Liquidity, Capital Constraints, and Rating Migration in Structured Fixed Income

Stephen L. Buschbom[a] — *University of Georgia*
Evan M. Eastman[b] — *University of Georgia*

December 13, 2016

Abstract

This study examines the investment decisions of regulated financial institutions. Specifically, an empirical model is developed to examine the selling behavior of insurers following a rating downgrade of a commercial mortgage-backed security (CMBS). The regulatory environment in the insurance industry creates a setting where firms must consider not only the regulatory impact of selling a security, but also the price of the security. By modeling the selling decision using a hazard model, it is possible to capture a dynamic characterization of the firm- and bond-specific attributes which affect the selling decision. Similar to prior studies, the model controls for an insurer's aggregate portfolio risk exposure but introduces an important variable: price. Estimating each security's price allows for creation of a proxy for an insurer's unrealized gain or loss. The results provide evidence that insurers are not primarily motivated by regulatory capital, but instead are influenced by aggregate portfolio risk exposure as well as the size of an unrealized gain or loss, which is found to be asymmetric between high- and low-risk exposure insurers, when evaluating a prospective sale transaction for a downgraded holding.

Keywords: Mortgage-Backed Securities, Regulation, Liquidity, Insurance Companies, Ratings Agencies

JEL classification: G11, G12, G18, G21, G22

---

[a]Terry College of Business, Department of Insurance, Legal Studies, and Real Estate, University of Georgia, 206 Brooks Hall, Athens, GA 30602, Tel.: 706-542-4290, Fax: +1-706-542-4295, buschbom@uga.edu.
[b]Terry College of Business, Department of Insurance, Legal Studies, and Real Estate, University of Georgia, 206 Brooks Hall, Athens, GA 30602, Tel.: 706-542-4290, Fax: +1-706-542-4295, eeastman@uga.edu.

1. Introduction

In this paper, we examine the trading behavior of life and property-casualty (P&C) insurers for their commercial mortgage-backed securities (CMBS) holdings. First, we examine how overall portfolio risk impacts an insurer's decision to sell a downgraded CMBS bond. Prior studies are primarily concerned with an insurer's risk-based capital (RBC), but the majority of firms are not constrained by regulatory capital requirements.[1,2] We instead propose that insurers will be motivated to sell based on the riskiness of their portfolio, where riskier insurers are less likely to sell downgraded securities if such a sale fails to increase capital. Second, we examine the role of unrealized gains and losses in the decision to sell a CMBS bond. We hypothesize that unrealized gains and losses will interact with portfolio risk when deciding whether to sell an asset. Third, we use a hazard model to empirically model the decision to sell a downgraded asset. Prior studies (e.g., Ellul, Jotikasthira, and Lundblad, 2011; Hanley and Nikolova, 2015) have generally reported on a single event window when modeling the decision to sell. While shorter windows are potentially appropriate in certain contexts, CMBS bonds are not as liquid as corporate bonds, making short windows less tractable for empirical estimation due to a limited number of sellers. Hazard models have been used by prior studies in finance and have several advantages over static models (Shumway, 2001).

This topic is of interest not only to researchers, but also to regulators and investors. Acharya and Ryan (2016) call for researchers to exploit the insurance industry as a laboratory to examine the trading behavior of regulated financial institutions. This is exactly the approach we use. Regulators are particularly interested in the investment behavior of

[1]Regulatory intervention occurs when a firm's RBC ratio is less than 2.0. The average RBC ratio reported by Ellul, Jotikasthira, and Lundblad (2011) is 25.63. The average RBC ratio reported by Hanley and Nikolova (2015) is 56.42 for life insurers and 79.61 for P&C insurers.

[2]A number of studies also point out that insurers are generally not bound by regulatory capital requirements (e.g., Cummins and Doherty, 2002; de Haan and Kakes, 2010; Fier, McCullough, and Carson, 2013).

insurers. Investment in mortgage-backed securities play an important role in an insurer's RBC ratio (Hanley and Nikolova, 2015). The selling behavior of insurers is also of particular interest due to its potential to contribute to systemic risk (Chiang and Niehaus, 2016). The National Association of Insurance Commissioners (NAIC) recently passed regulation that changes the way MBS are accounted for in RBC calculations (Becker and Opp, 2014; Hanley and Nikolova, 2015), so this issue is of regulatory importance.

Using a hazard model we estimate the duration when a security is downgraded and sold on a set of firm- and bond-specific characteristics theorized to if and when a firm sells a downgraded security. Hazard models have several advantages over static models typically used to model the sell decision with the primary benefit being we can estimate effects for time dependent variables (Shumway, 2001). We are particularly interested in how the riskiness of a firm's portfolio impacts the sell decision, as well as the gain or loss a firm will make from selling a CMBS bond.

Our results indicate that insurers with riskier bond portfolios are less likely to sell downgraded CMBS bonds. The majority of downgrades in our sample occur between 2009 and 2012. The CMBS market was characterized by low liquidity and high price volatility during this time. Accordingly, insurers holding downgraded securities would have to weigh the costs of selling a bond and realizing a loss versus holding the bond and suffering a penalty to regulatory capital. Our results indicate that these riskier firms were more likely to hold than their less risky counterparts. Our results also indicate that the unrealized gain or loss on a bond plays a significant role in determining whether an insurer will sell a downgraded bond. Specifically, we document an asymmetric and non-linear effect where only the riskiest firms sell to harvest unrealized gains, presumably to increase capital, and are also less likely sell and realize a loss relative to lower risk firms.

We make several contributions to the literature. First, we contribute to the evolving literature examining the trading behavior of institutional investors, generally, and financial institutions, specifically. Recent studies have found evidence of fire sales (Ellul, Jotikasthira, and Lundblad, 2011), reaching for yield (Becker and Ivashina, 2015), and investment herding (Chiang and Niehaus, 2016). We contribute to this literature by examining different motivations for selling while modeling the decision to sell in a novel way. Second, we contribute to the literature examining systemic risk in the financial sector. Following the 2007-2009 financial crisis there has been a focus on causes and implications of the recent financial crisis (Billio et al., 2012; Berry-Stölzle, Nini, and Wende, 2014; Koijen and Yogo, 2015). The trading behavior of financial institutions, specifically insurers, plays a role in systemic risk transmission and we provide evidence that riskiness is related to insurer selling decisions. Finally, we contribute to the literature examining the holdings of mortgage-backed securities. These financial instruments are distinctly different in their structure compared to corporate bonds as well as residential mortgage-backed securities (RMBS) and our study specifically focuses on the motivations of insurers to sell these securities. Prior studies typically focus on other asset classes or pool CMBS bonds with other securities.

The rest of this paper proceeds as follows. In Section 2 we provide background on the trading behavior of financial institutions. In Section 3 we provide an explanation of our research design as well as provide our results. In Section 4 we give a brief conclusion.

2. Financial Institution Trading Behavior

Trading behavior of regulated financial firms has received attention from regulators and researchers for a number of reasons. Regulatory capital requirements create an environment where firms must balance capital implications with security prices. Given the recent financial crisis, there has been a particular focus on the role that trading activity among financial institutions plays in contributing to systemic risk (Billio et al., 2012). The insurance industry in particular has received a good deal of focus as a result of having regulatory capital requirements, the industry's role in the recent financial crisis, and the wealth of data on asset transactions.

A number of studies have examined whether financial institutions partake in "fire sales." Fire sales occur when there is a forced sale of an industry-specific asset (Shleifer and Vishny, 1992, 2011). In the context of financial institutions, forced sales are generally attributed to regulatory capital constraints. These forced sales will create price pressures, since all firms in an industry face financial constraints. This limits liquidity and, therefore, results in below-fundamental prices. Ellul, Jotikasthira, and Lundblad (2011) examine fire sales of corporate bonds by both P&C and life insurers. They first find evidence that insurers with lower RBC ratios are more likely to sell downgraded bonds. They next find evidence bond prices deviate from fundamental expectations for bonds with substantial holdings among insurers. They interpret these empirical results as evidence of fire sales in the insurance industry. Ambrose, Cai, and Helwege (2012) evaluate returns of corporate bonds following a downgrade which did not appear to reveal new information and find little evidence of price-pressure from forced sales. Merrill et al. (2014) also examine fire sales in the insurance industry, but instead of corporate bonds, as in Ellul, Jotikasthira, and Lundblad (2011), they look for evidence of fire sales in the residential mortgage-backed securities market (RMBS). They find evidence that capital constrained P&C and life insurers were more likely to sell downgraded RMBS bonds during the 2007-2009 financial crisis.

Ellul et al. (2015) examine how financial reporting requirements impacts insurers trading behavior. Specifically, they explore the differing incentives created by historical cost accounting versus fair value accounting. Ellul et al. (2015) contend that the insurance industry provides an ideal setting to examine this question since life and property/casualty insurers are regulated differently (in addition to having different business models) and also because insurance is regulated at the state level.[3] Theoretical studies suggest that fair value

[3]Historically, the insurance industry has been regulated at the state level. While the NAIC serves as a national organization, it has no power to pass legislation, aside from issuing "Model Laws" that states can decide whether or not to pass or not on their own. For a recent discussion of insurance regulation, see Klein

accounting requirements can lead to fire sales (Allen and Carletti, 2008; Plantin, Sapra, and Shin, 2008). Contrary to theory, however, Ellul et al. (2015) find empirical evidence that historical cost accounting is no more effective at dissuading forced sales when regulatory capital implications are taken into account. They find evidence of gains trading for firms subject to historical cost accounting during periods of financial stress (i.e., the 2007-2009 financial crisis).

Becker and Opp (2014) and Hanley and Nikolova (2015) examine the implications of recent changes in capital regulation for the insurance industry. In 2010, the NAIC changed the way CMBS were considered in RBC calculations. Specifically, instead of using credit ratings the NAIC would now require firms to use valuation estimates from BlackRock.[4] Hanley and Nikolova (2015) find empirical evidence that insurers are less likely to sell distressed CMBS and RMBS following this regulatory change.[5] They also find evidence that firms are more likely to hold securities with low ratings, as regulatory capital costs are significantly reduced.

Becker and Ivashina (2015) empirically examine whether insurers "reach for yield" in the corporate bond market. Reaching for yield is the propensity of investors to buy riskier assets in order to achieve higher yields (Cox, 1967). Becker and Ivashina (2015) find evidence that insurers tend to invest in higher yield bonds, after conditioning their holdings on credit ratings. They also find that insurers that reach for yield are more likely to experience large losses and interpret these results as evidence that insurers contribute to systemic risk.

In our present setting, we are focused on the trading behavior of insurers regarding their CMBS bond holdings following rating downgrades where these downgrades increase the amount of regulatory capital required should these insurers continue to hold the bond. One main area we focus our study on is the riskiness of an insurer's asset holdings and a

(2012).

[4]In 2009 the NAIC also changed the way RMBS were considered, using PIMCO valuation estimates instead of credit ratings.

[5]Hanley and Nikolova (2015) pool CMBS and RMBS sales in their empirical tests.

second is the impact of CMBS prices.

While prior studies focus on the effect of regulatory constraints on the decision to sell (i.e., fire sales), we instead expect that the riskiness of an insurer's overall asset portfolio is more likely to play a role in determining whether an insurer will sell a CMBS bond. Risk-based capital requirements were instituted in the early 1990s by the NAIC as a way to regulate an insurer's capital and to serve as a mechanism to identify potential insurer insolvencies. The system identifies an insurer's Risk-Based Capital Ratio as follows:

$$\text{RBC Ratio} = \frac{\text{Total Adjusted Capital}}{\text{Total Risk-Based Capital}} \tag{1}$$

where Total Adjusted Capital is an insurer's actual capital and surplus.[6] Total Risk-Based Capital is intended to measure an insurer's riskiness. In addition to asset risk (e.g., CMBS investment), the RBC ratio also considers insurance risk, interest rate risk, and business risk. Each risk has an associated "capital charge," where riskier assets, for example, will have higher charges. As long as an insurer's RBC ratio is above 2.0 (i.e., an insurer holds more than \$2 of actual capital for every \$1 of "risk"), no regulatory action is taken. The intent of the RBC ratio is to provide a measure of whether an insurer holds an adequate amount of capital, but it is is specifically *not* intended to be an overall measure of an insurer's financial strength (Grace, Harrington, and Klein, 1998).

Accordingly, we expect RBC requirements to play a limited role in determining insurer investment decisions. Instead, we expect their investment risk to be more informative regarding whether an insurer will sell a downgraded bond. These insurers will have considerations beyond their capital requirements such as shareholder pressures or ratings agency consider-

[6]There are some adjustments made to capital and surplus for the purposes of calculating the RBC Ratio. For example the asset valuation reserve is counted in total adjusted capital for life insurance firms.

ations.[7,8] Given these pressures, we expect an insurer's portfolio risk to play a predominant role in the decision to sell.

A specific consideration—in conjunction with overall risk—is the unrealized gain or loss on a given investment. This factor has generally not been explored in aforementioned studies, but is an important factor in the decision to sell. Whether a bond will be sold for a gain or a loss will be influenced by the risks an insurer is taking with its other investments. Specifically, we expect insurers who are overall riskier will be less likely to sell bonds at losses. These insurers will be unable to sell downgraded bonds without, in turn, hurting their capital position. Since the current financial crisis is a time when many of these bonds would have been sold at losses, we expect this to play an important role in our analysis. Finally, we expect insurers unrealized gains and losses enter into the decision to sell conditional upon the amount of portfolio risk an insurer is exposed to relative to their peers.

3. Research Design

3.1. Data and Sample Construction

Our data are from a number of sources: NAIC, Trepp, Fitch, Moody's, S&P, and Bank of America. We use annual NAIC statutory filings to obtain insurer characteristics as well as year-end investment holdings and quarterly statutory filings for investment transactions between January 2006 and December 2013. We include only Life and P&L insurers.[9] In-

[7]A.M. Best is a ratings agency that provides insurer-specific financial strength ratings. These ratings provide an assessment of whether an insurer will be able to pay policyholder claims. Prior research has found evidence that these ratings are an important consideration for insurance firms (Doherty and Phillips, 2002; Epermanis and Harrington, 2006; Doherty, Kartasheva, and Phillips, 2012).

[8]A.M. Best specifically takes an insurer's investments into account when providing a rating. For example, in ING USA Annuity and Life Insurance Company's rating rationale in Best's Insurance Report, 2009 edition, Best issues a "Negative" outlook for ING, partially due to Best's belief that "CMBS...will experience elevated defaults given the severe recessionary U.S. economic climate."

[9]There are separate reporting forms for other types of insurers (e.g., health), but these insurers make up relatively small portions of the insurance market. As of year-end 2011, life and P&L insurers accounted for 97 percent of the aggregate insurance industry CMBS exposure based on book value (NAIC Capital Markets Bureau, 2012b).

vestment holdings and transaction data is at the individual CUSIP level which allows us to create month-end holdings which includes the prior year-end carry price for a given firm-CUSIP observation so that we can estimate the unrealized gain/loss.[10] Similar to Ellul, Jotikasthira, and Lundblad (2011) and Hanley and Nikolova (2015), we exclude non-arm's length transactions using the broker field in the quarterly transaction filings data.

We match the aforementioned insurer CMBS holdings to bond characteristic data from Trepp, LLC who is a prominent data and analytics service provider for securitized commercial real estate. The Trepp data provides CMBS pool-level and bond-level characteristics at issuance as well as subsequent monthly updates for time-variant characteristics. We include variables commonly used in the literature on asset sales by regulated firms (issue size and age) and utilize variables unique to Trepp (monthly bond factor, credit enhancement, and pool-level delinquency). We utilize bond factors to supplement our non-arm's length transaction exclusion criteria by excluding firm-month-CUSIP observations with a factor not equal to one.[11] We adjust each bond's credit enhancement for a given month using the percentage of loans in that bond's mortgage pool which are in serious delinquency (sum of foreclosure and REO). We preform this adjustment given credit enhancement accounts for past losses while an investment manager's selling decision accounts for expected losses which is likely based on, at least in part, loans in serious delinquency.

We obtain rating information from Fitch, Moody's, and S&P. We merge insurer month-end holdings with rating downgrade events. If a downgrade by any of the three rating

[10] An insurer's month-end position for a given CUSIP is calculated using the prior year-end par amount plus the cumulative net par amount traded within a given year. We exclude any firm-CUSIP observations if a negative month-end par holding is observed and require the absolute difference between the calculated December month-end par amount held and the reported year-end par amount held be less than or equal to $\$1,000$.

[11] Principal repayment reported in Schedule D Part 4 (bonds sold within a given quarter) often has a broker code indicative of a non-arm's length transaction (call, repayment, amortization, etc.), but is an imperfect identifier of such transactions. A bond which pays principal and interest whose factor is less than one is either being paid back principal or has incurred a loss and choose to exclude these bonds as we are more likely to have measurement error for monthly carry and market price estimates.

agencies triggers an increase regulatory capital, we use the exact downgrade date to measure the duration until one of the following three events occur for a given firm-CUSIP: 1) the insurer sells the bond, 2) another downgrade occurs within one year which triggers an increase regulatory capital, or 3) one year expires without a sell transaction or downgrade.[12]

To estimate monthly prices for each bond in our sample, we harvest insurer reported fair value prices from the NAIC year-end holding data and observed transaction prices from the NAIC quarterly data. With the exception of December which corresponds to year-end reporting, we calculate the weighted-average price for each CUSIP-month using the aggregate market value bought or sold by all insurers in that month divided by the aggregate par traded. For December observations, we combine the aforementioned transaction data with aggregate year-end fair value and par by CUSIP for all insurers in our sample. While year-end fair values are not ideal, these prices are intended to reflect the most likely selling price for a CUSIP which is generally a broker's bid price if an active market exists and a model generated price otherwise provided by a third party vendor.[13] While mispricing is a concern, we believe year-end prices on average reflect fair value since vendor arbitrage via mispricing cannot exist in an efficient market and a vendor who unintentionally misprices bonds will either correct their model or lose market share to vendors with more accurate pricing information.

The aforementioned CUSIP prices provide us with an incomplete monthly time series but provide a series of price nodes in time from which we can interpolate. We use four CMBS total return indices from Bank of America for interpolation: AAA, AA, A and BBB. We merge monthly CUSIP price nodes with the total return index corresponding to the current

[12]We use the second highest rating in determining whether a downgrade triggers an increase regulatory capital according to Table 1.

[13]Third party price vendors often use a "matrix" pricing process where bonds are grouped into similar risk profile bins. The yield from bonds in the bin which transact is used to price bonds in the bin which have not traded recently. See Boudry et al. (2015) for a more detailed description of CMBS matrix pricing.

Moody's rating.[14] The price of bond i at time t is:

$$P_i(t) = P_i(u)\frac{I_k(t)}{I_k(u)} + \frac{t-u}{v-u}\left[P_i(v) - P_i(u)\frac{I_k(v)}{I_k(u)}\right] \tag{2}$$

where $P_i(u)$ is the most recent monthly price observed, k is the index rating level to which bond i is assigned, $I_k(u)$ is the total return index level corresponding to month u in which the most recent price is observed, and $P_i(v)$ is the next observed price in month v with a corresponding total return index value of $I_k(v)$.

Table 2 provides summary statistics for 781 life and P&C insurers in our sample which includes only those insurers who have exposure to a CMBS bond prior to a downgrade event which triggers an increase regulatory capital. Financial variables are measured using the year preceding a downgrade event.[15] The majority of unique firms in our sample are life insurers (69.5 percent) and these insurers have an even larger exposure to capital increasing downgrade events in our sample relative to P&C insurers (86.6 percent) which is somewhat unsurprising given the difference in total assets between these two types of insurers. Life insurers in our sample appear to be exposed to bonds with a lower average adjusted credit enhancement measured at the point when a downgrade occurs which is consistent with our belief that P&C insurers hold less concentration in the riskiest CMBS tranches as these assets are less well suited to match P&C liabilities (CE less the total percent of a pool in foreclosure or REO). The RBC ratio is commonly used to asses insurer risk where a ratio below 2 signals under-capitalization. Both types of insurers appear to be well capitalized in our sample. The variable risky-to-total is the ratio of bonds classified as SVO 3 through 6 relative to the book value of an insurer's total bond portfolio. RBC did not reveal a noticeable difference in median risk profile between life and P&C insurers, but the risky-to-total ratio

[14] Bonds rated Aaa by Moody's are assigned to the AAA index, Aa1 to Aa3 to the AA index, A1 to A3 to the A index, and bonds rated Baa1 or below by Moody's are assigned to the BBB index.

[15] We use unique firm-year data for financial variables so that an insurer who exposed to more than one downgrade event within a year will have only one firm-year record.

indicates otherwise. P&C insurers have shorter duration liabilities compared to life insurers and the nature of P&C liabilities generally requires greater asset liquidity. The difference in risk profile between these two insurer types is more apparent looking at the risky-to-C&S variable which uses the same numerator as risky-to-total and the denominator is a insurer's total capital and surplus. Later results show pooling these two insurer groups dilutes the marginal effect of portfolio risk on the likelihood of selling a downgraded bond. Figure 1 shows the median RBC (Panel A), risky bond percentage (Panel B), and ratio of risk bonds to capital and surplus (Panel C) as well as the median year-over-year change for life and P&C insurers in our sample. The change in levels shows more clearly the information signal difference between RBC and portfolio risk (risky bond percentage) where RBC appears to trend upward from 2008 to 2012 while the portfolio risk measure signals an increase in credit risk not obvious if looking only at RBC. The ratio of risk bonds to capital and surplus in Panel C confirms insurers did not increase capital reserves proportionately to the increase in portfolio risk.

Table 3 provides a summary of downgrade events by year for the pooled sample of insurers and Table 4 separates life from P&C insurers in Panels A and B, respectively. The majority of downgrade events in our sample occur in 2009 through 2012 corresponding to the peak of financial distress following the 2008 subprime collapse. On average, firms in our sample have exposure to approximately eight CMBS bonds in 2009 and 2010 where a downgrade event triggered an increase in regulatory capital. Life insurers have greater exposure to capital increasing downgrade events in our sample, both in terms of the number of CMBS bonds and par amount. The number of sell events represents only bonds which are sold by an insurer within one year following a downgrade event.While life insurers have the greatest exposure to downgrades in our sample as shown in Panel A of Table 4 relative to P&C insurers in Panel B, P&C sell a higher percentage of downgraded bonds relative to life insurers which is consistent with our aforementioned comment regarding differing risk tolerance between life and P&C insurers (32 percent or 199/613 for P&C versus 18 percent or 721/3,967).

3.2. Empirical Strategy

The predominant econometric model used to explain an insurer's decision to sell a downgraded bond is a cross-sectional binary outcome model such as a probit similar to Ellul, Jotikasthira, and Lundblad (2011) and Hanley and Nikolova (2015):

$$Pr(Sell_{j,i,t+k} = 1) = \Phi(\alpha_0 + Z_{j,i,Y_t-1}\alpha_Z + X_{i,t}\alpha_X + Q_t\gamma_Q) \tag{3}$$

where $\Phi(\cdot)$ is the cumulative standard normal distribution, $Sell_{j,i,t+k}$ is an dummy variable equal to one if insurer j sells their holding of bond i within k days of the bond being downgraded at time t and zero otherwise, Z_{j,i,Y_t-1} is a vector of insurer characteristics as of the previous year-end ($Y_t - 1$) which may include information related to their holding of bond i (e.g., book value, cumulative impairment, cost of capital, etc.) as well time-invariant information (e.g., fixed effects for domicile state), $X_{i,t}$ is a vector of bond characteristics which may include both time-invariant (issue size, original rating, etc.) and time-variant information (bond age, current rating, etc.), and Q_t is a vector of year-quarter time fixed effects.

Our two primary concerns with Equation (3) are the arbitrary size of the decision window, k, and the inability to control for changes in insurer and bond characteristics within the decision window. With respect to window size, the choice of a short window of around a month obviates much of our concern regarding time-variant characteristics, but dramatically reduces the sample size depending on the asset class and sample period which potentially increases variance to obfuscate significance for variables which should theoretically be significant.[16] As the window size increases, omission new information becomes an increasing

[16]Only 105 of the 920 sell events in our sample (11 percent) occur within 30 days of a capital increasing downgrade event.

concern which is especially true for CMBS bonds where expected losses, reflected in both credit enhancement adjusted for the percent of loans in serious delinquency and current market price, may change following a downgrade and influence an insurer's sell decision. A more flexible model is needed if one wishes to avoid the aforementioned issues.

One such model is a hazard model which has several econometric advantages over static models (Shumway, 2001). Hazard models allow us to consider time as a factor in the selling decision. Intuitively, consider the cross-sectional probit model used in prior studies. These models only capture how firm or bond characteristics measured on the downgrade date impact the selling decision at some future point in time. There is no consideration of the evolution of firm or bond characteristics over time. We build upon prior studies in finance which use hazard models to estimate various firm outcomes (e.g., Shumway, 2001; Bharath and Shumway, 2008; Pagach and Warr, 2011; Griffin and Tang, 2012) where we use a hazard model to assess the determinants of a firm's decision to sell a CMBS bond.

We make use of a hazards model to relax the window size constraint imposed by a cross-sectional probit model which also allows us to update time dependent variables to model an insurer's decision to sell a downgraded bond. We use a Cox proportional hazard model to evaluate an insurer's sell decision defined as

$$\lambda_{j,i}(\tau; Z_j, V_{j,i}, X_i, Q_t) = \lambda_0(\tau) exp\big[Z_j(Y_{t+\tau}-1)\beta_Z + V_{j,i}(t+\tau)\beta_V + X_i(t+\tau)\beta_X + Q_t\gamma_Q\big] \quad (4)$$

where $\lambda_{j,i}(\tau)$ is the likelihood insurer j sells a downgraded bond i on day τ after the bond is downgraded at date t, $Z_{j,i}(Y_{t+\tau}-1)$ is a vector of insurer characteristics similar to Equation (3) except that we allow characteristics to change should the insurer hold the bond into the next calendar year following a downgrade represented by $(Y_{t+\tau}-1)$, $V_{j,i}$ is an insurer's unrealized gain or loss on bond i in the month corresponding to t, $X_{i,t}$ is a vector of bond characteristics in the month corresponding to t, and Q_t is identical to its definition in Equation (3). While this specification does not impose a strict window per se, Equation (4) allows τ to model an infinitely long hold decision up to the point a bond matures or incurs a 100 percent principal loss. We choose to limit τ to 365 days so that we are censored from observing a sell decision if the bond experiences another capital increasing downgrade within one year. The choice of one year is not ad hoc. Looking only at the 5,486 CMBS downgrades by Moody's between 2004 and 2013 which includes bonds not held by insurers in our sample, 1,315 downgrades or roughly 24 percent occur within one year of the previous downgrade. Two or more capital increasing downgrades with one year constitute a censoring event, assuming the bond is held up to that point. As we permit insurer characteristics to change up to one time for a given downgrade event, we believe one year is a sufficient amount of time to estimate sell decision determinants.

3.3. Main Results

We begin our analysis by empirically estimating Equation (4) to determine if an insurer's bond portfolio risk is a significant factor affecting the decision to sell downgraded CMBS assets. We measure an insurer's portfolio risk as the ratio of bonds classified as SVO 3 through 6 relative to an insurer's total bond portfolio scaled by 100. While we the majority of insurers appear well capitalized in our sample, we still include the natural log of the RBC ratio in the model to ensure against omitted variable bias. As mentioned earlier, studies evaluating insurer leverage decisions show RBC is not a binding constraint and insurers are more sensitive to risk perceptions of rating agencies and shareholders. Table 5 contains the results of a Cox proportional hazard model of the likelihood of an insurer selling a CMBS bond following a downgraded which triggers an increase in regulatory capital. The first model, titled *All Insurers*, pools life and P&C insurers together where we use a stratified baseline hazard to distinguish life from P&C insurers along with the new regulatory capital level, SVO 2 through 6, for the the bond resulting in five baselines for life and five for P&C

insurers.The last two models in Table 5 separate life from P&C insurers and use a stratified baseline hazard according to a bond's new regulatory capital level. Robust standard errors are used in the calculation of p-values for all results.

Results for the pooled sample in Table 5 are consistent with our theoretical prediction that current market conditions and asset specific risk affect an insurer's decision to sell a downgraded CMBS bond. The insignificance of portfolio risk as measured by *Risky-to-Total* highlights our concern about pooling life and P&C insurers together and is consistent with studies showing that estimation of capital constraint and portfolio risk effects in a model of trading decisions should evaluate life insurers separately from P&C insurers given the dissimilarity between underwritten liabilities which in turn influences the optimal level of investment risk for these firms as well as regulatory capital requirements (Ellul et al., 2015; Merrill et al., 2014). The variable *Gain/Loss* is a proxy for an insurer's unrealized gain or loss for a given CMBS bond and is measured using the difference between a bond's estimated market price (see Equation (2)) and an insurer's prior year-end carry price. We find insurers are more likely to sell a downgraded bond as losses are decreasing or gains are increasing. We separate gain and loss effects in later results to determine if price effects are linear and symmetric in that price effects are independent of portfolio risk. We find insurer capitalization (*ln(RBC)*) does not affect an insurer's decision to sell a downgraded CMBS bond independent of price and regulatory capital change effects (*Post-2010*) which are also found to be insignificant but will be evaluated further since there is an interaction effect between the regulatory capital regime change in 2010 and subsequent insurer risk capital.[17] The variable *Adj.CE* is a CMBS bond's current credit enhancement less the percent of

[17] As we lack BlackRock data on intrinsic prices (used for regulatory capital for CMBS from year-end 2010 onward), we cannot determine the exact capital requirement at the individual firm-CUSIP level but believe results should hold with the addition of this data given research from the NAIC indicates lower ratings dispersion between Moody's, S&P, and Fitch for CMBS relative to RMBS so that agency ratings would have resulted in regulatory capital requirements in 2010 and 2011 similar to those actually incurred under the new regulatory regime using BlackRock modeled intrinsic prices (NAIC Capital Markets Bureau, 2012a).

loans in that bond's mortgage pool in foreclosure or REO and is intended to capture credit risk (unadjusted CE) inclusive of future potential losses (foreclosure plus REO). We find insurers are less likely to sell bonds as credit enhancement is increasing. We find a bond's age (*ln(IssueAge)*) to be insignificant, but issue size (*ln(IssueSize)*) positive and significant consistent with studies finding issue size is positively related to liquidity (Edwards, Harris, and Piwowar, 2007; Ellul, Jotikasthira, and Lundblad, 2011). Last, we find mutual insurers are less likely to sell a downgraded CMBS bond which is opposite of what is found in other studies noting mutual insurers sell downgraded bonds as they cannot access external capital markets to repair capital. We postulate that mutual companies, at least in our sample, have formed portfolios in such a way to avoid forced selling of downgraded bonds as a substitute for external capital markets.

The second regression in Table 5 estimates the hazard of selling a downgraded bond for only life insurers. The estimates are materially similar to estimates using a pooled sample with the notable exception that portfolio risk (*Risky-to-Total*) is negative and significant, indicating that a life insurer is less likely to sell a downgraded CMBS bond as portfolio risk increases. We do not interpret our results as contradictory relative to the findings in other studies where portfolio risk is found to be insignificant or even positively related to the likelihood of selling a downgraded bond, but rather wish to stress that factors affecting a regulated firm's decision to sell a downgraded bond are likely sensitive to the level of aggregation (e.g., combining RMBS and CMBS or life and P&C insurers) as well as bond market conditions (liquidity and credit risk). The majority of downgrade events in our sample occur between 2009 and 2012 which is a period where the CMBS market is generally viewed as having constrained liquidity and higher price volatility. Insurers with higher portfolio risk compared to their peers are likely unable to reduce CMBS risk without incurring losses during our sample period which would in turn decrease capital so that we only expect to see insurers sell CMBS bonds when the realized loss is less than the net cost of capital to hold the bond.[18]

Figure 2 shows the cumulative hazard of selling a downgraded bond within one year for life insurers based upon the second regression in Table 5. The hazard is stratified by SVO level (2 through 6) for the cost of capital shown in Table 1. The empirical hazards reveal the likelihood of selling a downgraded bond is increasing both in time and the cost of capital required to hold the bond, where bonds which require the most capital, SVO5 (23% RBC) and SVO6 (30% RBC), have a cumulative sale likelihood of approximately 28% and 33% respectively. Even though SVO3 through SVO6 levels correspond to non-investment grade ratings, the regulatory capital required for SVO3 and SVO4 is much lower relative to SVO5 (80% and 57% lower respectively) and the cumulative sale likelihood within one year is lower by almost the same proportion (64% lower for SVO3 and 46% lower for SVO4 relative to SVO5). Figure 2 also highlights our concern with respect to small window sizes of one month or even one quarter for cross-sectional studies. The cumulative likelihood of sale within one month is approximately ⅛ of the one year likelihood for all SVO levels and the one quarter cumulative likelihood of sale is approximately ¼ of the one year likelihood. This finding is in line with the concerns of Ambrose, Cai, and Helwege (2008) who note that cross-sectional studies where downgraded bond sales represent a small fraction of total sales may falsely reject the reject the null of no fire sales.

The third and last regression in Table 5 evaluates only P&C insurers. The variable *Gain/Loss* is insignificant which may be the result of small sample size or an indication that the selling decision of P&C insurers is non-linear over gains and losses. We argue the latter, given that P&C insurers are subject to a different statutory accounting policy than life insurers, where P&C insurers holding bonds with an SVO rating of 3 or below must carry these assets at the lower of fair market value or amortized cost. This creates inherent

[18] The net cost of capital accounts for regulatory capital as well as the net present value of a bond's expected interest payments and principal losses.

gain/loss asymmetries in periods of increased price volatility and rating migration. Portfolio risk (*Risky-to-Total*) is not statistically significant, consistent with our argument that P&C insurers have difference portfolio risk profiles relative to their life counterparts. The effect of a bond's credit risk (*Adj.CE*) is similar to the effect found for the pooled sample of insurers. A bond's age (*ln(IssueAge)*) is not statistically different from zero, but issue size (*ln(IssueSize)*) maintains a positive and significant coefficient supporting the notion that P&C insurers face liabilities requiring them to hold assets of sufficient liquidity. As our sample contains a limited number of P&C insurers, we limit the remainder of our study to life insurers as they have the largest exposure to CMBS bonds in the insurance industry as a whole.

Table 6 contains results for life insurer sell hazards where we evaluate the effect of the RBC regime change at year-end 2010 when the NAIC stopped using ratings to determine capital requirements for CMBS bonds and instead used expected loss estimates from BlackRock to determine capital. The first two variables, *Gain/Loss* and *Risky-to-Total*, are remain unchanged from Table 5. As suspected, introduction of an interaction term between RBC and a dummy variable variable for observations after year-end 2010 when the RBC regime changed (*Post-2010*) proves significant but the significance of RBC is not as straight forward as Table 6 might lead one to initially believe. The hazard ratio for RBC depends upon the dummy variable for the RBC regime and significance is conditional upon the relative value of each of the variables in the interaction. We test for the range of RBC values over which the regime effect is significant. We find the regime change is insignificant for RBC values between 1.5 and 9.95 where insurers with an RBC ratio below 1.5 are less likely to sell downgraded CMBS bonds after the regime change in 2010 while insurers with an RBC ratio of 10 or greater are more likely to sell. As the threshold for regulatory action is 2.0 and Table 2 shows the median firm in our sample is well above that level, it is clear that the regime change did not affect the selling decision for the median firm in our sample and may have actually allowed firms with relatively healthy levels of capital de-risk their portfolios by selling downgraded CMBS bonds.

Table 7 contains results for life insurer sell hazards where we test for non-linear price effects. Table 1 details the capital requirements and accounting treatment for life and P&C insurers for each of the six tiers. The Securities Valuation Office (SVO) is responsible for credit analysis and subsequent risk capital requirements for insurers where SVO tier one assets require the least amount of capital and tier six requires the most capital. For bonds assigned to tiers three through six, which were previously in tiers one or two, P&C insurers are required to carry these bonds at the lower of amortized cost or fair market value which is likely to result in a loss if amortized cost is close to par ahead of a period of declining prices. The first two variables in Table 7 separate gain and loss effects, where gain is set to zero if a bond's estimated market price is below an insurer's carry price and represents the difference between market price and carry price otherwise. Loss is defined in the opposite manner of gain such that both gain and loss are strictly greater than or equal to zero. Hazard estimates for life insurers are virtually identical to those in Table 5 and a Wald test fails to reject equality of gain and loss effects.

As we have constrained gain/loss effects to be independent of portfolio risk in Table 6, we relax this assumption in Table 8 where we interact the continuous gain/loss variable with an insurer's relative level of portfolio risk using quartiles for the ratio of the highest risk bonds to total bonds (*Risky-to-Total*) for life insurers in our sample. Testing of significance for hazard ratios of gain/loss effects across quartiles (*Risky1* to *Risky4*) reveals gain/loss is significant only for the third and fourth quartiles which correspond to the highest levels of portfolio risk.

The last estimates presented in Table 9 test the conditional linear price effects of Table 8 where we interact portfolio risk quartiles with the gain and loss variables used in the hazard regression of Table 7. Again, we must test the hazard ratio significance for each quartile separately for conditional gain and loss effects. We find only the highest risk quartile of insurers are motivated to sell downgraded CMBS bonds to harvest gains and, similar to our findings of the model shown in Table 8, only insurers in the third and fourth quartiles correspond to the highest levels of portfolio risk are less likely to sell at a loss. The remainder of variables are materially unchanged from prior regressions in terms of size and significance.

4. Conclusion

This paper contributes to literature evaluating the effect of regulatory capital constraints on assets sales by isolating the effect in an asset class where a decreased reliance on rating agencies for regulatory capital determination did not appear to signal a change in loss expectations: CMBS. Ex post calculations from the NAIC show the average difference in required capital between the new model based expected loss regime and the prior regime which relied on rating agencies is approximately zero for CMBS over 2010 and 2011 (NAIC Capital Markets Bureau, 2012a). These results are confirmed by Becker and Opp (2014) who show agency ratings and model based expected losses are equally informative with respect to credit risk. In comparison to studies which find capital constrained firms are more likely to sell downgraded assets (Ellul, Jotikasthira, and Lundblad, 2011; Merrill et al., 2014; Ellul et al., 2015) or show this effect is insignificant (Hanley and Nikolova, 2015), we document such firms are less likely to sell downgraded CMBS bonds using a portfolio risk measure which is still directly related to regulatory capital but better explains a insurer's motivation to sell downgraded assets. Our results are not inconsistent with findings in these studies, however, as we document the effects which motivate life insurers to sell downgraded bonds are distinct from those for P&C insurers due to differences in accounting policy (Merrill et al., 2014; Ellul et al., 2015).

Our analysis documents the benefits of using a duration model such as the Cox proportional hazard as we are able to account for time variant effects of price and credit enhancement on a firm's sell decision which are not so easily controlled for in a cross-sectional probit model. The price effects are of interest for not only the obvious reason of controlling for unrealized loss but also because we show such effects are dependent upon portfolio risk for gains and non-linear between gains and losses for life insurers with the highest relative portfolio risk. The flexible hazard approach is well suited to model CMBS and RMBS transactions which are believed to be less liquid asset classes where results from cross-sectional models may be sensitive to window size, especially if the timing of an insurer's decisions is related to model factors.

As our study focuses on CMBS, we believe future research on RMBS using techniques similar to this paper may be of interest given regulatory capital changes provided more capital relief to insurers relative to CMBS. The flexibility of a duration approach may also help reveal transaction costs for these less liquid asset classes where early sellers, often classified as distressed sellers, may provide baseline information against which subsequent transactions for bonds within the same pool use to determine fair market value. Accounting for the pricing sequence should then reveal credit adjusted price expectations to determine the approximate discount or premium incurred by these early sellers.

References

Acharya, V., and S. G. Ryan, 2016, Banks' Financial Reporting and Financial System Stability, Forthcoming, *Journal of Accounting Research*.

Allen, F., and E. Carletti, 2008, Mark-to-Market Accounting and Liquidity Pricing, *Journal of Accounting and Economics*, 45: 358–378.

Ambrose, B. W., K. N. Cai, and J. Helwege, 2012, Fallen Angels and Price Pressure, *The Journal of Fixed Income*, 21: 74–86.

Ambrose, B. W., N. Cai, and J. Helwege, 2008, Forced Selling of Fallen Angels, *The Journal of Fixed Income*, 18: 72–85.

Becker, B., and V. Ivashina, 2015, Reaching for Yield in the Bond Market, *Journal of Finance*, 70: 1863–1902.

Becker, B., and M. Opp, 2014, Regulatory Reform and Risk-Taking: Replacing Ratings, Working Paper, Stockholm School of Economics.

Berry-Stölzle, T. R., G. P. Nini, and S. Wende, 2014, External Financing in the Life Insurance Industry: Evidence from the Financial Crisis, *Journal of Risk and Insurance*, 81: 529–562.

Bharath, S. T., and T. Shumway, 2008, Forecasting Default with the Merton Distance to Default Model, *Review of Financial Studies*, 21: 1339–1369.

Billio, M., M. Getmansky, A. W. Lo, and L. Pelizzon, 2012, Econometric Measures of Connectedness and Systemic Risk in the Finance and Insurance Sectors, *Journal of Financial Economics*, 104: 535–559.

Boudry, W. I., C. H. Liu, T. Mühlhofer, and W. N. Torous, 2015, Using Cash Flow Dynamics to Price Thinly Traded Assets, Working Paper, Cornell University School of Hotel Administration.

Chiang, C.-C., and G. Niehaus, 2016, Investment Herding by Life Insurers and Its Impact on Bond Prices, Working Paper, University of South Carolina.

Cox, A. H., 1967, Regulation of Interest on Deposits: An Historical Review, *Journal of Finance*, 22: 274–296.

Cummins, J. D., and N. A. Doherty, 2002, Capitalization of the Property-Liability Insurance Industry: Overview, *Journal of Financial Services Research*, 21: 5–14.

de Haan, L., and J. Kakes, 2010, Are Non-Risk Based Capital Requirements for Insurance Companies Binding?, *Journal of Banking & Finance*, 34: 1618–1627.

Doherty, N. A., A. V. Kartasheva, and R. D. Phillips, 2012, Information Effect of Entry Into Credit Ratings Market: The Case of Insurers' Ratings, *Journal of Financial Economics*, 106: 308–330.

Doherty, N. A., and R. D. Phillips, 2002, Keeping up with the Joneses: Changing Rating Standards and the Buildup of Capital by U.S. Property-Liability Insurers, *Journal of Financial Services Research*, 21: 55–78.

Edwards, A. K., L. E. Harris, and M. S. Piwowar, 2007, Corporate Bond Market Transaction Costs and Transparency, *Journal of Finance*, 62: 1421–1451.

Ellul, A., C. Jotikasthira, and C. T. Lundblad, 2011, Regulatory Pressure and Fire Sales in the Corporate Bond Market, *Journal of Financial Economics*, 101: 596–620.

Ellul, A., C. Jotikasthira, C. T. Lundblad, and Y. Wang, 2015, Is Historical Cost Accounting a Panacea? Market Stress, Incentive Distortions, and Gains Trading, *Journal of Finance*, 70: 2489–2538.

Epermanis, K., and S. E. Harrington, 2006, Market Discipline in Property/Casualty Insurance: Evidence from Premium Growth Surrounding Changes in Financial Strength Ratings, *Journal of Money, Credit and Banking*, 38: 1515–1544.

Fier, S. G., K. A. McCullough, and J. M. Carson, 2013, Internal Capital Markets and the Partial Adjustment of Leverage, *Journal of Banking & Finance*, 37: 1029–1039.

Grace, M. F., S. E. Harrington, and R. W. Klein, 1998, Risk-Based Capital and Solvency Screening in Property-Liability Insurance: Hypotheses and Empirical Tests, *Journal of Risk and Insurance*, 65: 213–243.

Griffin, J. M., and D. Y. Tang, 2012, Did Subjectivity Play a Role in CDO Credit Ratings?, *Journal of Finance*, 67: 1293–1328.

Hanley, K. W., and S. Nikolova, 2015, Rethinking the Use of Credit Ratings in Capital Regulation, Working Paper, Lehigh University.

Klein, R. W., 2012, Principles for Insurance Regulation: An Evaluation of Current Practices and Potential Reforms, *Geneva Papers on Risk and Insurance–Issues and Practice*, 37: 175–199.

Koijen, R. S. J., and M. Yogo, 2015, The Cost of Financial Frictions for Life Insurers, *American Economic Review*, 105: 445–475.

Merrill, C. B., T. D. Nadauld, R. Stulz, and S. M. Sherlund, 2014, Were There Fire Sales in the RMBS Market?, Working Paper, Brigham Young University.

NAIC Capital Markets Bureau, 2012a, Modeling of U.S. Insurance Industry's Holdings in Commercial Mortgage-Backed Securities, `http://www.naic.org/capital_markets_archive/120626.htm`.

NAIC Capital Markets Bureau, 2012b, Potential for Volatility in U.S. Insurer Holdings of Commercial Mortgage-Backed Securities, `http://www.naic.org/capital_markets_archive/120712.htm`.

Pagach, D., and R. Warr, 2011, The Characteristics of Firms that Hire Chief Risk Officers, *Journal of Risk and Insurance*, 78: 185–211.

Plantin, G., H. Sapra, and H. S. Shin, 2008, Marking-to-Market: Panacea or Pandora's Box?, *Journal of Accounting Research*, 46: 435–460.

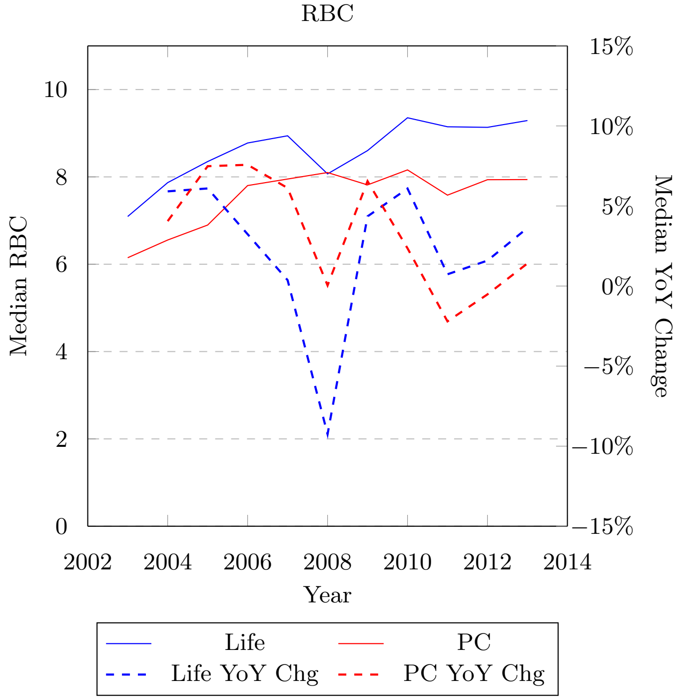
Shleifer, A., and R. Vishny, 2011, Fire Sales in Finance and Macroeconomics, *Journal of Economic Perspectives*, 25: 29–48.

Shleifer, A., and R. W. Vishny, 1992, Liquidation Values and Debt Capacity: A Market Equilibrium Approach, *Journal of Finance*, 47: 1343–1366.

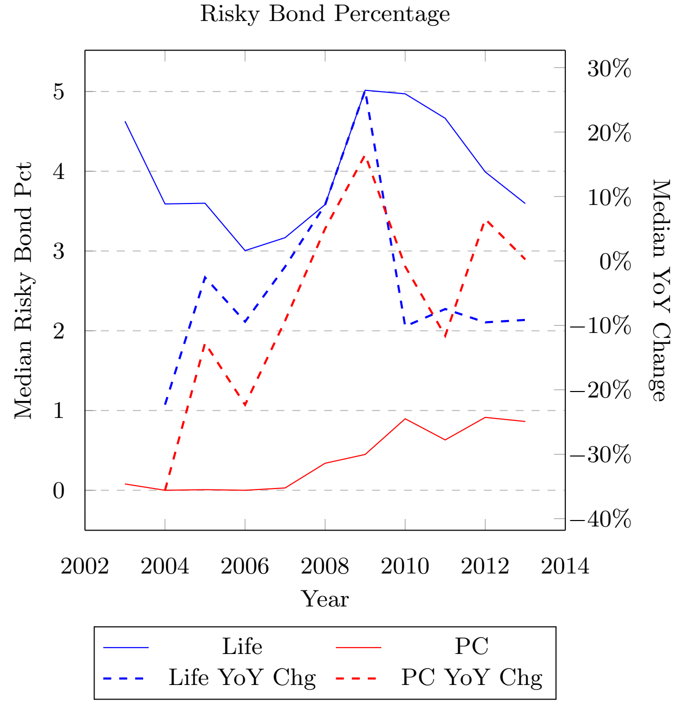
Shumway, T., 2001, Forecasting Bankruptcy More Accurately: A Simple Hazard Model, *Journal of Business*, 74: 101–124.

Figure 1: Insurer Risk Measures

(a)



(b)



(c)

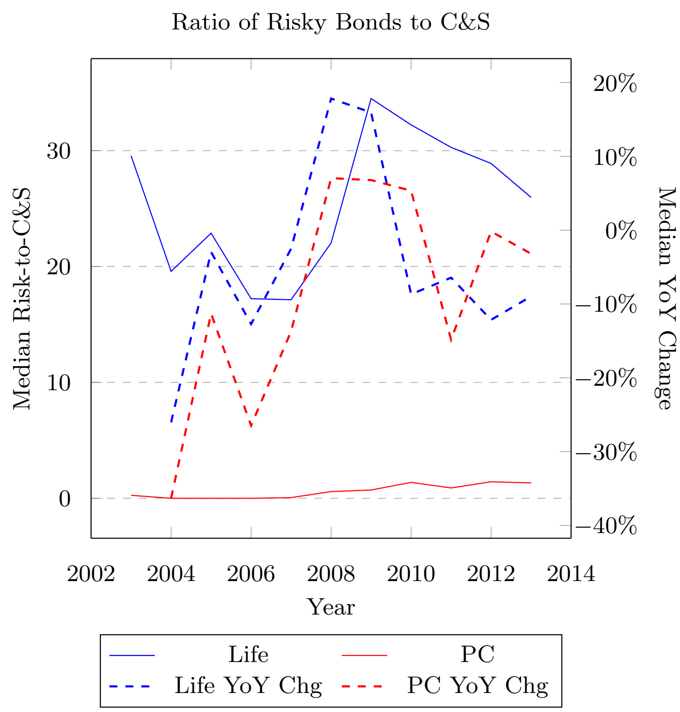


Figure 2: Cumulative Hazard of Selling after Downgrade
(by Cost of Capital for Life Insurers)

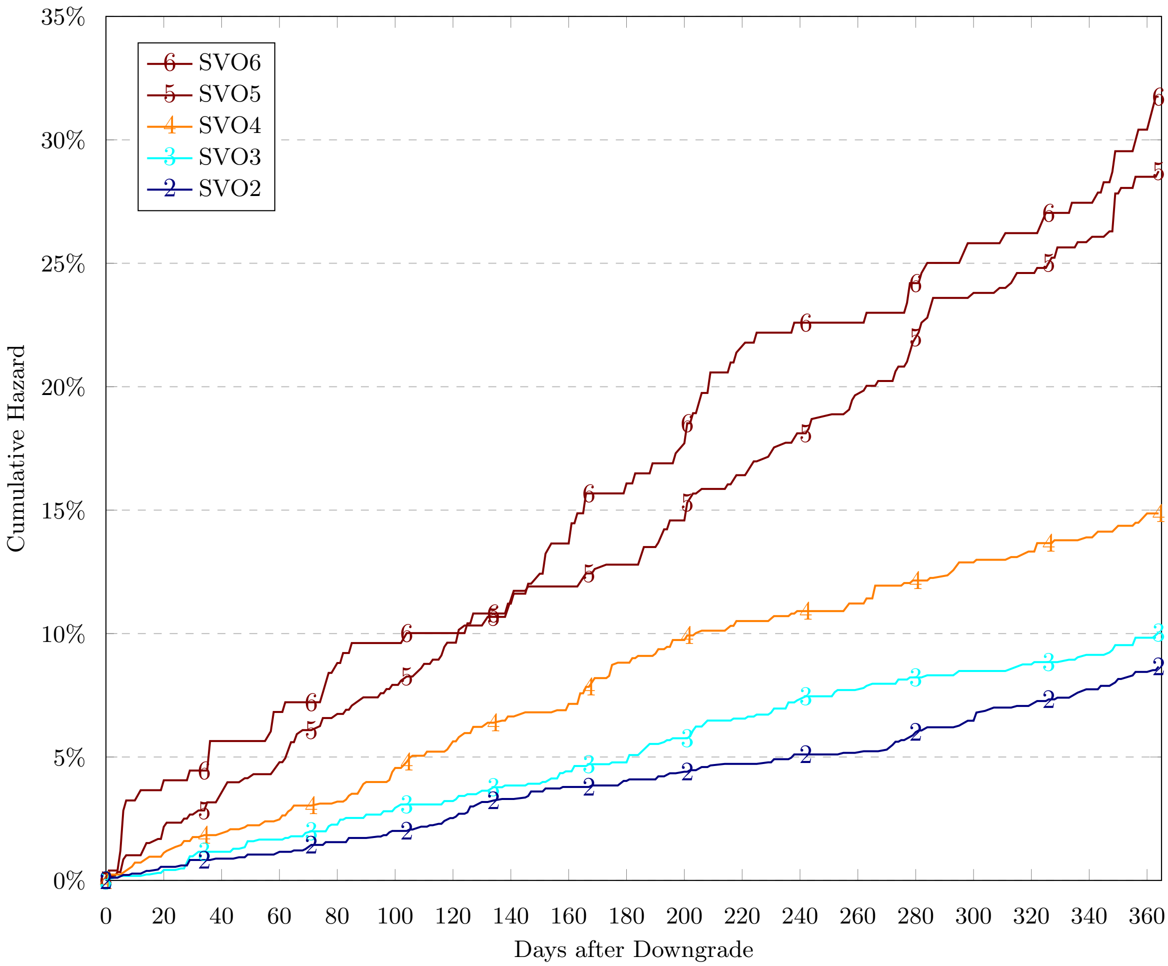


Table 1: Risk-Based Capital for Life and P&C Firms

		RBC Charge		Accounting Treatment	
SVO	Moody's Credit Rating	Life	P&C	Life	P&C
1	A3 and above	0.40%	0.30%	AC	AC
2	Baa 1, 2, 3	1.30%	1.00%	AC	AC
3	Ba 1, 2, 3	4.60%	2.00%	AC	FV
4	B 1, 2, 3	10.00%	4.50%	AC	FV
5	Caa 1, 2, 3	23.00%	10.00%	AC	FV
6	Ca, C	30.00%	30.00%	FV	FV

Table 2: Risk Exposure for Life and P&C

	Life		*P&C*	
	Average	Median	Average	Median
Adj. CE at DG	6.87		10.42	
Total Assets	30,739	8,541	3,850	557
Total Bonds (% of Assets)	63.30	68.33	70.73	72.02
RBC	11.00	8.52	16.47	7.00
Risky-to-Total	5.46	5.67	2.02	0.78
Risky-to-C&S	48.28	41.91	4.05	1.40
Num. of Firms	543		238	
Firm-DG Events	3,967		613	

Table 3: Insurer Downgrade Events by Year: Life and P&C Combined

Downgrade Year	Firms	Avg. Num. DG Events by Firm	Avg. Par Held($000)	Number of Sell Events
2006	9	1.22	2,194	9
2007	0	NA	NA	0
2008	14	1.50	4,889	2
2009	213	7.88	10,324	270
2010	179	8.07	7,394	335
2011	154	3.98	9,140	97
2012	162	4.58	8,125	190
2013	50	1.38	9,453	17
Total	781	5.86	8,827	920

Table 4: Composition of Insurer Downgrade Events by Year and Line of Business

Panel A: Life Insurers

Downgrade Year	Firms	Avg. Num. DG Events by Firm	Avg. Par Held($000)	Number of Sell Events
2006	7	1.29	2,555	7
2007	0	NA	NA	0
2008	13	1.54	4,784	2
2009	141	10.20	11,421	206
2010	121	10.69	7,596	276
2011	98	5.36	9,732	80
2012	118	5.24	9,097	138
2013	45	1.42	10,122	12
Total	543	7.31	9,514	721

Panel B: P&C Insurers

Downgrade Year	Firms	Avg. Num. DG Events by Firm	Avg. Par Held($000)	Number of Sell Events
2006	2	1.00	568	2
2007	0	NA	NA	0
2008	1	1.00	7,000	0
2009	72	3.35	3,783	64
2010	58	2.62	5,671	59
2011	56	1.57	5,609	17
2012	44	2.82	3,280	52
2013	5	1.00	883	5
Total	238	2.58	4,383	199

Table 5: Cox Proportional Hazard Estimate of Selling a Downgraded Bond

	All Insurers		*Life Only*		*P&C Only*	
	Parameter Estimate	Hazard Ratio	Parameter Estimate	Hazard Ratio	Parameter Estimate	Hazard Ratio
Gain/Loss	0.0076	1.008	0.0092	1.009	−0.0024	0.998
	(<.0001)		(<.0001)		(0.6055)	
Risky-to-Total	−0.0240	0.976	−0.0667	0.936	0.0126	1.013
	(0.1606)		(0.0015)		(0.2815)	
ln(RBC)	0.0312	1.032	0.0384	1.039	0.1137	1.120
	(0.6720)		(0.7474)		(0.3523)	
Post-2010	0.2091	1.233	0.3950	1.484	−0.5908	0.554
	(0.2858)		(0.0843)		(0.1071)	
Adj.CE	−0.0246	0.976	−0.0128	0.987	−0.0621	0.940
	(<.0001)		(0.0502)		(<.0001)	
ln(IssueAge)	−0.2227	0.800	0.0815	1.085	−1.0495	0.350
	(0.2102)		(0.6658)		(0.0855)	
ln(IssueSize)	0.2755	1.317	0.2778	1.320	0.3657	1.441
	(<.0001)		(<.0001)		(0.0013)	
Mutual	−0.3711	0.690	−0.3635	0.695	−0.3207	0.726
	(0.0154)		(0.0273)		(0.5843)	
Year-Qtr FE	Yes		Yes		Yes	
State FE	Yes		Yes		Yes	
Stratified Baseline	By Type & SVO		By SVO		By SVO	

Cox proportional hazard of selling a downgraded bond. The first model *All Insurers* pools life and P&C together using a stratified baseline hazard by insurer type (Life vs. P&C) and regulatory capital charge level for a given bond (SVO 2-6). The last two models separate life insurers from P&C and stratify the baseline hazard by regulatory capital charge level. *Gain/Loss* is the difference between a bond's estimated market price (see Eq. 2) and an insurer's prior year-end carry price. *Risky-to-Total* is the ratio of bonds classified as SVO 3 through 6 relative to an insurer's total bond portfolio scaled by 100. *ln(RBC)* the natural log of a firm's prior year-end RBC ratio. *Post-2010* is an indicator variable equal to 1 for observations after year-end 2010 and 0 otherwise. *Adj.CE* is a bond's credit enhancement as of given month less the % of loans in that bond's mortgage pool in foreclosure or REO. *ln(IssueAge)* is the natural log of a bond's age in years. *ln(IssueSize)* is the natural log of a bond's face value (par amount). *Mutual* is an indicator variable equal to 1 for mutual insurers and 0 otherwise. *Year-Qtr FE* and *State FE* are fixed effects for the year-quarter of a downgrade event and state in which an insurer is domiciled.

Table 6: Hazard of Selling a Downgraded Bond —
RBC Regime Effect for Life Insurers

	Parameter Estimate	Hazard Ratio	p-Value
Gain/Loss	0.0093	1.009	(<.0001)
Risky-to-Total	−0.0642	0.938	(0.0021)
ln(RBC)	−0.3923	NA	(0.0298)
Post-2010	−1.1317	NA	(0.0260)
*ln(RBC)*Post-2010*	0.6895	NA	(0.0006)
Adj.CE	−0.0120	0.988	(0.0671)
ln(IssueAge)	0.0959	1.101	(0.6108)
ln(IssueSize)	0.2752	1.317	(<.0001)
Mutual	−0.3255	0.722	(0.0466)
Year-Qtr FE		Yes	
State FE		Yes	
Stratified Baseline		By SVO	

The variable *ln(RBC)*Post-2010* is the interaction between the natural log of a firm's prior year-end RBC ratio (*ln(RBC)*) and an indicator variable, *Post-2010*, equal to 1 for observations after year-end 2010 and 0 otherwise. The baseline hazard of selling a downgraded bond is stratified by regulatory capital charge level for a given bond (SVO 2-6). Definitions for all other variables are detailed in Table 5.

Table 7: Hazard of Selling a Downgraded Bond — Gain/Loss Effect for Life Insurers

	Parameter Estimate	Hazard Ratio	p-Value
Gain	0.0124	1.012	(0.0120)
Loss	−0.0084	0.992	(0.0006)
Risky-to-Total	−0.0639	0.938	(0.0022)
ln(RBC)	−0.3926	NA	(0.0306)
Post-2010	−1.1193	NA	(0.0282)
*ln(RBC)*Post-2010*	0.6853	NA	(0.0007)
Adj.CE	−0.0123	0.988	(0.0621)
ln(IssueAge)	0.1125	1.119	(0.5529)
ln(IssueSize)	0.2794	1.322	(<.0001)
Mutual	−0.3266	0.721	(0.0457)
Year-Qtr FE		Yes	
State FE		Yes	
Stratified Baseline		By SVO	

Gain and *Loss* are calculated in the same manner as defined in Table 5 where *Gain* (*Loss*) is set to zero if market price is lower (higher) than an insurer's carry price and is the absolute difference between market price and an insurer's carry price otherwise. Definitions for all other variables are detailed in Table 5.

Table 8: Hazard of Selling a Downgraded Bond —
Gain/Loss Interaction with Portfolio Risk for Life Insurers

	Parameter Estimate	Hazard Ratio	p-Value
Gain/Loss	0.0040	NA	(0.4225)
Risky2	0.2186	NA	(0.2781)
Risky3	−0.0553	NA	(0.7813)
Risky4	−0.0243	NA	(0.8999)
*G/L*Risky2*	−0.0052	NA	(0.3367)
*G/L*Risky3*	0.0034	NA	(0.5364)
*G/L*Risky4*	0.0153	NA	(0.0064)
ln(RBC)	−0.3655	NA	(0.0439)
Post-2010	−1.2528	NA	(0.0163)
*ln(RBC)*Post-2010*	0.7475	NA	(0.0003)
Adj.CE	−0.0123	0.988	(0.0666)
ln(IssueAge)	0.0959	1.101	(0.6121)
ln(IssueSize)	0.2908	1.337	(<.0001)
Mutual	−0.3222	0.725	(0.0519)
Year-Qtr FE		Yes	
State FE		Yes	
Stratified Baseline		By SVO	

Risky2, *Risky3*, and *Risky4* are dummy variables indicating if an insurer's ratio of risky bonds (SVO 3 through 6) to total bonds is within a given quartile range where the lowest risk quartile (1) is the omitted group. Quartiles are calculated using the full sample period. *G/L*Risky2* through *G/L*Risky4* are interactions between risk quartiles and the continuous gain/loss measure. Definitions for all other variables are detailed in Table 5.

Table 9: Hazard of Selling a Downgraded Bond —
Gain and Loss Interaction with Portfolio Risk for Life Insurers

	Parameter Estimate	Hazard Ratio	p-Value
Gain	0.0193	NA	(0.0468)
Loss	−0.0011	NA	(0.8600)
Risky2	0.5089	NA	(0.0701)
Risky3	0.1932	NA	(0.4855)
Risky4	0.1385	NA	(0.6065)
*Gain*Risky2*	−0.0390	NA	(0.0693)
*Gain*Risky3*	−0.0179	NA	(0.2261)
*Gain*Risky4*	0.0035	NA	(0.7721)
*Loss*Risky2*	−0.0016	NA	(0.8163)
*Loss*Risky3*	−0.0095	NA	(0.1709)
*Loss*Risky4*	−0.0189	NA	(0.0089)
ln(RBC)	−0.3671	NA	(0.0416)
Post-2010	−1.2730	NA	(0.0155)
*ln(RBC)*Post-2010*	0.7535	NA	(0.0003)
Adj.CE	−0.0122	0.988	(0.0692)
ln(IssueAge)	0.1011	1.106	(0.5968)
ln(IssueSize)	0.2954	1.344	(<.0001)
Mutual	−0.3240	0.723	(0.0503)
Year-Qtr FE		Yes	
State FE		Yes	
Stratified Baseline		By SVO	

Risky2, *Risky3*, and *Risky4* are dummy variables indicating if an insurer's ratio of risky bonds (SVO 3 through 6) to total bonds is within a given quartile range where the lowest risk quartile (1) is the omitted group. Quartiles are calculated using the full sample period. *Gain*Risky2* through *Gain*Risky4* and *Loss*Risky2* through *Loss*Risky4* are interactions between risk quartiles and gain/loss measures described in Table 7. Definitions for all other variables are detailed in Table 5.