Figure 6.

To estimate the effect of capital requirements on insurers' selling of MBS, we run the following regression at the MBS-insurer-year-level sit, and use the same dependent variable as before (see Table 6):

$$Sold_{sit} = \sum_{k=1}^{5} \beta_k Threshold\ to\ NAIC\text{-}k{+}1_{sit-1} + \gamma \frac{BP_{sit-1} - IP_{st-1}}{BP_{sit-1}} + \eta_{it} + \epsilon_{sit}, \qquad (5)$$

where $Threshold\ to\ NAIC\text{-}X_{sit-1}$ equals 1 whenever $\frac{BP_{sit-1}-IP_{st-1}}{BP_{sit-1}}$ is equal to or exceeds the cutoff for the category NAIC-X (where X ranges from 2 to 6). BP_{sit-1} and IP_{st-1} are short-hand notations for book price ($= \frac{BV_{sit-1}}{PV_{sit-1}}$) and intrinsic price (based on $ELOSS$). η_{it} denotes insurer-year fixed effects. We double-cluster standard errors at the security and insurer levels, as the identifying variation is jointly determined at the security (due to $ELOSS$) and insurer levels (different book values across insurers).

In Table 7, we show the results from estimating (5) separately for life and P&C insurers in columns 1 to 5 and 6 to 10, respectively. Life insurers respond to various thresholds, and the respective increases in capital requirements, with different intensities. For example, based on our estimates in column 1, life insurers are more likely to sell any fraction of their legacy MBS by 3.4, 5.7, and 7.8 percentage points when the associated capital requirements increase from NAIC-2 to NAIC-3, from NAIC-3 to NAIC-4, and from NAIC-5 to NAIC-6, respectively. For these thresholds, the percentage-point increases in selling probabilities are proportional to the corresponding capital-requirement increases (see Table 1). That is, insurance companies respond more when the percentage-point increase in capital requirements is larger.

After we add quadratic and cubic splines in column 2, the first threshold is also associated with an increase in insurers' selling propensity (albeit a modest one, by one percentage point). All of these estimates remain robust when we replace insurer and year fixed effects by insurer-year fixed effects in column 3, thereby estimating the effect using insurers that hold multiple mortgage-backed securities in a given year. In addition, life insurers are now 2.8 percentage points more likely to sell any fraction of their legacy MBS when the associated capital requirements increase from NAIC-4 to NAIC-5.

In column 4, we include security fixed effects. As book prices tend to be highly persistent, and expected-loss assessments are time-invariant for 41% of the mortgage-backed securities in the regression sample, this forces the effects to be identified off variation across different cutoffs for different insurers holding the same security. This requirement is rather restrictive, and severely limits the number of securities being used for our estimation. Still, two coefficients remain statistically significant: life insurers' propensity to sell MBS increases by 1.6 and 3.2 percentage points when the associated capital requirements increase from NAIC-2 to NAIC-3 and from NAIC-5 to NAIC-6, respectively.

Finally, in column 5, we re-estimate the specification from column 3, but additionally control for the difference between the book price and the market price. In line with insurers' gains trading, the coefficient on the latter is negative and significant, while all other coefficients remain robust.

In contrast, the sensitivity of P&C insurers' selling behavior to capital requirements is much weaker and most of the time insignificant. Across all specifications from column 6 to 10, their sensitivity appears to be concentrated on the NAIC-5 cutoff the crossing of which is associated with an economically significant increase in P&C insurers' selling probability of up to 7.6 percentage points.

As the implementation of capital requirements following the regulatory reform is an RD setting with cumulative multiple cutoffs, we can further refine our cutoff-specific regression discontinuity treatment effects by employing local polynomial estimation and robust bias-corrected inference procedures (Cattaneo et al., 2016, 2020). While in Table 7, each observation above the NAIC-2 cutoff and below the NAIC-6 cutoff is used to estimate two different treatment effects, we can now choose the bandwidth to be non-overlapping, which ensures that observations are used only once. For this purpose, we trim the sample a bit more, such that $0 \leq \frac{BP_{sit-1} - IP_{st-1}}{BP_{sit-1}} \leq 0.3$, so as to yield a balanced number of observations on both sides of each cutoff.

The regression discontinuity plots are presented in Figure 7, separately for life (top panel) and P&C insurers (bottom panel). To match our baseline specification in Table 7 (columns 3 and 5 for life, and columns 8 and 10 for P&C), we use as dependent variable the residual from the regression of $Sold_{sit}$ on insurer-year fixed effects, estimated on the same samples as in Table 7. As can be seen by comparing the averages on both sides of each cutoff (indicated as straight lines, i.e., 0^{th} order polynomials), we find positive treatment effects on life insurers' propensity to sell MBS when capital requirements increase from NAIC-1 to NAIC-2, from NAIC-2 to NAIC-3, from NAIC-3 to NAIC-4, and from NAIC-5 to NAIC-6. This matches our regression results for life insurers in the first five columns of Table 7. Similarly, for P&C insurers, only crossing the NAIC-5 threshold is associated with an increase in P&C insurers' selling probability (see last five columns of Table 7).

In summary, we have presented evidence that capital requirements do matter in a causal way for insurance companies' selling of (mortgage-backed) securities. At the same time, this lends support to the idea that insurers' propensity to sell downgraded MBS (see Tables 5 and 6) has indeed decreased due to the regulatory reform.

4.3 Insurance Companies as Investors in New Security Issues

Having shown that the regulatory reform has reduced insurance companies' propensity to sell downgraded MBS, we next consider its effect on primary markets. Insurer behavior in new securities is essential for gauging the long-run impact of the reform since all pre-crisis holdings will eventually mature or default. Furthermore, primary markets for MBS are important because they fund large amounts of assets and investments in the U.S. economy. To investigate whether the reform has enabled insurance companies to actively invest in risky MBS, we use our comprehensive dataset of fixed-income securities issued between 2005 and 2015.

Figure 8 provides a graphical overview of these new (non-federal) issues, the total number of which (conditional on being rated) is just short of 1.6 million. Since MBS issuance is of particular interest to our study, it is useful to highlight that MBS issuance dropped significantly in 2008, recovered in 2012, but is still significantly below pre-crisis levels.

As can be seen in the respective summary statistics (Panel B of Table 2), P&C insurers hold slightly larger shares than do life insurers on average across securities. However, this is due to the fact that P&C insurers participate primarily in smaller issues: the total fraction of all new issues – approximately \$10tn p.a. – in a given year held by life insurers (2.6% on average) is twice as large as that held by P&C insurers (1.3% on average).

If the only goal of regulation had been to limit fire sales by insurers in the midst of the financial crisis, the capital relief could have applied only temporarily and/or only for securities held by insurers at the time of the reform. However, it applies permanently for MBS and, thus, also extends to newly issued MBS after the crisis, which allows us to examine the effect of the reform on insurers' participation in newly issued fixed-income securities.

For each new issue, we determine the fraction purchased by all insurance companies (vs. all other non-insurance investors combined). We use the sum of insurers' year-end holdings (book values) from our NAIC data for a given security in its issue year as a proxy (for insurers' purchases of a newly issued security), and divide it by the security's issue volume.[26] We hypothesize that insurance companies are more likely to invest in newly issued MBS after the regulatory reform, and especially so for low-rated securities that would have been associated with higher capital requirements in the absence of the regulatory reform.[27] To test this, we estimate the following regression specification at the security level:

$$\begin{aligned}Fraction\ insurers_{st} = {} & \beta_1 MBS_s \times HY_s \times Post_t + \beta_2 MBS_s \times HY_s + \beta_3 HY_s \times Post_t \\ & + \beta_4 HY_s + \psi_{kt} + \epsilon_{st}, \end{aligned} \tag{6}$$

where $Fraction\ insurers_{st}$ is the fraction, between 0 and 1, of newly issued security s (belonging to asset category k) in year t held by insurance companies, MBS_s is an indicator variable for whether security s is a mortgage-backed security, HY_s is an indicator variable for whether security s is a (high-yield) security rated BB+ or worse, $Post_t$ is an indicator variable for the year 2010 and onwards, and ψ_{kt} denotes asset class by year fixed effects. Standard errors are clustered at the security level. In additional specifications, we also control for interactions of HY_s and year fixed effects, as well as interactions of HY_s and asset-class fixed effects.

In column 1 of Table 8, we estimate a simple difference-in-differences specification, including only asset-class and year fixed effects. We use as dependent variable the fraction, between 0 and 1, of new issues held by insurance companies. The estimated coefficient on $MBS_s \times Post_t$ reflects that following the reform, the fraction of MBS purchased by insurers increases by 4.2 percentage points.

In column 2 (and hereon out), we drop all securities with an issuance volume of less than \$5m (e.g., very small municipal bonds), leaving us with the top quarter of the volume distribution across all security categories. After doing so, our estimate of the increase in the fraction of MBS purchased by insurers after the reform drops somewhat to 2.4 percentage points, and remains significant at the 1% level.

While these findings are in line with our conjecture, as the regulatory reform affects solely (non-agency) MBS, we would expect even stronger effects for high-yield MBS, which we define as MBS rated BB+ or worse. To test this, we estimate (6) in column 3. In doing so, we can include asset-class-year fixed effects, which capture any differential trajectory across fixed-income asset classes, as we exploit variation in high-yield vs. non-high-yield

[26] Our data only allow us to back out the aggregate investment of all non-insurance investors for each issue, as given by the difference between the issue volume and the total investment by the U.S. insurance industry. This precludes us from including time-varying fixed effects for each investor in a security.

[27] Note that even MBS issues that are highly rated at the time of the issue benefit from the reform in a dynamic sense as (potential) future downgrades will not lead to increases in capital requirements.

securities within the asset class of all MBS.

In comparison to other MBS, the fraction of high-yield MBS purchased by insurers is 4.6 percentage points higher after the regulatory reform. This estimate is not only larger than that in column 2 but also economically significant in absolute terms, as the sample mean is 4.7%, with a standard deviation of 17.9%. This confirms our hypothesis also for the purchasing, rather than selling, behavior of insurance companies.

In column 4, we add interactions of the high-yield indicator with asset-class and year fixed effects, and our estimate is virtually unchanged. When we drop all securities with an issuance volume of less than $20m in column 5, the estimate increases somewhat compared to that in column 4. Excluding municipal bonds, this sample corresponds to the top 60% of all issues according to their issuance volume.

In the last two columns, we calculate the dependent variable separately for life and P&C insurers, so that the two respective estimates add up to our estimate from column 5. The coefficient for the fraction invested by life insurers in new issues (column 6) is even larger, whereas the coefficient on $MBS_s \times HY_s \times Post_t$ is negative for P&C insurers.

These findings hold up to replacing the dependent variable by an indicator for whether insurance companies hold any non-zero fraction of new issues in Table Appendix F.3. Notably, most coefficients are relatively similar to those in Table 8. This indicates that when insurers invest in a newly issued high-yield MBS, they do so by purchasing a relatively high fraction of the new issue. Indeed, the average fraction of new issues held by insurance companies conditional on their non-zero participation is 42.2% in our sample.

Having estimated insurance companies' participation in newly issued securities relative to that of other investors, we conclude our analysis by zooming in on the relative importance of insurer-level covariates for the type of risk-taking behavior we just documented. For this purpose, we build an insurer-year panel for the post-reform period from 2010 to 2015, and use as dependent variable the fraction of newly issued (non-agency) MBS to all new issues purchased by a given insurer i in year t. That is, we estimate the correlation of different insurer-level characteristics – some of which are time-invariant, which precludes us from including insurer fixed effects – with the share of new MBS issues in the total portfolio of new issues that insurers invest in.

In columns 1 and 2 of Table 9, life and large insurers are particularly prone to allocate more funds to new MBS issues among their total investment in new issues in general. Controlling for business line, the organizational form – i.e., whether insurance companies are held by their shareholders or policyholders – is not correlated with the propensity to hold MBS. This continues to hold true even after controlling for the historical fraction of MBS over total assets in $2005 - 2008$, as a proxy for losses incurred during the financial crisis. Even though the average value for the dependent variable is small, it is still notable that the life business model and total admitted assets go a long way in explaining the respective variation. These two variables also exhibit the strongest correlation with the fraction of new high-yield MBS issues in the portfolio of new MBS issues that insurers invest in (columns 3 and 4). This holds true even after controlling for the fraction of MBS out of all new issues (column 5).

Interestingly, we have shown these two characteristics to differ drastically for insurers that benefited from the reform vs. those that did not in Table 4. This suggests that there may be substantial overlap in the set of insurers that profited the most from the reform and those that continue to invest in MBS.

5 Concluding Remarks

The U.S. insurance industry provides a unique setting for analyzing the effects of capital requirements for an important institutional investor with over $3.6tn in total assets. We uncover that a capital-requirement reform aimed at "replacing flawed credit ratings" for mortgage-backed securities goes far beyond its stated purpose by essentially removing capital requirements for this asset class altogether.

One interpretation is that the reform reflects industry interests rather than the long-term goal of financial stability. Alternatively, the rules could reflect the short-term desire to avoid defaults and fire sales, which can be considered an improvised macroprudential regulation. However, these potential benefits need to be balanced against the associated long-run costs. In this paper, we have characterized risk taking by insurance companies in the market for MBS as a potential building block of such long-run costs. Interestingly, while both life and P&C insurers are subject to the same reduction in capital requirements, our evidence suggests that only life insurers exploit this reform by engaging in greater risk taking. This difference in the response is consistent with the view that the trade-off between short-term risk-taking benefits and long-run charter value is different between these two most important insurer types.

Our results can help inform policy regarding the effects of changing inputs to regulatory-capital requirements. As such, they attest to the importance of regulatory-capital constraints for institutional asset demand (see Koijen and Yogo, 2019).

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6 Figures

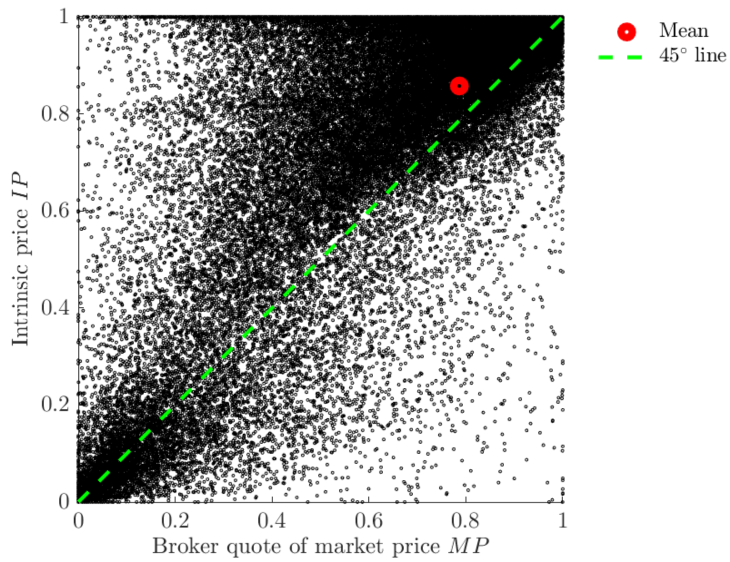


Figure 2. Intrinsic Price vs. Market Price. This graph plots IP (i.e., $1-ELOSS$) against MP. We plot intrinsic prices for all modeled MBS tranches from 2009-2015 against brokerage quotes of year-end market prices. The respective brokerage quotes are obtained from NAIC Schedule D Part 1 by computing the ratio of "fair value" and "par value."

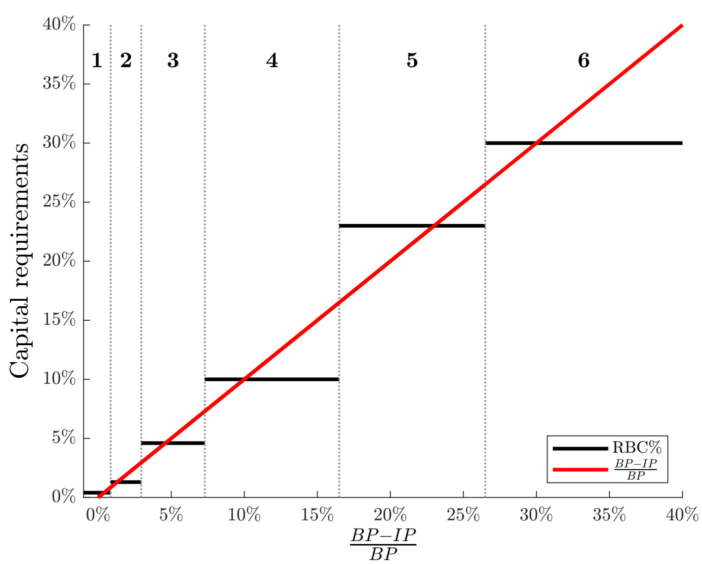


Figure 3. Discontinuous Implementation of MBS RBC Charges. This graph plots the RBC% for life insurers as a function of $\frac{BP_{si}-IP_s}{BP_{si}}$. The dotted lines refer to the cutoffs for the respective NAIC 1-6 risk classification (as determined by column 5 in Table 1). The red line visualizes the approximation implied by (3).

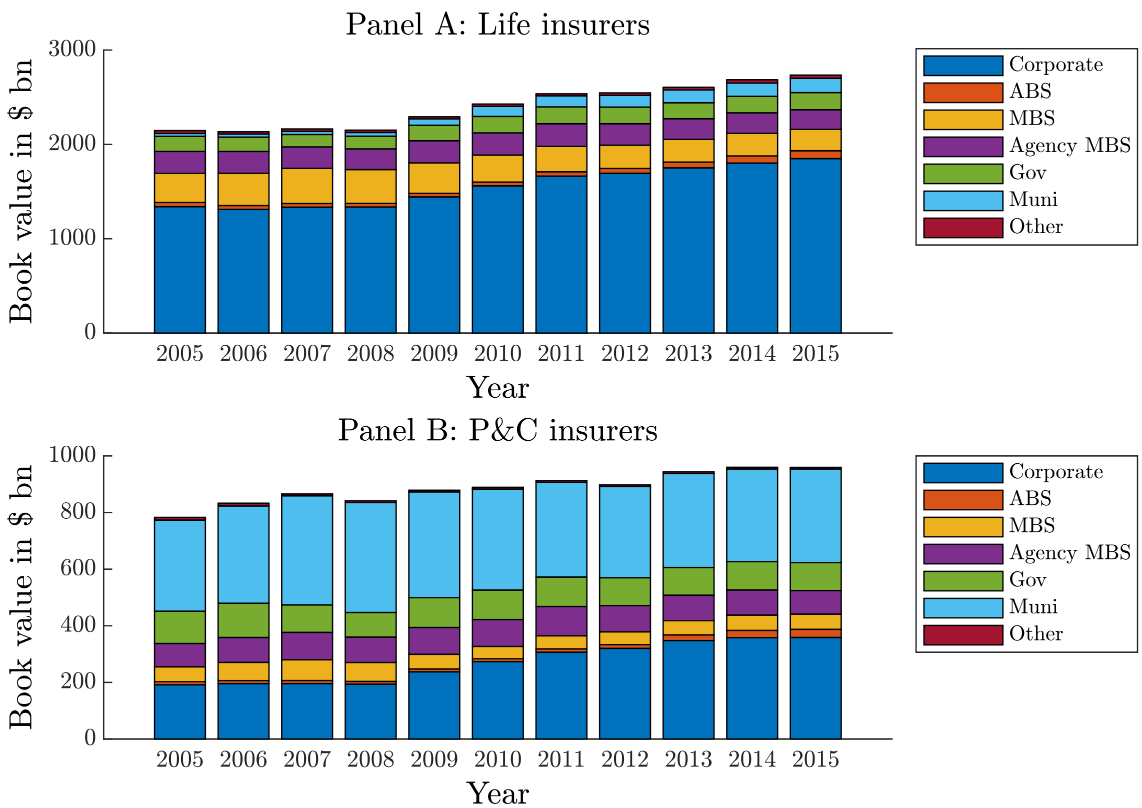


Figure 4. Fixed-income Asset Allocation by Insurance Companies. The graphs plot the evolution of book-adjusted carrying values across fixed-income categories from 2005 to 2015 for life insurers (Panel A) and P&C insurers (Panel B).

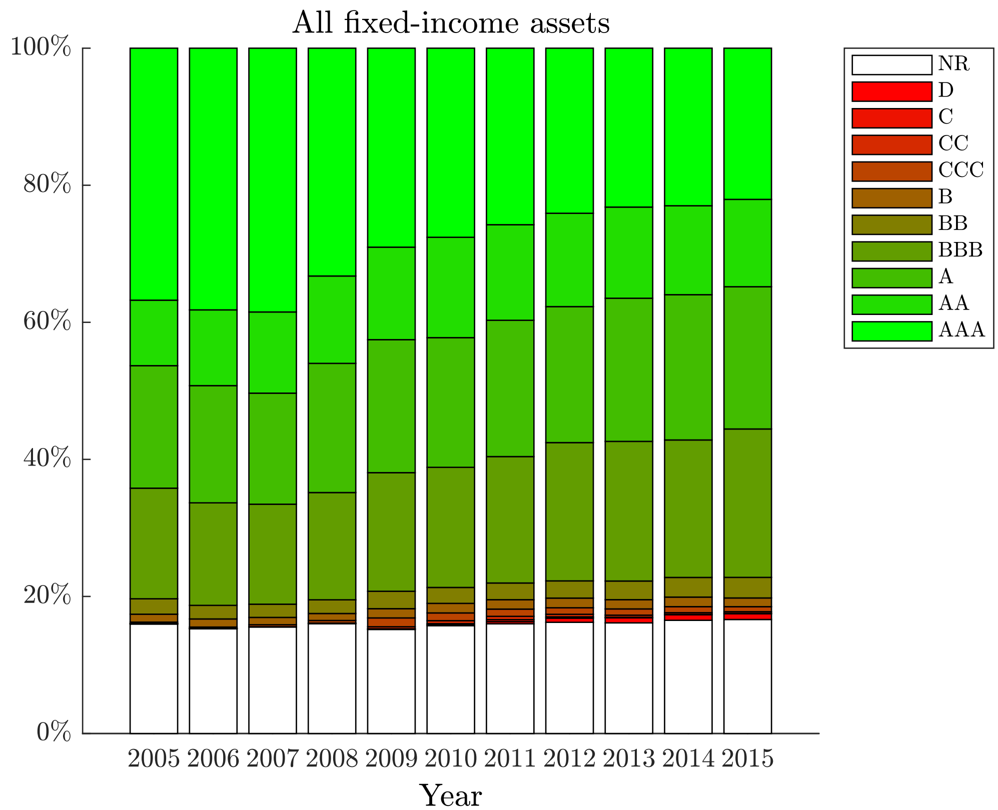


Figure 5. Ratings Distribution of all Fixed-income Assets Over Time. For each year-end from 2005 to 2015, this graph plots the ratings distribution (weighted by the combined book value of life and P&C insurers). The category "NR" refers to securities for which we do not observe a rating, either because no rating exists or because those securities are not covered by any of our databases.

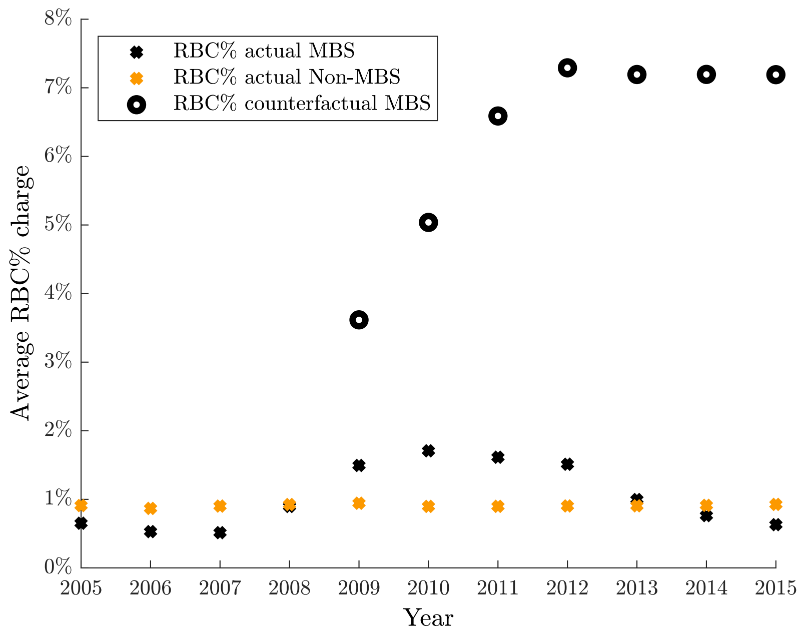
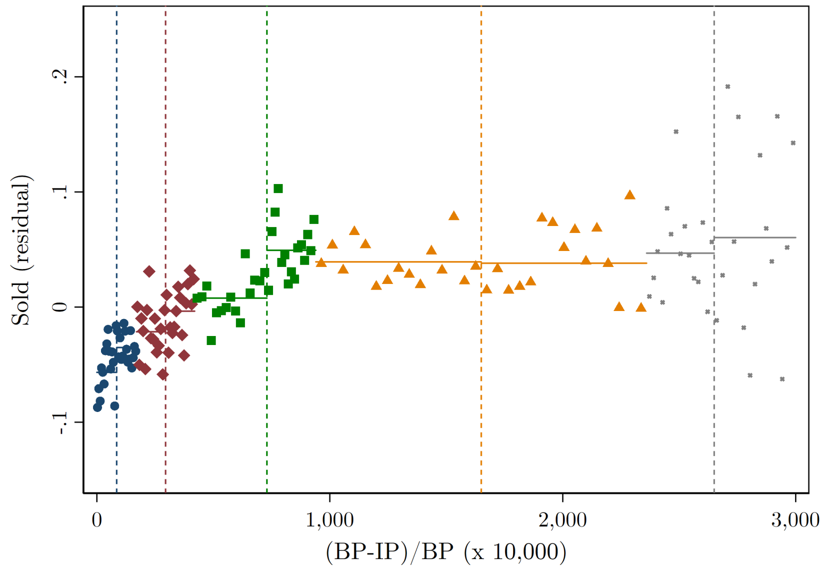
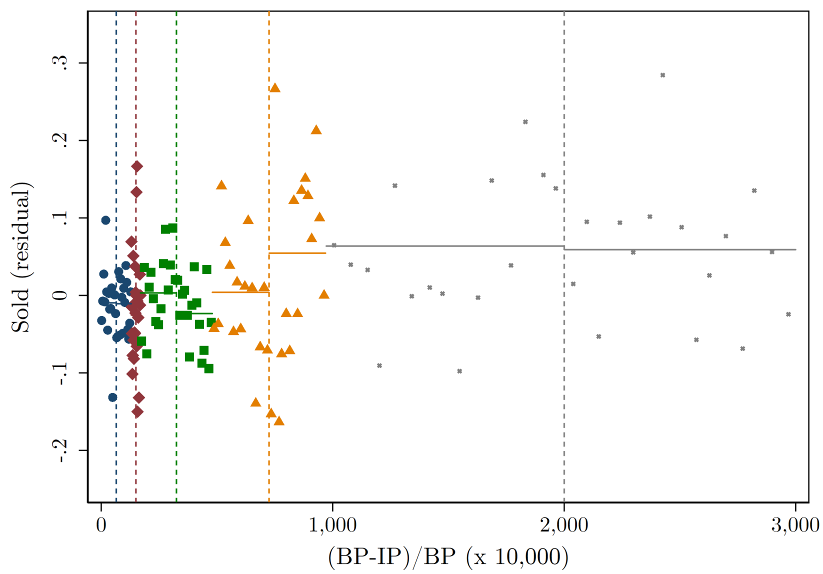


Figure 6. Regulatory Capital Charge for MBS and Non-MBS Held by Insurance Companies. The graph plots the time series of actual year-end capital requirements (as a fraction of book values) for insurers' non-MBS holdings, MBS holdings, and starting year-end 2009 the counterfactual capital requirements (as a fraction of book values) for MBS holdings based on the previous (ratings-based) system. The sample of securities included in this graph requires the availability of at least one rating in the respective year.



(a) Life insurers



(b) P&C insurers

Figure 7. RD Estimates Using Five Cutoffs for Life and P&C Insurers. The graphs present cutoff-specific regression discontinuity treatment effects based on local polynomial methods (Cattaneo et al., 2016, 2020). The dependent variable is the residual from the regression of $Sold_{sit}$, which is an indicator variable for whether insurer i sold a non-zero fraction of security s in year t, on insurer-year fixed effects on the sample at the RMBS-insurer-year level sit from 2010 to 2015 (CMBS-insurer-year level from 2011 to 2015), i.e., non-maturing RMBS (CMBS) s held by insurer i (individual company level) in year $t-1$ and traded in year t after the regulatory reform. The sample is furthermore limited to MBS with non-zero expected loss. The estimates are plotted using 15 bins below and above each one of the five cutoffs (see Table 1) separately for life (top panel) and P&C insurers (bottom panel). The running variable is $\frac{BP_{sit-1}-IP_{st-1}}{BP_{sit-1}} \in [0, 0.3]$.

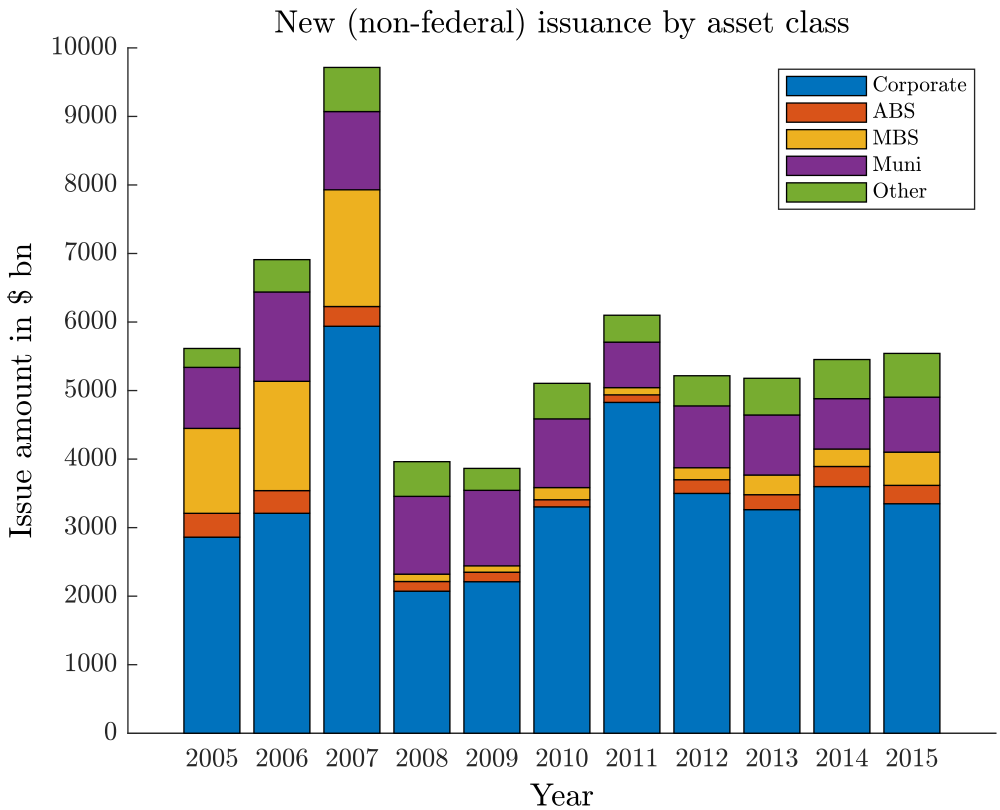


Figure 8. New Issuance of Fixed-income Securities Over Time. The graphs plot the evolution of total new issues by asset class from 2005 to 2015, for all non-federal issues.

7 Tables

Table 1. NAIC Risk Classification and Capital Requirements

NAIC	RBC%		Rating Threshold	Threshold for $(BP-IP)/BP$	
	Life	P&C		Life	P&C
1	0.4%	0.3%	A	0.85%	0.65%
2	1.3%	1%	BBB	2.95%	1.5%
3	4.6%	2%	BB	7.3%	3.25%
4	10%	4.5%	B	16.5%	7.25%
5	23%	10%	CCC	26.5%	20%
6	30%	30%	D		

This table shows risk-based charges (RBC%) for fixed-income securities as a function of the NAIC risk category $(1-6)$ for life and P&C insurers (columns 2 and 3). Column 4 illustrates the minimum rating that guarantees the respective risk category in column 1. Column 4 is applicable for all non-MBS fixed-income securities, for non-agency RMBS until 2009, and for CMBS until 2010. The cutoffs in the new MBS system based on $\frac{BP_{si}-IP_s}{BP_{si}}$ are listed in columns 5 and 6 for life and P&C insurers, respectively.

Table 2. Summary Statistics

Panel A: Security-insurer-year level (2006 – 2015)	Mean	Std. dev.	Min	Max	N
Sold any fraction	0.128	0.334	0	1	5,806,490
Sold > 50% of position	0.099	0.298	0	1	5,806,490
MBS	0.083	0.276	0.000	1	5,806,490
$\max\left\{\Delta RBC^{ratings}_{sit-1}, 0\right\}$	0.001	0.014	0	0.297	5,806,490
$\max\left\{\Delta RBC^{ratings}_{sit-1}, 0\right\}$ if MBS = 1	0.009	0.038	0	0.297	482,888
Life insurer	0.620	0.485	0	1	5,806,490

Panel B: New security issues (security level, 2005 – 2015)	Mean	Std. dev.	Min	Max	N
Issue volume in 2015 $m	63.627	2,758.296	0.000	2,199,949	1,552,612
Fraction by insurers	0.047	0.179	0.000	1	1,552,612
Fraction by life insurers	0.014	0.093	0.000	1	1,552,612
Participation by insurers	0.112	0.315	0	1	1,552,612
Participation by life insurers	0.045	0.208	0	1	1,552,612
MBS	0.047	0.212	0	1	1,552,612
High yield (HY)	0.019	0.138	0	1	1,552,612
HY if MBS = 1	0.121	0.326	0	1	73,416

The summary statistics in Panel A refer to flow variables from the run-time of year 2006 until the run-time of year 2015, and correspond to the respective descriptions in Table 6. The variables in Panel B correspond to the respective descriptions in Table 8.

Table 3. Comparison of Life and P&C Insurance Companies

Life insurers	Min	p25	p50	p75	Max	Mean	Std. dev.	N
Stock $\in \{0, 1\}$	0	1	1	1	1	0.901	0.300	372
Mutual $\in \{0, 1\}$	0	0	0	0	1	0.097	0.296	372
Assets in $bn	0.101	0.421	1.548	10.627	390.843	16.857	45.294	372
MBS/Assets	0.000	0.012	0.052	0.104	0.418	0.067	0.065	372
ROE	-0.443	0.028	0.070	0.138	0.584	0.080	0.129	364
Leverage ratio	0.010	0.793	0.896	0.935	0.996	0.823	0.183	372
RBC ratio	0.594	7.101	9.411	12.709	183.590	11.574	12.407	370
A.M. Best Financial Strength Rating	C+	A-	A	A+	A++	A	1.5 notches	343
A.M. Best Capital Adequacy Ratio	58	175	219	289	999	255.742	134.207	345

P&C insurers	Min	p25	p50	p75	Max	Mean	Std. dev.	N
Stock $\in \{0, 1\}$	0	1	1	1	1	0.779	0.415	995
Mutual $\in \{0, 1\}$	0	0	0	0	1	0.167	0.373	995
Assets in $bn	0.100	0.193	0.367	1.073	161.777	1.889	7.994	995
MBS/Assets	0.000	0.000	0.016	0.063	0.440	0.040	0.056	995
ROE	-0.387	0.024	0.061	0.109	0.534	0.067	0.082	990
Leverage ratio	0.000	0.478	0.590	0.684	0.986	0.561	0.174	995
RBC ratio	0.582	5.816	8.992	14.523	500.466	23.689	53.503	971
A.M. Best Financial Strength Rating	C-	A	A	A+	A++	A	1.2 notches	906
A.M. Best Capital Adequacy Ratio	45	200.1	252.3	321.7	999.9	279.908	128.610	907

Summary statistics are shown for all insurers (individual company level), with total assets in excess of $100m and a leverage ratio (defined as one minus the ratio of equity to total admitted assets) of at most 1, that are active in 2015, separately for life (top panel) and P&C insurers (bottom panel). A.M. Best Financial Strength Ratings comprise (at most) 15 notches.

Table 4. Comparison of Insurance Companies Based on Reform Impact

Insurers that benefited from the reform	Min	p25	p50	p75	Max	Mean	Std. dev.	N	p-value test of group mean equality
Life $\in \{0,1\}$	0	0	0	1	1	0.400	0.490	560	0.000
Stock $\in \{0,1\}$	0	1	1	1	1	0.818	0.386	560	0.762
Mutual $\in \{0,1\}$	0	0	0	0	1	0.148	0.356	560	0.933
Assets in \$bn	0.101	0.305	1.077	4.480	316.204	9.984	31.129	560	0.000
ROE	-0.451	0.036	0.077	0.134	0.557	0.082	0.110	555	0.008
Leverage ratio	0.001	0.582	0.689	0.890	0.983	0.703	0.191	560	0.000
RBC ratio	0.688	5.954	8.396	11.412	422.337	12.056	24.723	556	0.001
A.M. Best Financial Strength Rating	C-	A-	A	A+	A++	A	1.302	526	0.897
A.M. Best Capital Adequacy Ratio	66	168.7	207.6	262	999.9	230.560	102.885	527	0.000

Insurers that did not benefit from the reform	Min	p25	p50	p75	Max	Mean	Std. dev.	N
Life $\in \{0,1\}$	0	0	0	0	1	0.178	0.383	667
Stock $\in \{0,1\}$	0	1	1	1	1	0.811	0.392	667
Mutual $\in \{0,1\}$	0	0	0	0	1	0.150	0.357	667
Assets in \$bn	0.100	0.178	0.338	0.869	135.726	1.748	8.234	667
ROE	-0.473	0.019	0.061	0.114	0.583	0.065	0.111	661
Leverage ratio	0.000	0.490	0.619	0.727	0.992	0.601	0.197	667
RBC ratio	-0.139	6.221	8.858	13.713	412.932	17.992	36.990	654
A.M. Best Financial Strength Rating	C	A-	A	A+	A++	A	1.330	614
A.M. Best Capital Adequacy Ratio	35	188.2	243.15	302.8	999.9	266.693	130.726	610

Summary statistics are shown for all insurers (individual company level), with total assets in excess of \$100m and a leverage ratio (defined as one minus the ratio of equity to total admitted assets) of at most 1, that are active in 2010, separately for those that saved > 0 in terms of risk-based capital thanks to the reform (top panel) and those that saved ≤ 0 (bottom panel). The last column indicates the p-value of a one-sided difference-in-means test. A.M. Best Financial Strength Ratings comprise (at most) 15 notches.

Table 5. Effect of Regulatory Reform on Insurers' Total Fixed-income Holdings

	Δln(Par)	Δln(Par)	Δln(Par)	$\min\{\Delta\ln(\text{Par}), 0\}$	$\max\{\Delta\ln(\text{Par}), 0\}$	Δln(Par of Life)	Δln(Par of P&C)
Sample	MBS	non-MBS	All	All	All	All	All
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Downgrade × MBS × Post			0.031***	0.036***	-0.005	0.114***	-0.046
			(0.008)	(0.007)	(0.003)	(0.022)	(0.029)
Downgrade × Post	0.018**	-0.019***	-0.013***	-0.020***	0.007***	-0.007	-0.031***
	(0.007)	(0.003)	(0.003)	(0.003)	(0.001)	(0.010)	(0.010)
Downgrade × MBS			0.011	0.018***	-0.007***	-0.036**	0.037*
			(0.007)	(0.006)	(0.003)	(0.018)	(0.022)
Downgrade	-0.002	0.092***	-0.013***	-0.013***	0.000	-0.042***	-0.053***
	(0.006)	(0.002)	(0.002)	(0.002)	(0.001)	(0.007)	(0.007)
Year FE	Y	Y	N	N	N	N	N
Asset-class-year FE	N	N	Y	Y	Y	Y	Y
N	193,780	1,955,974	2,149,754	2,149,754	2,149,754	2,149,746	2,149,752

The sample is a panel at the security-year level st from 2006 to 2015, i.e., non-maturing security s held by any insurers in year t. The dependent variable in the first three columns is the first difference in the natural logarithm of the total par value of security s held by any insurers in year t (in comparison to $t-1$). The dependent variable in the fourth (fifth) column is the minimum (maximum) of zero and the first difference in the natural logarithm of the total par value of security s held by any insurers in year t (in comparison to $t-1$). The dependent variable in the sixth (seventh) column is the first difference in the natural logarithm of the total par value of security s held by life (P&C) insurers in year t (in comparison to $t-1$). $Downgrade_{st-1}$ is an indicator variable for whether security s is downgraded (at all) in year-end $t-1$. MBS_s is an indicator variable for whether security s is a mortgage-backed security, and $Post_t$ is an indicator variable for the year 2010 and onwards. All singletons are dropped from the total number of observations N. Robust standard errors (clustered at the security level) are in parentheses.

Table 6. Effect of Regulatory Reform on Insurers' Selling Legacy Securities

	Sold any fraction of security $\in \{0,1\}$								
Securities	MBS	MBS	MBS	MBS	MBS	All	All	All	All
Insurers	All	All	All	Life	P&C	All	All	Life	P&C
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\max\{\Delta\text{RBC}^{\text{ratings}}, 0\} \times \text{MBS} \times \text{Post}$						-0.748***	-0.624***	-0.674***	0.238
						(0.139)	(0.140)	(0.152)	(0.355)
$\max\{\Delta\text{RBC}^{\text{ratings}}, 0\} \times \text{Post}$	-0.540***	-0.658***	-0.644***	-0.732***	-0.282	0.034	-0.058	-0.098	-0.339
	(0.053)	(0.091)	(0.091)	(0.096)	(0.287)	(0.103)	(0.106)	(0.115)	(0.240)
$\max\{\Delta\text{RBC}^{\text{ratings}}, 0\} \times \text{MBS}$						0.567***	0.266**	0.290**	-0.350
						(0.123)	(0.125)	(0.135)	(0.321)
$\max\{\Delta\text{RBC}^{\text{ratings}}, 0\}$	0.789***	0.672***	0.701***	0.853***	0.315	0.141*	0.474***	0.610***	0.470**
	(0.051)	(0.087)	(0.087)	(0.093)	(0.277)	(0.085)	(0.087)	(0.096)	(0.198)
Security FE	N	Y	N	N	N	Y	N	N	N
Security-insurer FE	N	N	Y	Y	Y	N	Y	Y	Y
Year FE	Y	N	N	N	N	N	N	N	N
Rating-asset-class-year FE	N	Y	Y	Y	Y	Y	Y	Y	Y
ΔRating-asset-class-year FE	N	Y	Y	Y	Y	Y	Y	Y	Y
Insurer-year FE	N	Y	Y	Y	Y	Y	Y	Y	Y
N	482,888	477,510	454,125	351,030	103,052	5,677,802	5,264,392	3,333,116	1,931,013

The sample is a panel at the security-insurer-year level sit from 2006 to 2015, i.e., non-maturing security s held by insurer i (group level) in year $t-1$ and traded in year t. In the first five columns, we consider only (non-agency) mortgage-backed securities. In the fourth and eighth column, the sample is limited to insurance groups with the majority of their assets held by life insurers. In the fifth and ninth column, the sample is limited to insurance groups with the majority of their assets held by P&C insurers. The dependent variable is an indicator variable for whether insurer i sold a non-zero fraction of security s in year t. $\max\{\Delta RBC^{ratings}_{sit-1}, 0\}$ is the absolute increase in risk-based charges (RBC, from 0 to 0.297) of security s as a function of the NAIC risk category according to credit ratings (also after the regulatory reform) for life and P&C insurers i in year-end $t-1$ (compared to the previous year). MBS_s is an indicator variable for whether security s is a mortgage-backed security, and $Post_t$ is an indicator variable for the year 2010 and onwards. Rating-asset-class-year fixed effects are determined by security s's rating in year $t-1$, and ΔRating-asset-class-year fixed effects are determined by the change in ratings (in notches) between year t and $t-1$. All singletons are dropped from the total number of observations N. Robust standard errors (clustered at the security level) are in parentheses.

Table 7. Effect of Regulatory Reform on Insurers' Selling Legacy Securities – Regression Discontinuity

	Sold any fraction of security $\in \{0,1\}$									
Sample	ELOSS $\neq 0$, $-0.5 \leq \frac{BP_{sit-1}-IP_{st-1}}{BP_{sit-1}} \leq 0.5$									
	Life	Life	Life	Life	Life	P&C	P&C	P&C	P&C	P&C
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Threshold to NAIC-2	0.001	0.010*	0.011**	0.005	0.012**	-0.024*	-0.015	-0.015	-0.004	-0.014
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)
Threshold to NAIC-3	0.034***	0.038***	0.040***	0.016***	0.041***	0.017	0.019	0.015	-0.016	0.011
	(0.009)	(0.011)	(0.012)	(0.006)	(0.012)	(0.018)	(0.018)	(0.015)	(0.015)	(0.015)
Threshold to NAIC-4	0.057***	0.063***	0.063***	0.008	0.063***	0.017	0.021	0.012	-0.012	0.012
	(0.012)	(0.015)	(0.016)	(0.009)	(0.016)	(0.021)	(0.021)	(0.017)	(0.016)	(0.017)
Threshold to NAIC-5	0.015	0.019	0.028**	0.002	0.028**	0.059**	0.072***	0.076***	0.030	0.071***
	(0.011)	(0.013)	(0.012)	(0.009)	(0.012)	(0.026)	(0.026)	(0.025)	(0.022)	(0.024)
Threshold to NAIC-6	0.078***	0.051**	0.050**	0.032*	0.035*	0.066*	0.084**	0.030	0.002	0.026
	(0.021)	(0.022)	(0.020)	(0.019)	(0.020)	(0.036)	(0.035)	(0.030)	(0.039)	(0.030)
Linear spline	-0.208***	-0.340***	-0.343***	-0.102**	-0.316***	-0.080**	-0.231***	-0.155**	0.008	-0.120*
	(0.047)	(0.110)	(0.118)	(0.045)	(0.118)	(0.035)	(0.075)	(0.064)	(0.077)	(0.065)
$BP_{sit-1} - MP_{st-1}$					-0.061***					-0.084**
					(0.018)					(0.039)
Quadratic and cubic splines	N	Y	Y	Y	Y	N	Y	Y	Y	Y
Insurer FE	Y	Y	N	N	N	Y	Y	N	N	N
Year FE	Y	Y	N	N	N	Y	Y	N	N	N
Insurer-year FE	N	N	Y	Y	Y	N	N	Y	Y	Y
Security FE	N	N	N	Y	N	N	N	N	Y	N
N	83,010	83,010	82,756	80,113	82,756	23,222	23,222	22,451	21,202	22,451

The sample is a panel at the RMBS-insurer-year level sit from 2010 to 2015 (CMBS-insurer-year level from 2011 to 2015), i.e., non-maturing RMBS (CMBS) s held by insurer i (individual company level) in year $t-1$ and traded in year t after the regulatory reform. The sample is limited to MBS with non-zero expected loss and $-0.5 \leq \frac{BP_{sit-1}-IP_{st-1}}{BP_{sit-1}} \leq 0.5$. Furthermore, the sample is split into life (P&C) insurers in the first five (last five) columns. The dependent variable is an indicator variable for whether insurer i sold a non-zero fraction of MBS s in year t. *Threshold to NAIC-X*$_{sit-1}$ equals 1 whenever $\frac{BP_{sit-1}-IP_{st-1}}{BP_{sit-1}}$ is equal to or exceeds the cutoff for the category NAIC-X (where X ranges from 2 to 6, see Table 1). BP_{sit-1} and IP_{st-1} are short-hand notations for book price $(= \frac{BV_{sit-1}}{PV_{sit-1}})$ and intrinsic price (based on $ELOSS$), and MP_{st-1} refers to the market price. All singletons are dropped from the total number of observations N. Robust standard errors (double-clustered at the security and insurer levels) are in parentheses.

Table 8. Fraction Invested by Insurance Companies in Newly Issued Securities

	Fraction by insurers $\in [0,1]$					Life	P&C
Sample	All	$\geq$ \$5m	$\geq$ \$5m	$\geq$ \$5m	$\geq$ \$20m	$\geq$ \$20m	$\geq$ \$20m
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MBS × Post	0.042***	0.024***					
	(0.003)	(0.003)					
MBS × HY × Post			0.046***	0.045***	0.051***	0.057***	-0.006**
			(0.007)	(0.007)	(0.010)	(0.010)	(0.003)
MBS × HY			-0.044***				
			(0.002)				
HY × Post			-0.060***				
			(0.002)				
High yield (HY)			-0.040***				
			(0.001)				
Asset-class FE	Y	Y	N	N	N	N	N
Year FE	Y	Y	N	N	N	N	N
Asset-class-year FE	N	N	Y	Y	Y	Y	Y
HY-asset-class FE	N	N	N	Y	Y	Y	Y
HY-year FE	N	N	N	Y	Y	Y	Y
N	1,552,612	403,506	403,506	403,506	221,580	221,580	221,580

The sample consists of all new securities i rated and issued at date t anytime from 2005 to 2015. The sample in the second to fourth (fifth to seventh) column is limited to all new issues with a size of at least \$5m (\$20m). The dependent variable in the first five columns is the fraction, between 0 and 1, of newly issued security s held by insurance companies. The dependent variable in the sixth and seventh column is the fraction of newly issued security s held by life and P&C insurance companies, respectively. MBS_s is an indicator variable for whether security s is a mortgage-backed security, HY_s is an indicator variable for whether security s is a (high-yield) security rated BB+ or worse, and $Post_t$ is an indicator variable for the year 2010 and onwards. All singletons are dropped from the total number of observations N. Robust standard errors (clustered at the security level) are in parentheses.

Table 9. Insurers' Portfolios of New Issues Post Reform

	Fraction MBS of new-issue purchases in %		Fraction HY MBS of MBS new-issue purchases in %		
Mean dependent variable	2.963	2.963	0.028	0.028	0.028
Variable	(1)	(2)	(3)	(4)	(5)
Life $\in \{0,1\}$	1.456***	1.075***	0.051***	0.049***	0.042***
	(0.321)	(0.312)	(0.019)	(0.018)	(0.016)
Stock $\in \{0,1\}$	0.325	0.277	-0.002	-0.003	-0.004
	(0.315)	(0.301)	(0.005)	(0.005)	(0.005)
Mutual $\in \{0,1\}$	0.319	0.408	0.003	0.004	0.001
	(0.377)	(0.364)	(0.011)	(0.011)	(0.011)
ln(Assets)	0.593***	0.441***	0.020***	0.019***	0.016***
	(0.069)	(0.071)	(0.006)	(0.005)	(0.004)
ROE	0.422	0.560	-0.036	-0.035	-0.039
	(0.819)	(0.796)	(0.049)	(0.049)	(0.049)
Leverage ratio	-0.213	-0.299	-0.014	-0.015	-0.013
	(0.560)	(0.553)	(0.012)	(0.012)	(0.012)
A.M. Best Financial Strength Rating	-0.158**	-0.151**	0.007	0.007	0.008*
	(0.070)	(0.068)	(0.005)	(0.005)	(0.005)
Share MBS $2005-2008$		12.792***		0.080	0.001
		(1.545)		(0.075)	(0.050)
Fraction MBS of new-issue purchases					0.006**
					(0.003)
Year FE	Y	Y	Y	Y	Y
N	11,947	11,947	11,947	11,947	11,947
R^2	0.061	0.075	0.009	0.009	0.017

The sample is a panel at the insurer-year level it from 2010 to 2015, for all newly issued securities purchased by insurer i (individual company level) in year t. The dependent variable in the first two columns is the fraction of newly issued (non-agency) MBS to all new issues purchased by insurer i in year t, measured in % (from 0 to 100). The dependent variable in the last three columns is the fraction of newly issued (non-agency) MBS with a rating of BB+ or worse to all newly issued (non-agency) MBS purchased by insurer i in year t, measured in % (from 0 to 100). $Life_i$ is an indicator for whether insurer i is a life insurer. $Stock_i$ is an indicator for whether insurer i is owned by its shareholders. $Mutual_i$ is an indicator for whether insurer i is owned by its policyholders. $\ln(Assets_{it-1})$ and ROE_{it-1} denote, respectively, the natural logarithm of total admitted assets and the return on equity ratio of insurer i in year $t-1$ $Leverage\ ratio_{it-1}$ is defined as one minus the ratio of equity to total admitted assets of insurer i in year $t-1$. A.M. Best Financial Strength Ratings are coded from 1 (A++) to 15 (F), and included for each insurer i in year $t-1$. $Share\ MBS\ 2005\text{–}2008_i$ equals the average ratio of (non-agency) MBS to total assets of insurer i in the period $2005-2008$. All singletons are dropped from the total number of observations N. Robust standard errors (clustered at the insurer level) are in parentheses.

Appendix A NAIC Reform Proposal

National Association of Insurance Commissioners

The Center for Insurance Policy and Research

To: **NAIC Executive Committee/NAIC Members**
From: **Commissioner Al Gross (VA), Chair of the E Committee**
Date: **November 3, 2009**
Re: **Residential Mortgage Backed Securities (RMBS) Proposal**

On October 14, 2009, the Valuation of Securities (E) Task Force held a joint conference call with the Financial Condition (E) Committee to consider the RMBS Proposal. This memo summarizes the issues underlying the proposal as well as the details of the proposal.

History of the RMBS Proposal

Presently residential mortgage-backed securities (RMBS) are treated in the same manner as corporate bonds when determining RBC requirements: the credit-quality designation provided by an Acceptable Rating Organization (ARO) or the NAIC's Securities Valuation Office (SVO) is used to establish the appropriate risk-based capital (RBC) charge. Securities with higher credit quality ratings receive lower RBC charges, and vice versa.

Two main issues have prompted the NAIC to consider a new approach for RMBS: (i) concerns with the ratings provided by AROs, and (ii) concerns the current process does not consider the severity or amount of loss that will be experienced by RMBS. Consequently, an alternative method of handling RMBS ratings has been the subject of discussion by the Valuation of Securities Task Force. Specifically, in trying to determine an alternative approach, members of the Valuation of Securities Task Force agreed consideration needs to be given to the amount of expected loss for a particular RMBS when establishing capital charges in RBC.

In addition to the work of the Valuation of Securities Task Force, the NAIC's Rating Agency Working Group held a public hearing at the NAIC 2009 Fall National Meeting during which rating agency representatives indicated state insurance regulators should not rely upon their ratings for regulatory purposes.

Regulators have therefore developed the RMBS Proposal to address the concerns with reliance upon rating agency ratings as well as to address the need to use expected loss amounts for RBC purposes.

The RMBS Proposal

The proposal would be applicable to year-end 2009 reporting and include utilization of a model to establish ranges of prices for each NAIC designation (1 through 6) for each of the approximately 18,000 RMBS. Assuming this proposal is adopted by the NAIC membership, the plan is for the NAIC to contract with an independent third party to assist with the modeling efforts.

An insurer's carrying value for a particular RMBS would be mapped to the price ranges to identify the appropriate NAIC designation for use in RBC.

Approximately 350 of the RMBS would not be subject to modeling. Of these, roughly 300 would be subject to utilization of the existing ARO ratings along with the carrying value to determine the NAIC designation, and the resulting RBC factor more accurately. The remaining approximately 50 RMBS with no ARO ratings would instead follow the existing 'Not Rated' or 'NR' process, requiring subsequent filing with the NAIC's Securities Valuation Office, or be subjected to the '5*/6* process' (referred to as 'five-star/six-star process,' a certification process set forth in the SVO's Purposes and Procedures Manual).

Finally, re-remics (Re-securitization of Real Estate Mortgage Investment Conduits) are to be subject to the modeler analysis.

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Appendix B Capital Requirements for U.S. Insurers

For all insurer types (life, P&C, and health), overall risk-based capital requirements are a function of the risk sources, R_s, that an insurer faces on the asset as well as on the liability (underwriting) side:

$$\text{Risk-based capital requirement } = R_0 + \sqrt{\sum_{i=1}^{5} R_i^2}. \tag{7}$$

For example, for a P&C insurer, R_0 to R_2 represent asset risks (from affiliate companies, fixed income, and equities, respectively), whereas categories R_3 to R_5 account for credit risk, reserving risk, and premium risk (see Table Appendix B.1). The (square-root) formula suggests that this regulation implicitly assumes that the risk sources 1 to 5 have zero correlation.[28]

Table Appendix B.1. Overall Risk Components for Life, P&C, and Health Insurers

	Life	P&C	Health
R_0	- Affiliate investment - Off-balance sheet risk - Business risk I	- Affiliate investment - Off-balance sheet risk	- Affiliate investment - Off-balance sheet risk
R_1	- Invested asset risk - Interest rate risk - Reinsurance risk	- Fixed income asset risk	- Invested asset risk
R_2	- Equity asset risk	- Equity asset risk	- n/a
R_3	- Insurance Risk	- Credit risk - 50% reinsurance risk	- Insurance Risk
R_4	- Health provider credit risk	- Loss reserve risk - 50% reinsurance risk	- Credit risk
R_5	- Business risk II	- Premium risk - Growth risk	- Business risk

The capitalization of an insurer is measured at an annual level by the risk-based capital (RBC) ratio, which relates total adjusted surplus (roughly an insurer's book equity) to the overall risk-based capital requirement given by (7):

$$\text{RBC ratio } = \frac{\text{Total adjusted surplus}}{\text{Risk-based capital requirement}}. \tag{8}$$

The more severe the capital shortage based on the RBC ratio, the stronger is the regulatory intervention. It ranges from the regulator mandating changes from the company to the

[28] The term R_0 is outside of the square root to prohibit regulatory arbitrage via the legal structure of companies. Koijen and Yogo (2016b) show that captive reinsurance can be used to sidestep this.

regulator taking over control. The five action levels are:

1. No Action, which means that a company's RBC ratio is at least 2.
2. Company Action Level, which means that the RBC ratio is at least 1.5 but less than 2.
3. Regulatory Action Level, which means that the RBC ratio is at least 1 but less than 1.5.
4. Authorized Control Level, which means that the RBC ratio is at least 0.7 but less than 1.
5. Mandatory Control Level, which means that the RBC ratio is less than 0.7.

Since the safety buffer to avoid regulatory action (RBC ratio of 2) is very low,[29] virtually all insurers exceed this minimum requirement in non-crisis times. Multiple studies (see, e.g., Merrill et al., 2014) suggest that the RBC ratio still matters, not just in crisis times. First, the RBC ratio is an input to credit ratings of insurance companies (which are used as a marketing tool to sell life-insurance policies to customers). Second, in a dynamic setting, capital requirements may matter even if the capital constraint does not bind in each period.

Appendix C Marking-to-Market Rules

We provide a quick overview of marking-to-market rules (for details see Merrill et al., 2014, who use the difference in accounting rules of life and P&C insurers for their identification strategy). A bond's book value is either given by amortized cost (typically at par) or the market value.

Previous system. Life insurers have to mark to market if a bond is rated NAIC-6, i.e., if its rating is "D" (see Table 1). P&C insurers have to mark to market if a bond is considered NAIC-3 or worse.

New system. The accounting treatment of MBS now depends on the intrinsic price. If the amortized cost per unit of par (AC) of a bond is sufficiently above the intrinsic price (IP), then the bond has to be marked to market, and can no longer be held at AC. The cutoffs for marking-to-market differ across life and P&C insurers. For life insurers, the cutoff is the NAIC 5-6 threshold, i.e., if IP is 26.5% below AC. For P&C insurers, the cutoff is the NAIC 2-3 threshold, i.e., if IP is 1.5% below AC. Once a bond is marked to market, so that $BP = MP$, the capital charge typically becomes NAIC-1, since the market price is below IP for most bonds (see Figure 2).

[29] To get a sense of the implicit safety buffer built into this regulation, consider a hypothetical insurer that only faces asset risks in the form of a stock portfolio (essentially acting as a mutual fund). The current regulation sets the capital requirement for stocks to 15% of the book value, i.e., a \$100m stock portfolio would require a risk-based capital requirement of \$15m, translating into a \$30m minimum equity requirement to avoid regulatory interventions. Thus, the risk buffer for the relevant annual observation horizon is roughly equal to twice the annual stock market volatility of 15% (see Campbell et al., 2001).

Appendix D Bias of ELOSS

The market price of any bond (as percentage of par) should equal the present value (PV) of (expected) principal and coupon payments:

$$MP = PV\,(\text{Principal}) + PV\,(\text{Coupon}) \tag{9}$$
$$= 1 - R_F - ELOSS_M + PV\,(\text{Coupon})\,. \tag{10}$$

The portion of the value associated with principal repayments can be expressed as the difference of a risk-free zero coupon bond (with associated market price $1 - R_F$) and the expected discounted loss of principal, $ELOSS_M$. In contrast to $ELOSS$, the "true" market value of losses, $ELOSS_M$, is computed by discounting losses in each state of the world with the appropriate stochastic discount rate rather than the coupon rate. Now, using the definition of $IP = 1 - ELOSS$ and (10), we obtain the following decomposition of IP:

$$IP = MP + ELOSS_M - ELOSS + R_F - PV\,(\text{Coupon})\,. \tag{11}$$

We will now argue that $IP > MP$ for the typical security since $R_F \approx PV\,(\text{Coupon})$ and $ELOSS_M > ELOSS$. The first argument is empirical. Coupons are typically modest on structured securities (riskier tranches are often issued below par (low coupons) to avoid large cash flows to these tranches before senior claims have been paid). Thus, $PV\,(\text{Coupon})$ is likely of similar magnitude as R_F. Second, asset pricing theory suggests that $ELOSS_M > ELOSS$. The present-value calculation of $ELOSS$ performed by PIMCO/BlackRock uses the coupon rate as the discount rate. In contrast, the market assessment, $ELOSS_M$, should depend on state-contingent prices. To make concrete predictions, we make the following (empirically supported) assumption.

Assumption 1 *The typical risky structured security pays a coupon c that is greater than the risk-free rate, and has higher losses in bad aggregate states (high marginal utility).*

Proposition 1 *If Assumption 1 holds, then $ELOSS_M > ELOSS$.*

Proof: Assume there exists a unique stochastic discount factor $\tilde{m}$ and let $\tilde{L}$ denote the stochastic realization of the loss of principal, then

$$ELOSS_M = \mathbb{E}\left[\tilde{m}\tilde{L}\right] = Cov\left(\tilde{m}, \tilde{L}\right) + \mathbb{E}\left[\tilde{m}\right]\mathbb{E}_M\left[\tilde{L}\right].$$

Moreover, let r_F denote the risk-free rate which satisfies $1 + r_F = \frac{1}{\mathbb{E}_M[\tilde{m}]}$. Since losses are expected to be high in bad aggregate states (high marginal utility), $Cov_M\left(\tilde{m}, \tilde{L}\right) > 0$ (see Cochrane, 2009). Thus,

$$ELOSS_M > \frac{\mathbb{E}\left[\tilde{L}\right]}{1 + r_F}.$$

Finally, since it is empirically true that (almost all) bonds have a coupon rate c that is greater than the risk-free rate, we obtain that:

$$ELOSS_M > \frac{\mathbb{E}\left[\tilde{L}\right]}{1+r_F} > \frac{\mathbb{E}\left[\tilde{L}\right]}{1+c} = ELOSS.$$

■

Appendix E Classification of Sales

To classify an active trade in NAIC Schedule D Part 4, we rely on information from two fields, i.e., "*name of purchaser*" and "*realized gain (loss) on disposal.*" First, we require that the *name of purchaser* does not contain information that precludes active trading. Based on inspection of the most common field entries, we create the following four broad categories and list examples of relevant keywords after. (The full keywords list, alongside Stata code, can be obtained from the authors upon request.)

1. **(Scheduled) maturity of security:** "matured," "maturity"
2. **Partial prepayment:** "redemption," "principal paid," "paydown," "called at 100," "amortization"
3. **Default:** "write-off," "tranche loss," "principal loss"
4. **Other:** "conversion to equity," "security reclassification," "exchange"

In addition, we require that active sales imply either a strictly positive or a strictly negative value for "*realized gain (loss) on disposal.*" The rationale underlying this restriction is that transactions in secondary markets will unlikely take place exactly at book values and, thus, generate either realized gains or losses. The data indicate that scheduled prepayments (almost) always lead to exactly zero gains or losses. As such, this restriction does not bind in the case where the information from the field "name of purchaser" is sufficiently precise. However, it does have a bite and is helpful when the field "name of purchaser" is empty or is generic, e.g., "various."

Appendix F Supplementary Tables

Table Appendix F.1. Effect of Regulatory Reform on Insurers' Selling Legacy Securities – Individual Company Level

	Sold any fraction of security $\in \{0,1\}$								
Securities	MBS	MBS	MBS	MBS	MBS	All	All	All	All
Insurers	All	All	All	Life	P&C	All	All	Life	P&C
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\max\{\Delta \text{RBC}^{\text{ratings}}, 0\} \times \text{MBS} \times \text{Post}$						-0.731***	-0.616***	-0.684***	0.170
						(0.144)	(0.148)	(0.169)	(0.285)
$\max\{\Delta \text{RBC}^{\text{ratings}}, 0\} \times \text{Post}$	-0.403***	-0.638***	-0.657***	-0.792***	-0.368*	0.085	-0.049	-0.096	-0.416**
	(0.053)	(0.087)	(0.089)	(0.100)	(0.209)	(0.114)	(0.117)	(0.135)	(0.205)
$\max\{\Delta \text{RBC}^{\text{ratings}}, 0\} \times \text{MBS}$						0.471***	0.153	0.199	-0.381
						(0.126)	(0.130)	(0.148)	(0.254)
$\max\{\Delta \text{RBC}^{\text{ratings}}, 0\}$	0.689***	0.645***	0.687***	0.876***	0.370*	0.156*	0.533***	0.670***	0.647***
	(0.050)	(0.084)	(0.085)	(0.096)	(0.200)	(0.094)	(0.097)	(0.112)	(0.170)
Security FE	N	Y	N	N	N	Y	N	N	N
Security-insurer FE	N	N	Y	Y	Y	N	Y	Y	Y
Year FE	Y	N	N	N	N	N	N	N	N
Rating-asset-class-year FE	N	Y	Y	Y	Y	Y	Y	Y	Y
ΔRating-asset-class-year FE	N	Y	Y	Y	Y	Y	Y	Y	Y
Insurer-year FE	N	Y	Y	Y	Y	Y	Y	Y	Y
N	662,713	656,780	621,402	444,370	176,998	7,563,474	6,959,957	3,534,067	3,425,589

The sample is a panel at the security-insurer-year level sit from 2006 to 2015, i.e., non-maturing security s held by insurer i (individual company level) in year $t-1$ and traded in year t. In the first five columns, we consider only (non-agency) mortgage-backed securities. In the fourth and eighth column, the sample is limited to life insurers. In the fifth and ninth column, the sample is limited to P&C insurers. The dependent variable is an indicator variable for whether insurer i sold a non-zero fraction of security s in year t. $\max\{\Delta RBC_{sit-1}^{ratings}, 0\}$ is the absolute increase in risk-based charges (RBC, from 0 to 0.297) of security s as a function of the NAIC risk category according to credit ratings (also after the regulatory reform) for life and P&C insurers i in year-end $t-1$ (compared to the previous year). MBS_s is an indicator variable for whether security s is a mortgage-backed security, and $Post_t$ is an indicator variable for the year 2010 and onwards. Rating-asset-class-year fixed effects are determined by security s's rating in year $t-1$, and ΔRating-asset-class-year fixed effects are determined by the change in ratings (in notches) between year t and $t-1$. All singletons are dropped from the total number of observations N. Robust standard errors (clustered at the security level) are in parentheses.

Table Appendix F.2. Effect of Regulatory Reform on Insurers' Selling Legacy Securities – Restrictive Sales Definition

	Sold > 50% of position in security $\in \{0,1\}$								
Securities	MBS	MBS	MBS	MBS	MBS	All	All	All	All
Insurers	All	All	All	Life	P&C	All	All	Life	P&C
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\max\{\Delta\text{RBC}^{\text{ratings}}, 0\} \times$ MBS $\times$ Post						-0.479***	-0.349***	-0.305**	0.529*
						(0.131)	(0.131)	(0.143)	(0.309)
$\max\{\Delta\text{RBC}^{\text{ratings}}, 0\} \times$ Post	-0.515***	-0.541***	-0.506***	-0.533***	-0.027	-0.087	-0.166*	-0.225**	-0.410*
	(0.050)	(0.084)	(0.083)	(0.090)	(0.231)	(0.099)	(0.101)	(0.110)	(0.230)
$\max\{\Delta\text{RBC}^{\text{ratings}}, 0\} \times$ MBS						0.251**	-0.081	-0.165	-0.663**
						(0.117)	(0.117)	(0.129)	(0.272)
$\max\{\Delta\text{RBC}^{\text{ratings}}, 0\}$	0.675***	0.518***	0.533***	0.635***	0.031	0.282***	0.628***	0.812***	0.538***
	(0.048)	(0.081)	(0.080)	(0.088)	(0.220)	(0.082)	(0.084)	(0.093)	(0.189)
Security FE	N	Y	N	N	N	Y	N	N	N
Security-insurer FE	N	N	Y	Y	Y	N	Y	Y	Y
Year FE	Y	N	N	N	N	N	N	N	N
Rating-asset-class-year FE	N	Y	Y	Y	Y	Y	Y	Y	Y
ΔRating-asset-class-year FE	N	Y	Y	Y	Y	Y	Y	Y	Y
Insurer-year FE	N	Y	Y	Y	Y	Y	Y	Y	Y
N	482,888	477,510	454,125	351,030	103,052	5,677,802	5,264,392	3,333,116	1,931,013

The sample is a panel at the security-insurer-year level sit from 2006 to 2015, i.e., non-maturing security s held by insurer i (group level) in year $t-1$ and traded in year t. In the first five columns, we consider only (non-agency) mortgage-backed securities. In the fourth and eighth column, the sample is limited to insurance groups with the majority of their assets held by life insurers. In the fifth and ninth column, the sample is limited to insurance groups with the majority of their assets held by P&C insurers. The dependent variable is an indicator variable for whether insurer i sold more than half of its position in security s in year t. $\max\{\Delta RBC_{sit-1}^{ratings}, 0\}$ is the absolute increase in risk-based charges (RBC, from 0 to 0.297) of security s as a function of the NAIC risk category according to credit ratings (also after the regulatory reform) for life and P&C insurers i in year-end $t-1$ (compared to the previous year). MBS_s is an indicator variable for whether security s is a mortgage-backed security, and $Post_t$ is an indicator variable for the year 2010 and onwards. Rating-asset-class-year fixed effects are determined by security s's rating in year $t-1$, and ΔRating-asset-class-year fixed effects are determined by the change in ratings (in notches) between year t and $t-1$. All singletons are dropped from the total number of observations N. Robust standard errors (clustered at the security level) are in parentheses.

Table Appendix F.3. Participation by Insurance Companies in Newly Issued Securities

	Participation by insurers $\in \{0,1\}$					Life	P&C
Sample	All	$\geq$ \$5m	$\geq$ \$5m	$\geq$ \$5m	$\geq$ \$20m	$\geq$ \$20m	$\geq$ \$20m
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MBS $\times$ Post	0.164***	0.075***					
	(0.005)	(0.006)					
MBS $\times$ HY $\times$ Post			0.036**	0.053***	0.112***	0.132***	-0.020
			(0.017)	(0.017)	(0.029)	(0.028)	(0.024)
MBS $\times$ HY			-0.234***				
			(0.007)				
HY $\times$ Post			-0.117***				
			(0.007)				
High yield (HY)			0.040***				
			(0.005)				
Asset-class FE	Y	Y	N	N	N	N	N
Year FE	Y	Y	N	N	N	N	N
Asset-class-year FE	N	N	Y	Y	Y	Y	Y
HY-asset-class FE	N	N	N	Y	Y	Y	Y
HY-year FE	N	N	N	Y	Y	Y	Y
N	1,552,612	403,506	403,506	403,506	221,580	221,580	221,580

The sample consists of all new securities i rated and issued at date t anytime from 2005 to 2015. The sample in the second to fourth (fifth to seventh) column is limited to all new issues with a size of at least \$5m (\$20m). The dependent variable in the first five columns is an indicator for whether insurance companies hold any non-zero fraction of newly issued security s. The dependent variable in the sixth and seventh column is an indicator for whether life and P&C insurance companies, respectively, hold any non-zero fraction of newly issued security s. MBS_s is an indicator variable for whether security s is a mortgage-backed security, HY_s is an indicator variable for whether security s is a (high-yield) security rated BB+ or worse, and $Post_t$ is an indicator variable for the year 2010 and onwards. All singletons are dropped from the total number of observations N. Robust standard errors (clustered at the security level) are in parentheses.