Fire Sales, Fair Value Estimation, and

Impairment Recognition of Downgraded Securities

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Abstract: This paper explores the fire sales, valuation, and value recognition of downgraded bonds. I categorize downgrades as dual downgrades — where both credit ratings downgrade and regulatory risk designation downgrade (latter negatively affecting the risk-based capital ratio) occur, and single downgrades — where only credit ratings downgrade occurs. I find that insurers are more likely to dispose immediately of bonds that experience dual downgrades than single downgrades, but the association is weaker for riskier bonds, primarily because of illiquidity. Moreover, insurers are more likely to recognize other-than-temporary impairment (OTTI) and with greater magnitude upon a dual downgrade than a single downgrade, but the relation becomes weaker for riskier bonds. Additionally, cross-sectional analyses show that the likelihood of fire sales upon a dual downgrade for riskier bonds is higher in higher MTM (mark-to-market accounting) states and among securities that are more commonly held by insurers, and lower for securities that are subject to higher impairment risk. Impairment recognition (fair value estimation) upon a dual downgrade for riskier bonds is less likely or smaller (more favorable) in lower MTM states, for firms with poorer financial performance, and for securities that are less commonly held (for firms with poorer financial performance). In sum, findings suggest that insurers are less likely to dispose immediately of riskier bonds that experience dual downgrades. Nevertheless, they are more likely to engage in opportunistic valuations of such bonds, possibly providing stakeholders with a distorted picture of their financial performance.

Keywords: Fire sales, disposals, fair value estimation, other-than-temporary impairment recognition, credit ratings, corporate bonds, insurance companies

1. Introduction

I explore the fire sales, valuation, and value recognition upon a credit rating downgrade coupled with a regulatory risk designation downgrade by different categories of risk. Statements of Statutory Accounting Principles (SSAP) 26R (43R) require insurers to use NAIC designation to disclose the credit quality of bonds (structured securities such as asset-backed securities). NAIC 1-2 (3-6) are categorized as investment (speculative) grade securities, where NAIC 1 (6) represents the safest (riskiest) class.[1] Prior literature documents that bonds that are downgraded from investment to non-investment are more likely to be sold than comparable bonds that are not downgraded (Ambrose et al. 2008), primarily due to regulatory capital constraints (Merrill et al 2012; Ellul et al 2011). However, less is known on the selling activity upon downgrades by different risk categories. Disposal decisions between high and low credit quality bonds may differ depending on regulatory capital incentives, investment holding restrictions, and liquidity concerns. Moreover, valuation and value recognition upon credit rating downgrade have been understudied to date. This question is important particularly for passive institutional investors such as insurance companies that are more likely to maintain asset portfolios, instead of engaging in trading activities (Ambrose et al. 2008).

Based on a sample of 334,239 security-insurer-year observations during 2014-2017, I find that 13% of bonds are downgraded by rating agencies and that out of the downgraded bonds, around 30% are accompanied by a NAIC designation downgrade. I define credit ratings downgrade coupled with NAIC designation downgrade as a dual downgrade, and without NAIC designation downgrade as a single downgrade. Former increases the risk factor calculated in the denominator of a risk-based capital (RBC) ratio, thereby negatively affecting the key performance

[1] Speculative, non-investment, and junk-status are used interchangeably.

metrics of life insurers, while latter does not affect change in risk factor. Thus, I first expect that life insurers with capital incentives will more likely immediately sell securities that experience dual downgrades than single downgrades. Next, I explore how the effect of dual downgrade on fire sales decision vary with the level of credit risk category. On the one hand, exponentially increasing risk factor for higher risk category and strict holding restrictions on lower- and medium-grade investments may induce insurers to dispose of lower grade bonds[2] upon a dual downgrade. On the other hand, illiquidity risk may increase with higher risk category, causing insurers to dispose less immediately of lower-quality securities. The empirical findings document that the likelihood of fire sales is greater upon a dual downgrade than single downgrade, which is consistent with Lu et al. (2017)'s finding. I further find evidence that fire sales upon a dual downgrade are less likely to occur for riskier bonds.

I additionally perform tests to explore which concern primarily explains the likelihood of sales upon a dual downgrade for riskier bonds out of three concerns: regulatory capital concern, holding restriction concern, or illiquidity concern. Findings show that illiquidity is associated with higher risk category and that illiquidity decreases the likelihood of fire sales upon a dual downgrade. But I do not find evidence that the likelihood of fire sales upon a dual downgrade for lower-grade bonds differ between insurers that are capital-constrained and not capital constrained, and between insurers in states with high holding restrictions and with low holding restrictions. Overall findings suggest that the illiquidity concern dominates other two concerns.

Next, I examine how insurers engage in valuation decisions upon a dual downgrade: in particular, other-than-temporary-impairment (OTTI) recognition and fair value estimation at the period of credit ratings announcements. First, the effect of dual downgrade on the probability and

[2] Low NAIC designation, low quality, low grade, and high risk category are used interchangeably.

magnitude of impairment is not straightforward. On the one hand, a dual downgrade may lead to a more frequent OTTI recognition with a greater magnitude as well as a more conservative fair value estimation, because a dual downgrade, which directly affects the RBC ratio, may provide a worse signal than a single downgrade, which does not directly affect the RBC ratio[3]. Moreover, insurers generally share similar asset portfolios, and such common holdings of securities may induce a greater fire sale risk (Nanda et al. 2018) that may negatively affect market value. Insurers would have to recognize other-than-temporary-impairment with a higher frequency and with a greater magnitude, and estimate a more conservative fair value upon a dual downgrade than a single downgrade, since former is exposed to a higher fire sale risk than latter. On the other hand, since a dual downgrade negatively impacts the RBC ratio, insurers may have greater incentives to delay the impairment recognition, reduce the impairment amount, or inflate the fair value, in order to prevent further exacerbation of their performance metrics. Additionally, I explore how the impairment recognition and fair value estimation vary with different risk categories. In one direction, higher risk category (i.e., Lower NAIC designation) is associated with higher risk factor, leading to a lower valuation assigned by the market. This will prompt insurers to value more conservatively. In the other direction, higher risk factor may also induce capital-based incentivized insurers to engage in a more strategic valuation. The empirical results show that there are greater likelihood and magnitude of impairment recognition, and a more negative change in fair value estimates upon a dual downgrade than a single downgrade, but that such associations are mitigated among lower grade bonds, suggesting the presence of opportunistic valuation strategies for lower-quality bonds upon a dual downgrade.

[3] A single downgrade may indirectly affect RBC ratio, if an insurer recognizes other-than-temporary-impairment due to credit deterioration. A single downgrade within NAIC 6 bonds may directly affect RBC ratio, if such downgrade decreases fair market value of the securities, since NAIC 6 category bonds are recognized at lower of cost or market.

I also examine cross-sectional variations in the immediate disposal and valuation decisions using five dimensions. First, I predict insurers in higher MTM (mark-to-market) states are more likely to sell, more likely to recognize OTTI with greater magnitude, and less likely to inflate fair value upon a dual downgrade for lower grade bonds. Second, I explore whether the fire sales and valuation decisions upon a dual downgrade for lower-grade bonds are different between securities with high impairment risk and low impairment risk. Third, I expect that insurers with poorer performance, proxied by lower RBC ratio or lower financial strength rating, are more likely to immediately sell, less likely to recognize OTTI, and more likely to inflate the fair value of lower-grade bonds upon a dual downgrade. Fourth, I expect that the likelihood of fire sales is higher, the change in fair value estimates is lower and the likelihood and magnitude of OTTI recognition are higher upon a dual downgrade for riskier bonds with high commonality of holdings across insurers than with low commonality. Fifth, I examine whether investment holding restriction causes higher likelihood of disposals upon a dual downgrade for lower-grade bonds. Collectively, findings confirm the first (MTM), third (firm performance), and fourth (commonality) cross-sectional predictions, while rejecting the fifth (holding restriction) prediction. For the second null cross-sectional hypothesis, I find that insurers are less likely to recognize impairment upon a dual downgrade for lower-grade bonds with high impairment risk than low impairment risk, but once they need to, they recognize with a greater magnitude of OTTI. I also find a lower likelihood of fire sales upon a dual downgrade of lower-grade bonds with high impairment risk than low impairment risk.

I perform two additional analyses. First, I extend the period of impairment recognition to the next period and find that there are greater likelihood and magnitude of impairment upon a dual downgrade than a single downgrade and that the association is weaker for riskier bonds, which is consistent with the main results. Second, I examine whether insurers engage in sales and valuations of bonds that are imminent to experience dual downgrades. I find that although insurers recognize less impairment for lower-grade bonds closer to dual downgrade, it appears that they generally do not make decisions in advance of the actual ratings change.

This study is closely related to a branch of literature that explores the fire sale decisions upon downgrades from investment to non-investment. I further explore how the disposal decisions upon downgrades vary with the credit risk category. Moreover, while previous literature documents that regulatory capital incentive is a primary explanation for higher probability of fire sales upon a downgrade from investment to non-investment (Ellul et al. 2011; Merrill et al. 2012), illiquidity concern is a major explanation for comparatively lower frequency of fire sales upon a dual downgrade among junk-status bonds.

More importantly, this study explores the valuation strategies for securities that experience change in credit ratings, which have been less explored in the prior literature. This question is important since insurance companies engage in a low frequency of trading activities (Ambrose et al. 2008), thus the valuation of holding securities becomes a critical concern. I provide empirical evidence that the likelihood and magnitude of impairment recognition are lower and fair value estimates are more favorable upon a dual downgrade for the lower-grade bonds, suggestive of the opportunistic valuation. Additionally, I find that poor insurer performance exacerbates, while the mark-to-market accounting (compared to historical accounting), and investment holding commonality alleviate such opportunism.

The rest of the paper proceeds as follows. Section 2 presents the institutional background and hypothesis development. Section 3 describes the data, estimation models and descriptive statistics. Section 4 reports the empirical results. Section 5 concludes.

2. Hypothesis Development

2.1. Background on NAIC Designation

NAIC requires insurers to disclose the NAIC designation of bonds, where NAIC designation close to NAIC 1(6) implies higher quality (closer-to-default) bonds. NAIC designation is based on the credit ratings provided by NRSROs (Nationally Recognized Statistical Rating Organization), such as Moody's, S&P, and Fitch.[4] For example, Moody's (Fitch or S&P) ratings between Aaa (AAA) and A3 (A-) are equivalent to NAIC 1 (NAIC Securities Valuation Office (SVO) 2004; NAIC 2018).[5] If more than one NRSRO rating exists, then the second highest NRSRO rating is used (NAIC 2018).

The risk factor of a security increases from NAIC 1 to NAIC 6 and is calculated into a denominator of the RBC ratio. For example, the risk factor of NAIC 1 is 0.004, NAIC2 is 0.0096, and NAIC 5 is 0.1696. Suppose an insurer holds $1,000 of NAIC 1, $1,500 of NAIC 2, and $3,000 of NAIC 5 bonds. Then, the risk factor is calculated as $1,000*0.004 + $1,500*0.0096 + $3,000*0.1696 = $527.2 and will be an input to the denominator of RBC ratio.[6]

2.2. The Likelihood of Fire Sales upon a Dual Downgrade

Since higher risk factor leads to a lower RBC ratio, insurers would prefer to hold high quality bonds. But at the same time, insurers are inclined to buy and hold riskier assets under the same NAIC designation (Becker and Ivashina 2015). However, if the riskier security is downgraded by the rating agency and the NAIC designation level also becomes lower (e.g, from

[4] Until 2006, five rating agencies (Standard & Poor's, Moody's, Fitch, DBRS and AM Best) had been certified as NRSROs by SEC. In 2006, however, the U.S. Congress passed the Credit Rating Agency Reform Act (CRARA), in order to increase competition, and improve transparency. As a result, as of 2019, there are ten rating agencies certified as NRSROs by SEC (NAIC 2019).

[5] When a security does not obtain any ratings from NRSROs, an insurance company or the Securities Valuation Office (SVO) should determine the designation (NAIC Securities Valuation Office (SVO) 2004; NAIC 2018).

[6] Asset risk, insurance risk, interest rate risk, and business risk are taken into consideration in the denominator of the RBC ratio (Herzog 2011).

NAIC 3 to NAIC 4), insurers will be less inclined to hold that asset. I define rating agency downgrades coupled with the NAIC designation downgrade as a dual downgrade, while rating agency downgrade without the NAIC designation downgrade as a single downgrade. I predict that insurers are more likely to sell securities with dual downgrade than single downgrade, because former increases the risk factor and negatively impacts the RBC ratio, while the latter does not have any impact on the denominator of the RBC ratio.[7] They would no longer have incentives to hold riskier assets coupled with downgraded NAIC designation, since there is a cost of lower RBC ratio while the yields, yet high, remains fixed. Based on the prediction, the first hypothesis is as follows:

H1a: The credit rating agency downgrade coupled with the NAIC designation downgrade (i.e., dual downgrade) leads to a higher likelihood of fire sale than the credit rating agency downgrade without the NAIC designation downgrade (i.e., single downgrade).

The effect of dual downgrade on fire sales decision might vary with the level of risk category.[8] On the one hand, the probability of sales for dually downgraded securities may increase with the risk category. The risk factor increases exponentially as a security is designated to a lower-grade bond (NAIC 1 = 0.004, NAIC 2=0.0096, NAIC 3=0.039, NAIC 4=0.0738, NAIC 5= 0.1696, NAIC 6= 0.1950). Thus, the dual downgrade of riskier bonds will have more negative impact on the RBC ratio. This will lead to a greater propensity to engage in an immediate disposal decision. In addition, although NAIC 1-5 securities are carried at amortized costs, NAIC downgrade for riskier category bonds may be more subject to higher likelihood of other-than-temporary-impairment, since the future cash flows to be collected is more uncertain and volatile for lower-

[7] Rating agency downgrade without the NAIC designation downgrade can still negatively impact the nominator of the RBC ratio, if an insurer has to recognize other-than-temporary-impairment following the downgrade. Rating upgrade without the NAIC designation upgrade, however, cannot positively impact the nominator of the RBC ratio, since most of the securities (NAIC 1-5) are carried at amortized cost and cannot be written up.

[8] I will use risk category and NAIC designation category, interchangeably.

quality bonds. Higher likelihood of OTTI recognition, in turn, would have negative impact on the numerator of the RBC ratio. The impact of the downgrade from NAIC 5 to NAIC 6 becomes even more severe, since NAIC 6 securities are carried at fair value, if the fair value becomes unfavorable upon the NAIC designation downgrade, it would directly decrease the numerator of the RBC ratio.

Moreover, NAIC adopted a model law in 1996 restricting insurers to hold certain percentage of non-investment grade bonds and holding restrictions are tighter for lower NAIC designation securities.[9] For example, insurers can hold NAIC 3-6 (4-6) investments no more than 20% (10%) of admitted assets, and can hold NAIC 5-6 (6) investments no more than 3% (1%) of admitted assets (NAIC 1997). Moreover, according to Fenn and Cole (1994) and DeAngelo et al. (1994), a policyholder's perception of portfolio risk is an extremely important factor for market share and profitability in the life insurance industry. Thus, insurers will likely sell lower-grade bonds that experience dual downgrades, in order to meet the condition of investment restrictions.

On the other hand, the probability of sales upon a dual downgrade may be lower for lower-grade bonds. Prior studies document that bid-ask spread is negatively associated with credit rating (Meng and ap Gwilym 2008) and that investment-grade securities show higher levels of liquidity than non-investment grade securities (Pu 2009). Thus, insurers may less likely sell lower grade bonds that experience dual downgrades than higher grade bonds because of higher illiquidity concerns.

I additionally perform tests to explore which explanation dominates for the likelihood of fire sales decision of lower-grade bonds upon a dual downgrade: regulatory capital concern, holding restriction concern, or illiquidity concern. First, I test whether insurers with lower RBC

[9] Not all states adopted this model. The tightness of restrictions vary with states. For instance, Arkansas may grant temporary relief from the investment limitations on NAIC 3-6 obligations. On the other hand, Florida legislation imposes stricter restrictions on the percentage of non-investment grade investment holdings.

are more induced to immediately sell lower-grade bonds upon a dual downgrade than higher grade bonds. Second, I explore whether insurers in states with higher restrictions on lower and medium grade securities will be more induced to dispose quickly of such bonds upon a dual downgrade. Third, I test whether illiquidity is negatively associated with NAIC designation and if so, whether illiquidity causes a lower likelihood of immediate sales of riskier bonds upon a dual downgrade than of less riskier bonds.

H1b (null): The likelihood of fire sales upon a dual downgrade is not different between low and high grade bonds.

H1c (regulatory capital concern): The likelihood of fire sales upon a dual downgrade for lower grade bonds is higher for insurers that are capital-constrained than for those that are not capital constrained.

H1d (holding restriction concern): The likelihood of fire sales upon a dual downgrade for lower grade bonds is higher in states with high holding restrictions than in states with low holding restrictions.

H1e (illiquidity concern): The illiquidity is negatively associated with NAIC designation and the likelihood of fire sales upon a dual downgrade is lower for illiquid bonds than liquid bonds.

2.3. The Likelihood of Impairment Recognition and Fair Value Estimation upon a Dual Downgrade

Credit rating downgrade is one of the main factors for other-than-temporary-impairment (OTTI) recognition of securities (Griffin Financial Group 2009; Business Wire 2003; FDIC 2005).[10] A dual downgrade can induce more aggressive OTTI recognition and lower fair value estimation than a single downgrade, since the dual downgrade can provide a more unfavorable signal than the single downgrade for security holders such as insurers, who are generally required by state to

[10] Conversely, if a loan-backed security had been treated as an OTTI investment, SSAP No. 43R may provide for a "write-up" in value of the investment, which is certainly unique under statutory accounting principles (Bennett and Greenberg 2015).

maintain a safe investment portfolio and have restrictions on holding riskier assets. Moreover, Nanda et al. (2018) document that investment commonalities across insurers led investors to fire sale risk and induced widespread disposal of a bond following a rating downgrade from investment- to speculative-grade. Consistently, if an insurer expects that a security is widely held across insurers with similar capital-based incentives and unless the insurer sells the security, it will expect higher fire sale risk and lower market value in case of dual downgrade than of single downgrade, leading to a timelier and higher magnitude of OTTI recognition. Insurers that hold commonly held securities will have less discretion to subjectively value their assets, by delaying the OTTI or inflating the fair value; otherwise, their deviated action from other insurers may easily be detected by auditors or state regulators.

On the other hand, since dual downgrade negatively impacts RBC ratio, while single downgrade does not, insurers may be more incentivized to delay or reduce the OTTI recognition and inflate the fair value upon a dual downgrade than a single downgrade. OTTI recognition and fair value estimation can be discretionary. Hanley et al. (2018) argue that insurers may inflate the fair value of securities in order to delay recognition of OTTI and maintain a certain RBC ratio. Insurers may also defer the recognition, by arguing that the decline in fair value is not due to the credit deterioration or by asserting that they have intention and ability to hold until recovery (Griffin Financial Group 2009).[11] Because the directions are not straightforward, I set the following hypotheses as null:

H2a (null): The likelihood and magnitude of other-than-temporary impairment recognition is not different between a dual downgrade - and a single grade condition.

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[11] Fitch also expressed concerns that OTTI policies are divergent across insurers. Some insurers will recognize OTTI if they expect an imminent default, while others will recognize it is downgraded by a credit rating agency, and although no default is expected, the bond is not expected to be upgraded and recover the declines in its market value (Business Wire 2003).

H2b (null): The change in fair value estimates is not different between a dual downgrade - and a single grade condition.

An OTTI recognition and a conservative fair value estimation upon a dual downgrade can be aggravated for lower grade bonds. Since lower NAIC designation leads to higher risk factor, the market will assign a lower valuation, leading to a lower fair value. This will prompt timelier and greater magnitude of OTTI recognition. On the other hand, insurers may less likely recognize OTTI and more likely inflate fair value upon a dual downgrade for lower grade bonds. Higher risk factor would greatly reduce RBC ratio, prompting insurers to strategically inflate the fair value and delay OTTI recognition, in order to prevent further reduction of the ratio.

H2c (null): The likelihood and magnitude of other-than-temporary impairment recognition upon a dual downgrade is not different between low and high grade bonds.

H2d (null): The change in fair value estimates upon a dual downgrade is not different between low and high grade bonds.

2.4. Cross-Sectional Analysis

In this section, I will predict cross-sectional variations in a fire sale and valuation decision upon a dual downgrade. I particularly focus on the dual downgrade for low grade bonds, which has a greater impact on the change in fair value estimation, OTTI recognition and eventually on the RBC ratio than a dual downgrade for high grade bonds.

2.4.1. MTM (Mark-to-Market) States

Ellul et al. (2015) define and identify high MTM (mark-to-market) states as states where insurers are likely to yield greater level of market value recognition and more frequent OTTI recognition. In a high MTM state, if an insurer does not sell a dually downgraded bond, it will likely recognize the OTTI losses (reduction in the nominator of RBC ratio) and increase the risk factor (increase in the nominator of RBC ratio) upon a dual downgrade. If the insurer does sell, it will not consider the risk factor in the denominator for the disposed bond any longer but will likely recognize realized losses from sales, negatively impacting the nominator of RBC ratio. While the nominator and denominator worsen the RBC ratio under no disposal, only the nominator likely worsens the RBC ratio under the disposal of a dually downgraded bond, incentivizing insurers to engage in an immediate sales decision. However, in a low MTM state, if an insurer does not sell a dually downgrade bond, it is likely that only the denominator increases. If they do sell, it is likely that only the nominator might decrease because of the recognition of realized losses from sales. Thus, the comparison between the two circumstances (disposal vs no disposal) is more ambiguous for low MTM states than high MTM states. Thus, I expect that the disposal upon a dual downgrade for lower grade bonds is more likely under high MTM states than low MTM states.

Moreover, insurers will recognize lower fair value estimates and greater magnitude of impairment with higher frequency upon a dual downgrade under high MTM states than low MTM states, since in high MTM states, insurers are more forced to recognize mark-to-market and OTTI (Ellul et al. 2015).

H3a: The likelihood of fire sale is higher, the fair value estimation is less favorable, and the likelihood and magnitude of other-than-temporary impairment recognition are greater upon a dual downgrade of lower-grade bonds in high MTM states than in low MTM states.

2.4.2. Impairment Risk

One of the common indicators of OTTI recognition is whether the fair value is significantly below the carrying value (Griffin Financial Group 2009). I define those securities that have fair value lower than the carrying value in the prior period as securities that have high impairment risk.

Insurers that hold bonds with high impairment risk will generally recognize timelier and greater magnitude of OTTI and disclose a more conservative fair value estimates upon a dual downgrade than insurers with low impairment risk. On the one hand, such associations will be stronger for lower-grade bonds, since the bonds that are closer to default would likely face higher impairment risk. On the other hand, the association may be weaker for lower grade bonds; since the risk factor is noticeably higher for such bonds, negatively affecting the RBC ratio, insurers would have incentives to at least delay or reduce the magnitude of OTTI recognition, and inflate the fair value; otherwise, recognizing the OTTI in the current period will further exacerbate the RBC ratio.

With regards to an immediate disposal decision, if an insurer sells a lower-grade bond with high impairment risk upon a dual downgrade, it will likely realize losses from disposal, but will not consider the risk factor component for the disposed bond. If an insurer does not sell, on one hand, it will increase the risk factor and likely recognize OTTI upon a dual downgrade further reducing the RBC ratio. On the other hand, if an insurer may effectively delay or reduce the OTTI loss. Thus, the comparison of benefits between disposal and no disposal is ambiguous.

If an insurer sells a lower-grade bond with low impairment risk upon a dual downgrade, it will likely recognize lower or no loss from disposal, and consider no risk factor for the disposed bond. If an insurer does not sell, then it will increase the risk factor but less likely recognize OTTI upon a dual downgrade. Thus, the benefit under this circumstance is also ambiguous between disposal and no disposal. Collectively, the sales decision upon a dual downgrade for lower grade bonds may not differ between high and low impairment risk. Since the directions are not straightforward, I set a second cross-sectional hypothesis as null:

H3b (null): The likelihood of fire sale, the change in fair value estimates, and the likelihood and magnitude of other-than-temporary impairment recognition of lower-grade bonds upon a dual downgrade are not different between bonds with high impairment risk and bonds with low impairment risk.

2.4.3. Firm Performance

Insurers with poorer performance, proxied by the lowest quartile RBC ratio and non-investment grade financial strength ratings (Weiss rating), would be more keen on how dual downgrades may negatively impact their performance metrics. Due to stronger concerns over capital constraints, they will be more likely to immediately sell, less likely to recognize OTTI, and more likely to inflate the fair value of lower-quality bonds upon a dual downgrade. In a similar vein, Ellul et al. (2015) find that insurers that are relatively more capital-constrained are more likely to sell bonds downgraded from investment to speculative grades. Merrill et al. (2012) also document that capital-constrained insurers are more likely to sell downgraded securities at much lower prices than other insurers during the financial crisis.

H3c: The likelihood of fire sale is higher, the change in fair value estimates is higher, and the likelihood and magnitude of other-than-temporary impairment recognition are lower upon a dual downgrade of lower-grade bonds for firms with low RBC ratio than firms with high RBC ratio.

H3d: The likelihood of fire sale is higher, the change in fair value estimates is higher, and the likelihood and magnitude of other-than-temporary impairment recognition are lower upon a dual downgrade of lower-grade bonds for firms with low financial strength ratings than firms with high financial strength ratings

2.4.4. Investment Commonality

Insurers hold similar asset portfolios across a period of time. Girardi et al. (2018) document that insurers with more similar portfolios sell more in common, possibly because the asset liquidation of other firms may impact decline in asset prices and significant losses for security holders. Therefore, I predict that insurers that hold securities that are more commonly held across life insurers are more likely to engage in a fire sale upon a dual downgrade of lower-quality bonds. However, insurers that do not sell but maintain such securities may have to provide more conservative fair value estimates and recognize OTTI more frequently and in a greater magnitude, since the market value is expected to fall much lower when a security is more commonly held, thereby exposed to higher fire sale risk. Deviation from other insurers in recognizing the value of those assets will easily be detected, since monitoring stakeholders may readily cross-check the valuations across insurers that hold the same securities.

H3e: The likelihood of fire sale is higher, the change in fair value estimates is lower, and the likelihood and magnitude of other-than-temporary impairment recognition are greater upon a dual downgrade of lower-grade bonds with high commonality of holdings across insurers than with low commonality of holdings.

2.4.5. Investment Holding Restriction

I also explore whether the state-level regulation difference in investment holding restriction can induce a higher likelihood of fire sale upon dual downgrade. I expect that the probability of immediate sales upon a dual downgrade among lower-grade bonds increases with the greater stringency of holding restrictions on lower- and medium-quality bonds.

H3f: The likelihood of fire sale is higher upon a dual downgrade of lower-grade bonds in states with high holding restrictions on low- and medium- quality bonds than in states with low holding restrictions.

3. Research Design

3.1. Sample

The sample is constructed from security-insurer-years in NAIC Schedule D from 2014 to 2017. Schedule D Part 1 provides the fair value, par value, estimation source, and hierarchy level of each security across firms. Schedule D Part 4 provides the name and disposal date of securities that were disposed. Credit ratings of security issuers are collected from Mergent FSID database. Following Becker and Ivashina (2015), if the bond is rated by two rating agencies, I use the lowest rating; if the bond is rated by all three rating agencies, I use the median rating.[12] I additionally obtain MTM state classification from Ellul et al. (2015), and hand-collect state-level holding restrictions on lower- and medium-quality bonds (See Appendix C). Table 1 summarizes the sample selection process. First, I merge all insurer-security-years on Schedule D with credit ratings of security-years on Mergent FSID. Second, I exclude U.S. treasuries and U.S. government securities, because these securities are exempt from filing with SVO (NAIC 2018). I also remove structured securities such as RMBS and CMBS, since the "expected loss" assessment is employed instead of credit ratings when calculating the RBC ratio (NAIC 2018).[13] Third, I exclude security-years that do not obtain any rating from three major rating agencies: S&P, Moodys, or Fitch. Fourth, I remove observations with missing variables that are used in the regression. In the final step, I only keep insurer-security-years if the actual NAIC designation is equal to the expected NAIC designation based only on Mergent FSID credit ratings. This process can alleviate the concern that insurers might obtain ratings from rating agencies other than the big 3 rating agencies. Final sample consists of 2,591 insurer-year and 334,239 security-insurer-year observations.

[Insert Table 1 here]

3.2. Model Specification

I implement multivariate empirical tests using the OLS regression.[14] For models that have a binary variable as a dependent variable, I use the Logit regression. To test the effect of dual downgrades on insurer's fire-sales decision, I estimate the following models:

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[12] NAIC requires that if more than one NRSRO rating exists, then the second highest NRSRO rating be used (NAIC 2018).

[13] Following unprecedented downgrades of structured securities by rating agencies in 2008/2009, the NAIC decided to replace credit ratings with expected loss assessment in RBC ratio calculations: for RMBS starting from year-end 2009, and CMBS starting from year-end 2010 (Becker and Opp 2013).

[14] When the dependent variable is an indicator variable, we use a linear probability model because we control for security-level fixed effects. The results are consistent with our primary results, when we implement logit regressions.

$$FireSale[0,5]_{ijt}, \text{ or } FireSale[0,10]_{ijt} = \alpha_0 + \alpha_1 UG_{jt} + \alpha_2 UG2_{jt} + \alpha_3 DG_{jt} + \alpha_4 DG2_{jt} + \alpha_5 UG_{jt} * NAIC_{jt-1} + \alpha_6 UG2_{jt} * NAIC_{jt-1} + \alpha_7 DG_{jt} * NAIC_{jt-1} + \alpha_8 DG2_{jt} * NAIC_{jt-1} + \alpha_9 NAIC_{jt-1} + \alpha_{10} Rating_{jt-1} + Fixed\ Effects + \varepsilon_{ijt} \quad (1a)$$

$$FireSale[0,5]_{ijt}, \text{ or } FireSale[0,10]_{ijt} = \beta_0 + \beta_1 UG_{j,t} + \beta_2 UG2_{j,t} + \beta_3 DG_{j,t} + \beta_4 DG2_{jt} + \beta_5 UG_{jt} * ILLIQUID + \beta_6 UG2_{jt} * ILLIQUID + \beta_7 DG_{jt} * ILLIQUID + \beta_8 DG2_{jt} * ILLIQUID + \beta_9 ILLIQUID + \beta_{10} Rating_{jt-1} + Fixed\ Effects + \varepsilon_{ijt} \quad (1b)$$

, where $FireSale[0,5]_{ijt}$ ($FireSale[0,10]_{ijt}$) is an indicator variable that equals one if an insurer i disposes of a security j within 5 (10) days of ratings announcement date in period t, zero otherwise. $Rating_{j,t-1}$ is a lagged credit rating acquired by NRSROs. $UG_{j,t}$ ($DG_{j,t}$) is an indicator variable that is equal to one if the rating of security j has been upgraded (downgraded) by a credit rating agency, zero otherwise. $UG2_{j,t}$ ($DG2_{j,t}$) is an indicator variable that is equal to one if the rating of security j has been upgraded (downgraded) by a credit rating agency and the NAIC designation has additionally been upgraded (downgraded), zero otherwise. $NAIC_{j,t-1}$ is a lagged NAIC designation level between NAIC 1 and NAIC 6. *ILLIQUID* is a placeholder of illiquidity measures: $IQR\ Range_{jt}$ and $Roll_{jt}$. $IQR\ Range_{jt}$ is an interquartile range based on Schestag et al. (2016) and $Roll_{jt}$ is measured based on Dick-Nielson et al. (2012). In model (1a), H1a predicts α_4 to be positive, while H1b has no predictions on α_8. H1c-H1e are hypotheses developed, in order to provide better explanation on the tendency of fire-sales upon a dual downgrade for lower-grade bonds. Appendix A1 provides the expected test results based on each potential explanation.

Appendix A1.

Explanation / Model	Regulatory capital concern	Holding restriction concern	Illiquidity concern
Hypothesis	H1c	H1d	H1e
(1a)	$\alpha_8 > 0$	$\alpha_8 > 0$	$\alpha_8 < 0$
(1a)	α_8 (Low RBC Group) > α_8 (High RBC Group)	α_8 (Restriction Group) > α_8 (No Restriction Group)	
(1b)			$\beta_8 > 0$
			Correlation (*ILLIQUID, NAIC*) > 0

To test the effect of dual downgrade on impairment recognition and fair value estimation, I estimate the following model with OLS and Logit regression.

$$
\begin{aligned}
&OTTI_{ijt},\ or\ Dum\_OTTI_{ijt} = \alpha_0+\alpha_1 UG_{jt}+\alpha_2 UG2_{jt}+\alpha_3 DG_{jt} \\
&+\alpha_4 DG2_{jt}+\alpha_5 UG_{jt}*NAIC_{jt-1}+\alpha_6 UG2_{jt}*NAIC_{jt-1}+\alpha_7 DG_{jt}*NAIC_{jt-1} \qquad (2a) \\
&+\alpha_8 DG2_{jt}*NAIC_{jt-1}+\alpha_9 NAIC_{jt-1}+\alpha_{10} Rating_{jt-1}+Fixed\ Effects+\varepsilon_{ijt}
\end{aligned}
$$

$$
\begin{aligned}
&\Delta FV\ Difference_{ijt} = \alpha_0+\alpha_1 UG_{jt}+\alpha_2 UG2_{jt}+\alpha_3 DG_{jt}+\alpha_4 DG2_{jt} \\
&+\alpha_5 UG_{jt}*NAIC_{jt-1}+\alpha_6 UG2_{jt}*NAIC_{jt-1}+\alpha_7 DG_{jt}*NAIC_{jt-1} \qquad (2b) \\
&+\alpha_8 DG2_{jt}*NAIC_{jt-1}+\alpha_9 NAIC_{jt-1}+\alpha_{10} Rating_{jt-1}+\alpha_{11}\Delta Mode_{jt} \\
&+Fixed\ Effects+\varepsilon_{ijt}
\end{aligned}
$$

, where $OTTI_{ijt}$ is 100 times the other-than-temporary-impairment deflated by the par value for period t and $Dum\_OTTI_{i,j,t}$ is an indicator variable that is equal to one if security j is OTTI recognized at period t, zero otherwise. The dependent variable in model (2b), Δ*FV Difference* is the change in FV difference of security j for firm i from year t-1 to year t, where FV difference is fair value/par value of security j of firm i minus the mode value of fair value/par value of security j across firms in year t, multiplied by 100. In addition to the ratings change variables, I also control for Δ*Mode*, which indicates the change in the mode value of fair value/par value across all firms for security j, multiplied by 100. The coefficients of interest for H2a (H2c) and H2b (H2d) are α_4 (α_8) in model (2a) and (2b), respectively.

To test the cross-sectional variation in an immediate disposal and valuation decisions upon a dual downgrade of lower-grade bonds, I estimate the following model with OLS and Logit regression.

$$\begin{aligned}
&Firesale[0,5]_{ijt} = \alpha_0 + \alpha_1 UG_{jt} + \alpha_2 UG2_{jt} + \alpha_3 DG_{jt} + \alpha_4 DG2_{jt} \\
&+\alpha_5 UG_{jt}*NAIC_{jt-1} + \alpha_6 UG2_{jt}*NAIC_{jt-1} + \alpha_7 DG_{jt}*NAIC_{jt-1} \qquad (3a) \\
&+\alpha_8 DG2_{jt}*NAIC_{jt-1} + \alpha_9 UG_{jt}*NAIC_{jt-1}*CS + \alpha_{10} UG2_{jt}*NAIC_{jt-1}*CS \\
&+\alpha_{11} DG_{jt}*NAIC_{jt-1}*CS + \alpha_{12} DG2_{jt}*NAIC_{jt-1}*CS + \alpha_{13} NAIC_{jt-1}*CS \\
&+\alpha_{14} UG_{jt}*CS + \alpha_{15} UG2_{jt}*CS + \alpha_{16} DG_{jt}*CS + \alpha_{17} DG2_{jt}*CS + \alpha_{18} CS \\
&+\alpha_{19} NAIC_{jt-1} + \alpha_{20} Rating_{jt-1} + Fixed\ Effects + \varepsilon_{ijt}
\end{aligned}$$

$$\begin{aligned}
&OTTI_{ijt},\ or\ Dum_OTTI_{ijt} = \beta_0 + \beta_1 UG_{jt} + \beta_2 UG2_{jt} + \beta_3 DG_{jt} \\
&+\beta_4 DG2_{jt} + \beta_5 UG_{jt}*NAIC_{jt-1} + \beta_6 UG2_{jt}*NAIC_{jt-1} + \beta_7 DG_{jt}*NAIC_{jt-1} \qquad (3b) \\
&+\beta_8 DG2_{jt}*NAIC_{jt-1} + \beta_9 UG_{jt}*NAIC_{jt-1}*CS + \beta_{10} UG2_{jt}*NAIC_{jt-1}*CS \\
&+\beta_{11} DG_{jt}*NAIC_{jt-1}*CS + \beta_{12} DG2_{jt}*NAIC_{jt-1}*CS + \beta_{13} NAIC_{jt-1}*CS \\
&+\beta_{14} UG_{jt}*CS + \beta_{15} UG2_{jt}*CS + \beta_{16} DG_{jt}*CS + \beta_{17} DG2_{jt}*CS + \beta_{18} CS \\
&+\beta_{19} NAIC_{jt-1} + \beta_{20} Rating_{jt-1} + Fixed\ Effects + \varepsilon_{ijt}
\end{aligned}$$

$$\begin{aligned}
&\Delta FV\ Difference_{ijt} = \gamma_0 + \gamma_1 UG_{jt} + \gamma_2 UG2_{jt} + \gamma_3 DG_{jt} + \gamma_4 DG2_{jt} \\
&+\gamma_5 UG_{jt}*NAIC_{jt-1} + \gamma_6 UG2_{jt}*NAIC_{jt-1} + \gamma_7 DG_{jt}*NAIC_{jt-1} \qquad (3c) \\
&+\gamma_8 DG2_{jt}*NAIC_{jt-1} + \gamma_9 UG_{jt}*NAIC_{jt-1}*CS + \gamma_{10} UG2_{jt}*NAIC_{jt-1}*CS \\
&+\gamma_{11} DG_{jt}*NAIC_{jt-1}*CS + \gamma_{12} DG2_{jt}*NAIC_{jt-1}*CS + \gamma_{13} NAIC_{jt-1}*CS \\
&+\gamma_{14} UG_{jt}*CS + \gamma_{15} UG2_{jt}*CS + \gamma_{16} DG_{jt}*CS + \gamma_{17} DG2_{jt}*CS + \gamma_{18} CS \\
&+\gamma_{19} NAIC_{jt-1} + \gamma_{20} Rating_{jt-1} + \gamma_{21} \Delta Mode_{jt} + Fixed\ Effects + \varepsilon_{ijt}
\end{aligned}$$

, where CS is a placeholder for seven cross-sectional variables: $HighMTM_{it}$, $HImpair_{ijt}$, $LowRBC_{it-1}$, $LowWeissRating_{it-1}$, $Commonality_{jt}$ and $Restriction_{it}$ ($Restriction\_Alt_{it}$). *HighMTM* is a high market-to-market indicator defined by Ellul et al. (2015). $HImpair_{ijt}$ is an indicator variable that is equal to one if the fair value of security is lower than the carrying value of security j in prior period, zero otherwise. $LowRBC_{it-1}$ is an indicator variable equal to one if the insurer's year-end RBC ratio is in the bottom quartile among all insurers, zero otherwise (following Ellul et al. (2015)) $LowWeissRating_{it-1}$ is an indicator variable equal to one if an insurer obtains a non-investment grade rating from Weiss rating agency, zero otherwise. $Commonality_{jt}$ is the number of insurers that hold the security j divided by the total number of insurer-securities for the year t. $Restriction_{it}$ is an indicator variable equal to one if a state where an insurer i is domiciled explicitly regulates the holding restrictions on lower- and medium-grade securities, zero otherwise. $Restriction\_Alt_{it}$ indicates a discrete variable equal to two if a state follows NAIC model law, three (one) if a state has stricter (laxer) law than NAIC model law, zero otherwise. The variable of interest is the interaction term $DG2_{jt}* NAIC_{jt-1}*CS$. Appendex A2 provides the expected results for each cross-sectional analysis.

Appendex A2.

Cross-section / Model	MTM	Impairment Risk	Firm Performance	Investment Commonality	Holding Restriction
Hypothesis	H3a	H3b	H3c, H3d	H3e	H3f
(3a)	$\alpha_{12} > 0$	$\alpha_{12} = 0$	$\alpha_{12} > 0$	$\alpha_{12} > 0$	$\alpha_{12} > 0$
(3b)	$\beta_{12} > 0$	$\beta_{12} = 0$	$\beta_{12} < 0$	$\beta_{12} > 0$	*n/a*
(3c)	$\gamma_{12} < 0$	$\gamma_{12} = 0$	$\gamma_{12} > 0$	$\gamma_{12} < 0$	*n/a*

3.3. Data Overview

Table 2 provides the summary statistics for the variables used in the regression analyses. Overall, ratings downgrade (upgrade) accounts for 14.5% (13.5%) of the whole sample, while ratings downgrade (upgrade) accompanied by NAIC designation downgrade (upgrade) accounts for 3.6% (4.2%) of the whole sample. The distribution of bonds by NAIC designation suggests the insurers' proclivity to hold safer assets. Investment-grade bond (NAIC 1-2) comprises 88% of the sample, while medium-grade (NAIC 3) and low-grade (NAIC 4-6) comprise 7.7% and 4.2% of the sample, respectively. However, insurers appear to prefer holding riskier assets within same risk category, as can be shown by the higher average of *Closer_to_DG2* (29.8%) than the average of *Closer_to_UG2* (21.1%). On average, 0.7% (0.3%) of securities are sold 10 days (5 days) within ratings announcement date of year t. The average amount of impairment is 9% of par value and likelihood of impairment recognition is approximately 0.5%. Despite low likelihood of OTTI recognition, 29% of securities are subject to high impairment risk (*HImpair*). The fair value estimate, on average, changes 1% of the par value each period (Δ*FV Difference*). Additionally, 43% of insurers are likely to be in High MTM states and 37.5% of insurers are likely to be in states with stringent investment holding restrictions.

[Insert Table 2 here]

4. Empirical Findings

4.1. Fire Sales upon a Dual Downgrade

Table 3 Panel A reports the effect of dual downgrade on fire sales decision. Columns (1) and (2) confirm *H1a* and show that insurers are less likely to engage in a fire sale for lower-quality bonds.

[Insert Table 3 here]

I further explore the dominating explanation for disposal decisions of lower grade bonds upon a dual downgrade. Table 4 Panel A reports the effect of dual downgrade on disposals classified based on the RBC ratio. The coefficients on *DG2*SVO* are statistically not different between insurers with low RBC ratio and with high RBC ratio, rejecting H1c (i.e., capital constraint concerns). Table 4 Panel B reports the effect of dual downgrade on sales classified based on the states' holding restrictions on lower- and medium-grade bonds. The coefficients on *DG2*SVO* are statistically not different between insurers in states with high restrictions and low restrictions, rejecting H1d (i.e., holding restriction concerns). Lastly, I explore whether illiquidity concern is a dominating explanation. Table 4 Panel C presents the descriptive statistics for illiquidity measure by risk category and shows that illiquidity measure (*Roll, IQR Range*) increases with higher risk category. Moreover, Table 4 Panel D shows that NAIC designation is significantly correlated with both *Roll* (0.12) and *IQR Range* (0.20). Figure 1 also shows that the illiquidity increases drastically from NAIC 4 to NAIC 5. Table 4 Panel E reports the effect of illiquidity on fire sales decision upon a dual downgrade. The coefficient on *DG2*IQR Range* and *DG2*Roll* are statistically significant and negative, particularly when the dependent variable is *FireSale [0,5]* (t=-1.88, t=-2.18, for columns (3) and (6), respectively). Overall, findings suggest that likelihood of immediate disposals upon dual downgrade for riskier bonds can be primarily explained by illiquidity concerns.

[Insert Table 4 here]

4.2. Impairment Recognition and Fair Value Estimation upon a Dual Downgrade

Table 5 Panel A reports the effect of downgrade on the probability and magnitude of OTTI recognition. Column (1) and (2) show that insurers likely recognize greater magnitude of OTTI upon a dual downgrade (t=7.12, t=3.96 for columns (1) and (2), respectively), but the association is weaker when the quality of bond becomes lower (t= -14.43 for columns (1) and (2), respectively). Column (3) reports that insurers more frequently recognize OTTI upon a dual downgrade (t=3.43), but the association is also weaker for lower-quality bonds (t= -5.06).

Table 5 Panel B reports the effect of downgrade on the change in fair value estimates. Column (1) reports the baseline results and shows that the change in fair value estimate is less favorable upon a dual downgrade (t= -3.26), but the association is weaker for lower-grade bonds (t=4.47). Column (2) and (3) further show that the association is even weaker for Level 3 assets (t=3.65, t=2.34 for columns (2) and (3), respectively), of which the estimations are based on the management inputs and more subject to discretion (Hanley et al. 2018). However, I fail to find weaker association for Level 2 assets. Collectively, the findings suggest that the strategic fair value estimation upon a dual downgrade for lower-quality bonds can be mainly evidenced in Level 3 assets.

[Insert Table 5 here]

4.3. Cross-Sectional Analyses for Disposal and Valuation Decision

Table 6 reports how immediate sales and valuation decisions upon a dual downgrade for lower-grade bonds vary with the cross-sectional variables. Table 6 Panel A shows that insurers in high MTM states are more likely to immediately sell, and more likely to recognize impairment with greater magnitude upon a dual downgrade for lower-quality bonds than insurers in low MTM state, which is consistent with the expectation. However, I fail to find the difference of change in fair value estimates upon a dual downgrade for riskier securities between insurers in high and low MTM state.[15]

In Table 6 Panel B, columns (3)-(5) show that although insurers are less likely to recognize OTTI upon a dual downgrade of lower grade bonds, once they do, they recognize OTTI in a greater magnitude for bonds with high impairment risk than bonds with low impairment risk. Column (1) shows that insurers are less likely to sell lower-quality bonds upon a dual downgrade if they are subject to high impairment risk.

Table 6 Panel C reports the results of cross-sectional analyses based on RBC ratio. While RBC ratio does not have mediating effect between *Firesale* (or Δ*FV Difference*) and *DG2*NAIC*, as shown in columns (1) and (2), I find evidence there is a lower probability and magnitude of

[15] Using alternative proxies for MTM state, as suggested by Ellul et al. (2015), the results remain consistent.

OTTI recognition upon a dual downgrade of riskier bonds for insurers who have RBC ratios that are within the lowest quartile range, consistent with the expectation (t= -7.52, -1.81 in columns (3) and (5), respectively). Moreover, Table 7 Panel D shows evidence that the change in fair value estimates is likely to be more positive and the likelihood as well as the magnitude of impairment recognition to be more negative upon a dual downgrade of lower-quality bonds for insurers with lower financial strength ratings (t=3.49, t= -10.12, t= 0-6.90, in columns (2), (3) and (5) respectively). Findings suggest that low performing insurers have greater incentives to over-value their lower-grade bonds that experience dual downgrades, either by inflating the fair value or delaying the impairment recognition.

Table 6 Panel E provides the cross-sectional results based on the investment holding commonality across insurers. Column (1) shows that insurers are more likely to immediately sell lower-grade bonds upon a dual downgrade, particularly when those bonds are commonly held by other insurers. This finding confirms the prediction that insurers are more likely to dispose of the assets with commonality, because of higher fire sale risk. Moreover, I find evidence that insurers are more likely to recognize OTTI and with greater magnitude (t=2.36, t=3.04, in columns (3) and (5) respectively).

Table 6 Panel F reports results on whether higher holding restrictions on lower- and medium-grade bonds induce insurers to dispose of their lower-grade bonds upon a dual downgrade. There is no evidence that this is the case. Instead, I partially find negative coefficient on *DG*NAIC*Restriction* (t= -1.91) in column (2). This finding also rejects the holding restriction concerns for disposal decisions, as explained in section 4.1.

[Insert Table 6 here]

4.4. Additional Analyses

I further explore whether insurers can effectively delay the impairment recognition. Table 7 Panel A provides the results based on the probability and magnitude of OTTI further extended to the next period as a dependent variable. The coefficient on *DG2*NAIC* is statistically insignificant in Column (2). However, Column (1) shows that insurers can effectively recognize less impairment upon a dual downgrade for lower-grade bonds.

In addition, I examine whether insurers prepare for expected dual downgrades beforehand. *Close_to_DG2* (*Close_to_UG2*) is an indicator variable that equals one if a security is rated in the borderline between the current NAIC designation and one notch lower (higher) NAIC designation at period t-1, zero otherwise. *Close_to_DG2*NAIC* is the variable of interest across all columns. Collectively, insurers do not appear to expect ahead and sell or value securities beforehand for future downgrades that might be associated with NAIC designation downgrade. Still, there is partial evidence that insurers recognize lower magnitude of impairment for low-quality bonds that are expected to experience dual downgrades in the future (t=-11.68 in Column (4)).

[Insert Table 7 here]

5. Conclusion

In this study, I explore the fire sales, fair value estimation, and impairment recognition upon a dual downgrade. I find evidence that there is higher likelihood of fire sales upon a dual downgrade than single downgrade, but the association is mitigated among lower-grade bonds. Findings also show that there are higher probability and magnitude of OTTI recognition, and lower change in fair value estimates upon a dual downgrade than a single downgrade, but such relation is weaker among lower-grade bonds.

Cross-sectional analyses show that the likelihood of fire sales upon a dual downgrade for riskier bonds is higher in higher MTM states, and among securities that are more commonly held by insurers and lower for securities that are subject to higher impairment risk. The change in fair value estimates upon a dual downgrade for riskier bonds is higher for firms with lower financial strength ratings. Impairment recognition upon a dual downgrade for riskier bonds is more likely or larger in higher MTM states, for firms with higher RBC ratio or greater financial strength ratings, and for securities that are more commonly held. As for securities with high impairment risk, insurers are less likely to recognize OTTI of lower-grade bonds upon a dual downgrade but once they do, they recognize OTTI with a greater magnitude.

In summary, this study provides evidence that, although life insurers are less likely to immediately sell riskier bonds upon a dual downgrade, primarily because of illiquidity, they exhibit opportunistic valuations of such bonds, by delaying OTTI, recognizing the smaller amount of it, or inflating the fair value. Future research could extend the costs and benefits of strategic valuation and recognition upon a ratings downgrade.

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Appendix B: Variable Definitions

Appendix B describes the variables used in this study. I use NAIC filing database from 2014-2017. Credit ratings information is collected from Mergent FSID database.

Variable	Variable Definition
$UG(DG)_{j,t}$	Indicator variable equal to one if a security is graded upward (downward) by the rating agency from t-1 to t. For each period t-1 and t, if there are two ratings, the lower rating is considered. If there are three distinct ratings, the median rating is considered.
$UG2(DG2)_{j,t}$	Indicator variable equal to one if a security is graded upward (downward) by the rating agency and the NAIC SVO level is also upgraded (downgraded) from t-1 to t. For each period t-1 and t, if there are two ratings, the lower rating is considered. If there are three distinct ratings, the median rating is considered.
$Close\_to\_DG2_{j,t-1}$	Indicator variable that equals one if a security j has rating that is near downgrade change, and zero otherwise.
$Close\_to\_UG2_{j,t-1}$	Indicator variable that equals one if a security j has rating that is near upgrade change, and zero otherwise.
$SVO[k]_{i,j,t-1}$	Indicator variable equal 1 if a security j of firm i is designated at SVO k at period t-1, zero otherwise.
$Level3_{i,j,t}$	Indicator variable equal to one if a security j is designated at level 3, zero otherwise.
$FireSale[0,10]_{i,j,t}$	Indicator variable equal to one if a security j is disposed during the period t, within 10 days after it has been rated by a rating agency, zero otherwise. If there are two ratings, the lower rating is considered. If there are three distinct ratings, the medium rating is considered. If there is no selling activity, it is coded as zero.
$FireSale[0,5]_{i,j,t}$	Indicator variable equal to one if a security j is disposed during the period t, within 5 days after it has been rated by a rating agency, zero otherwise. If there are two ratings, the lower rating is considered. If there are three distinct ratings, the medium rating is considered. If there is no selling activity, it is coded as zero.
$OTTI_{i,j,t}$	100 times the other-than-temporary-impairment deflated by the par value for period t
$Dum\_OTTI_{i,j,t}$	Indicator variable that is equal to one if security j is OTTI recognized at period t, zero otherwise
$OTTI_{i,j,[t,t+1]}$	100 times the other-than-temporary-impairment during period between t and t+1 deflated by the par value for period t
$Dum\_OTTI_{i,j,[t,t+1]}$	Indicator variable that is equal to one if security j is OTTI recognized during the period between t and t+1, zero otherwise
$OTTI_{i,j,t-1}$	100 times the other-than-temporary-impairment deflated by the par value for period t-1.
$Dum\_OTTI_{i,j,t-1}$	Indicator variable that is equal to one if security j is OTTI recognized at period t-1, zero otherwise.
$\Delta FV\ Difference_{i,j,t}$	The change in FV difference of security j for firm i from year t-1 to year t, where FV difference is fair value/par value of security j of firm i minus the mode value of fair value/par value of security j across firms in year t, multiplied by 100.
$\Delta Mode_{j,t}$	Change in the mode value of fair value/par value across all firms for security j , multiplied by 100.
$NAIC_{j,t-1}$	SVO designation of a security j at period t-1
$Rating_{j,t-1}$	Rating of a security j at period t-1
$HighMTM_{i,t}$	High MTM state indicator defined by Ellul et al. (2015)
$HImpair_{i,j,t}$	Indicator variable that is 1 if the fair value of security in period t-1 is less than the carrying value of security j in period t-1, otherwise 0.

$RBC_{i,t-1}$	RBC ratio at period t-1, where RBC ratio is total adjusted capital divided by total risk-based capital.
$LowRBC_{i,t-1}$	Indicator variable equal to one if the insurer's year-end RBC ratio is in the botton quartile among all insurers, zero otherwise (following Ellul et al. (2015))
$WeissRating_{i,t-1}$	Insurer i's rating by weiss rating agency at period t-1
$LowWeissRating_{i,t-1}$	Indicator variable equal to one if the insurer i obtained non-investment grade rating from Weiss rating agency, zero otherwise
$IQR\ Range_{j,t}$	Interquartile range based on Schestag et al. (2016)
$Roll_{j,t}$	Roll measure based on Dick-Nielson et al. (2012)
$Commonality_{j,t}$	The number of insurers that hold the security j divided by the number of insurer-securities for the year t.
$Restriction_{i,t}$	Indicator variable equal to one if a state where an insurer i is domiciled explicitly regulates holding restrictions on lower- and medium-grade securities, zero otherwise.
$Restriction\_Alt_{i,t}$	Discrete variable equal to two if a state follows NAIC model law, three (one) if a state has stricter (laxer) law than NAIC model law, zero otherwise.

Appendix C: Classifications of U.S. States into Groups with and without Holding Restrictions of Lower- and Medium- Quality Investments

Appendix C Panel A lists the value of holding restrictions dummy for different U.S. states. The classifications are based on the insurance codes for each state. Baseline classification is based on whether a state has codes that restrict holdings of lower- and medium- quality investments. Alternative classification is based on the level of restrictions. If a state follows NAIC model law, without adjustment, it is coded as 2. If a state regulates with stricter (looser) restrictions than NAIC model law, it is coded as 3 (1). Appendix C Panel B exhibits examples of codes on holding restrictions, classified based on the stringency level of the regulation.

Panel A: Classification of Holding Restrictions

State	Baseline	Alternative
AL	0	0
AK	0	0
AZ	0	0
AR	1	1
CA	0	0
CO	0	0
CT	0	0
DE	1	2
FL	1	3
GA	0	0
HI	0	0
ID	0	0
IL	1	2
IN	0	0
IA	0	0
KS	0	0
KY	1	2
LA	0	0
ME	1	2
MD	0	0
MA	1	2
MI	1	1
MN	1	3
MS	0	0
MO	1	2
MT	1	2
NE	1	3
NV	1	2
NH	0	0
NJ	0	0
NM	0	0
NY	0	0

NC	1	2
ND	0	0
OH	1	1
OK	1	3
OR	1	1
PA	0	0
RI	0	0
SC	1	2
SD	1	2
TN	0	0
TX	0	0
UT	0	0
VT	1	2
VA	1	2
WA	0	0
WV	1	2
WI	0	0
WY	0	0

Panel B: Examples of Statutes

A. NAIC Model Law

A domestic insurer shall not acquire, directly or indirectly, a medium grade or lower-grade obligation of an institution if, after giving effect to the acquisition, the aggregate amount of all medium grade and lower-grade obligations then held by the domestic insurer would exceed twenty percent (20%) of its admitted assets provided that no more than ten percent (10%) of its admitted assets consists of obligations rated four, five or six by the Securities Valuation Office; and no more than three percent (3%) of its admitted assets consists of obligations rated five or six by the Securities Valuation Office, and no more than one percent (1%) of its admitted assets consists of obligations rated six by the Securities Valuation Office. Attaining or exceeding the limit of any one category shall not preclude an insurer from acquiring obligations in other categories subject to the specific and multi-category limits

B. Stricter Regulation compared to NAIC Model Law

Excerpts from 2016 Florida Statutes

The cost of investments in bonds, debentures, notes, commercial paper, or other debt obligations issued, assumed, or guaranteed by any solvent institution, which investments are classified as medium to lower-quality obligations, other than obligations of subsidiaries or related corporations as that term is defined in s. 625.325, shall be limited to:

(a) No more than 13 percent of an insurer's admitted assets.

(b) No more than 5 percent of an insurer's admitted assets in obligations that have been given a rating of 4, 5, or 6 by the Securities Valuation Office of the National Association of Insurance Commissioners.

(c) No more than 1.5 percent of an insurer's admitted assets in obligations that have been given a rating of 5 or 6 by the Securities Valuation Office of the National Association of Insurance Commissioners.

(d) No more than 0.5 percent of an insurer's admitted assets in obligations that have been given a rating of 6 by the Securities Valuation Office of the National Association of Insurance Commissioners.

(e) No more than 10 percent of an insurer's admitted assets, if the investments are in issuers from any one industry.

(f) No more than 2 percent of an insurer's admitted assets if the investment is in any one issuer.

C. Laxer Regulation compared to NAIC Model Law

Excerpts from 2017 Oregon Statutes

Investment of funds in obligations that are not investment quality; rules. Funds of an insurer may be invested in obligations that are not investment grade as established by the Director of the Department of Consumer and Business Services by rule, but the funds that an insurer may invest under this section shall not exceed 20 percent of the insurer's assets.

Figure 1. The Liquidity Measure by Risk Category

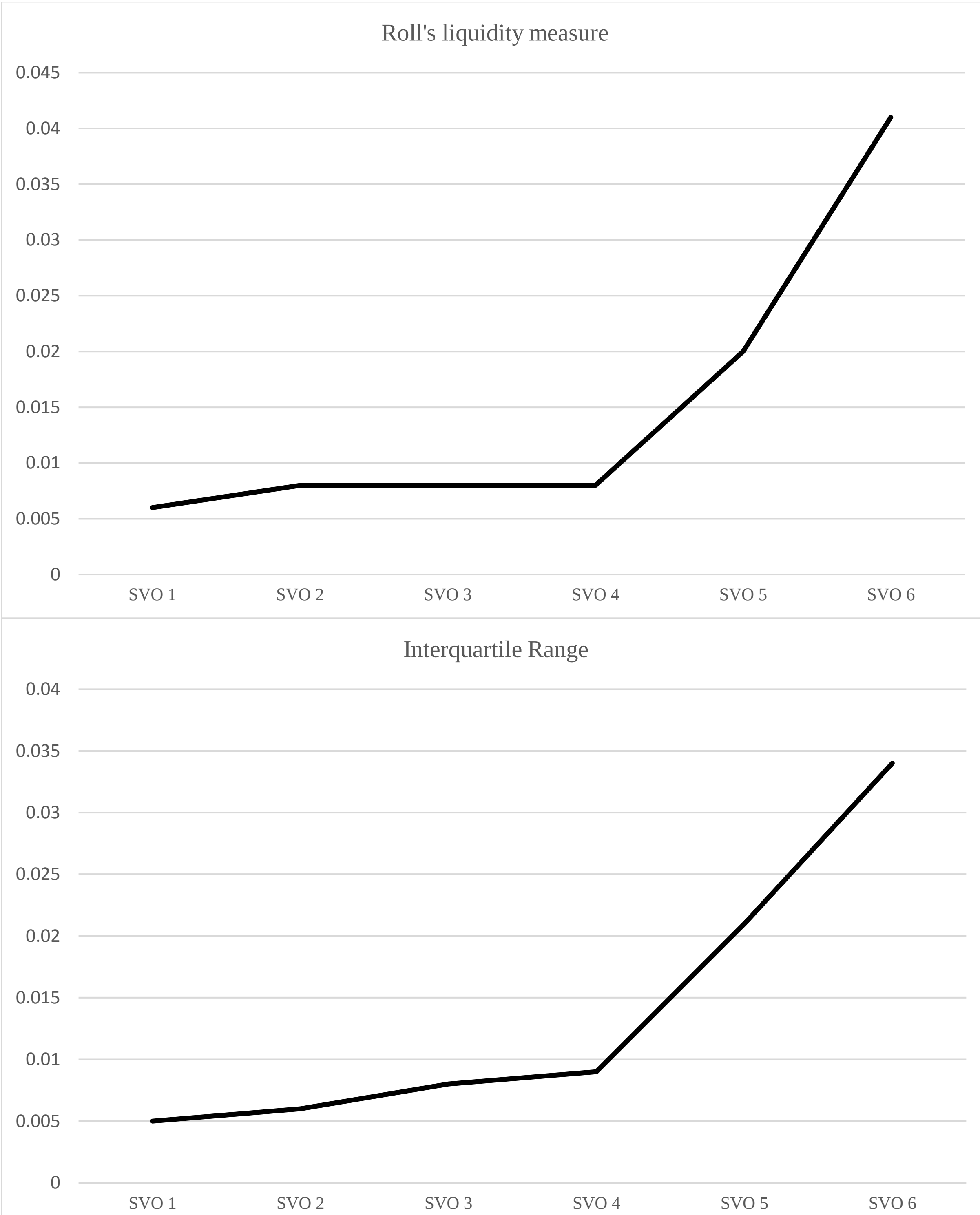

Table 1: Sample Selection Process

Steps	# Insurer-years	# Security-insurer-years
Step 1: All insurers on Schedule D filing during 2014-2017 merged with ratings from Mergent FSID	2,917	3,227,471
Step 2: Remove US-treasuries, US-government securities and structured securities (RMBS, CMBS, other structured securities)	2,793	2,576,669
Step 3: Remove security-years that did not obtain any rating from 3 rating agencies at period t-1 or t	2,591	602,747
Step 4: Remove observations with missing variables	2,591	434,914
Step 5: Keep when actual SVO (both t-1, t) equals the SVO based on Rating (both t-1, t)	2,591	334,239

Table 2: Insurer and Security Characteristics

Table 2 provides descriptive statistics for the variables used in main analysis. The Appendix B provides variable definitions.

	Mean	p25	p50	p75	sd
$UG_{j,t}$	0.145	0.000	0.000	0.000	0.352
$UG2_{j,t}$	0.036	0.000	0.000	0.000	0.187
$DG_{j,t}$	0.135	0.000	0.000	0.000	0.342
$DG2_{j,t}$	0.042	0.000	0.000	0.000	0.200
$Close\_to\_DG2_{j,t-1}$	0.298	0.000	0.000	1.000	0.458
$Close\_to\_UG2_{j,t-1}$	0.211	0.000	0.000	0.000	0.408
$NAIC\ 1_{i,j,t-1}$	0.417	0.000	0.000	1.000	0.498
$NAIC\ 2_{i,j,t-1}$	0.463	0.000	0.000	1.000	0.498
$NAIC\ 3_{i,j,t-1}$	0.077	0.000	0.000	0.000	0.244
$NAIC\ 4_{i,j,t-1}$	0.036	0.000	0.000	0.000	0.156
$NAIC\ 5_{i,j,t-1}$	0.005	0.000	0.000	0.000	0.059
$NAIC\ 6_{i,j,t-1}$	0.001	0.000	0.000	0.000	0.015
$FireSale[0,10]_{i,j,t}$	0.007	0.000	0.000	0.000	0.084
$FireSale[0,5]_{i,j,t}$	0.003	0.000	0.000	0.000	0.059
$OTTI_{i,j,t}$	0.091	0.000	0.000	0.000	2.107
$Dum\_OTTI_{i,j,t}$	0.005	0.000	0.000	0.000	0.068
$OTTI_{i,j,[t,t+1]}$	0.144	0.000	0.000	0.000	2.825
$Dum\_OTTI_{i,j,[t,t+1]}$	0.007	0.000	0.000	0.000	0.084
$\Delta FV\ Difference_{i,j,t}$	0.016	0.000	0.000	0.000	1.157
$\Delta Mode_{j,t}$	-0.069	-3.200	0.000	3.090	8.337
$NAIC_{j,t-1}$	1.750	1.000	2.000	2.000	0.793
$Rating_{j,t-1}$	8.148	6.000	8.000	10.000	2.727
$HighMTM_{i,t}$	0.434	0.000	0.000	1.000	0.496
$HImpair_{i,j,t}$	0.290	0.000	0.000	1.000	0.454
$RBC_{i,t-1}$	10.923	7.590	9.628	11.826	6.969
$LowRBC_{i,t-1}$	0.251	0.000	0.000	1.000	0.433
$WeissRating_{i,t-1}$	5.461	4.000	5.000	6.000	2.194
$LowWeissRating_{i,t-1}$	0.236	0.000	0.000	0.000	0.425
$Commonality_{jt}$	0.023	0.015	0.022	0.030	0.013
$IQR\ Range_{j,t}$	0.006	0.002	0.004	0.008	0.007
$Roll_{j,t}$	0.007	0.004	0.006	0.010	0.010
$Restriction\_{}_{i,t}$	0.377	0.000	0.000	1.000	0.485
$Restriction\_Alt_{i,t}$	0.759	0.000	0.000	2.000	1.059

Table 3: The Likelihood of Disposals upon a Dual Downgrade

Table 3 provides the propensity of fire sales upon a dual downgrade. The columns report OLS regression results using $FireSale[0,10]_{i,j,t}$, and $FireSale[0,5]_{i,j,t}$ as a dependent variable, respectively. The Appendix B provides variable definitions. ***, **, * indicate significance at 1%, 5%, and 10%, respectively.

Dependent Variable =	(1) *FireSale[0,10]*	(2) *FireSale[0,5]*
$UG_{j,t}$	0.353	0.907**
	(1.30)	(2.30)
$UG2_{j,t}$	-0.652	-0.095
	(-0.88)	(-0.10)
$DG_{j,t}$	-0.387	0.114
	(-1.57)	(0.34)
$DG2_{j,t}$	2.501***	1.973***
	(8.07)	(4.73)
$UG_{j,t} * NAIC_{j,t-1}$	-0.176	-0.507***
	(-1.43)	(-2.66)
$UG2_{j,t} * NAIC_{j,t-1}$	0.303	0.384
	(1.37)	(1.25)
$DG_{j,t} * NAIC_{j,t-1}$	0.241**	0.193
	(2.50)	(1.50)
$DG2_{j,t} * NAIC_{j,t-1}$	-0.698***	-0.622***
	(-5.36)	(-3.69)
$NAIC_{j,t-1}$	0.616***	-0.186
	(4.72)	(-0.90)
$Rating_{j,t-1}$	-0.015	0.281***
	(-0.39)	(4.32)
Observations	334,239	334,239
Pseudo R^2	0.029	0.032
Year FE	YES	YES
Firm FE	NO	NO

Table 4: Explanations for Fire Sales of Lower-Grade Bonds upon a Dual Downgrade

Table 4 tests whether liquidity is the factor that causes differences in sales decision upon a dual downgrade among risk categories. Panel A, B and E report OLS regression results using $FireSale[0,10]_{i,j,t}$, $FireSale[0,5]_{i,j,t}$ as a dependent variable, respectively. Panel C shows the descriptive statistics on liquidity measure classified based on NAIC designation. Panel D provides Pearson correlation statistics between NAIC risk category and liquidity measure. The Appendix B provides variable definitions. ***, **, * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: Low RBC Ratio

Dependent Variable =	(1) *FireSale[0,10]*	(2) *FireSale[0,10]*	(3) *FireSale[0,5]*	(4) *FireSale[0,5]*
Low RBC	YES	NO	YES	NO
$UG_{j,t}$	0.001	0.001	0.001	0.001**
	(0.72)	(1.46)	(1.28)	(2.19)
$UG2_{j,t}$	-0.011**	-0.004	-0.003	-0.003
	(-2.37)	(-1.57)	(-0.97)	(-1.42)
$DG_{j,t}$	-0.001	-0.003***	-0.001	-0.002***
	(-0.48)	(-4.35)	(-0.65)	(-3.53)
$DG2_{j,t}$	0.006***	0.010***	0.002	0.005***
	(2.79)	(7.99)	(1.35)	(5.46)
$UG_{j,t}$ * $NAIC_{j,t-1}$	-0.001	-0.001	-0.000	-0.001***
	(-0.94)	(-1.37)	(-0.87)	(-2.73)
$UG2_{j,t}$* $NAIC_{j,t-1}$	0.007***	0.001	0.003**	0.001**
	(4.67)	(1.20)	(2.57)	(1.99)
$DG_{j,t}$* $NAIC_{j,t-1}$	0.001**	0.002***	0.001**	0.001***
	(2.04)	(5.03)	(2.36)	(4.99)
$DG2_{j,t}$* $NAIC_{j,t-1}$	-0.003**	-0.002***	-0.001	-0.001***
	(-2.42)	(-3.65)	(-1.00)	(-2.85)
$NAIC_{j,t-1}$	0.002***	0.001***	0.000	-0.000
	(2.74)	(3.71)	(0.71)	(-0.12)
$Rating_{j,t-1}$	-0.000	-0.000	0.000	0.000***
	(-0.88)	(-0.02)	(1.01)	(3.50)
Observations	79,428	253,700	79,428	253,700
R-squared	0.010	0.005	0.005	0.004
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Test of Coefficients for $\boldsymbol{DG2_{j,t}}$*$NAIC_{j,t-1}$	χ2 (p-value) 0.03 (0.871)		χ2 (p-value) 0.07 (0.792)	

Panel B: State Holding Restrictions

Dependent Variable =	(1) *FireSale[0,10]*	(2) *FireSale[0,10]*	(3) *FireSale[0,5]*	(4) *FireSale[0,5]*
Holding Restrictions	YES	NO	YES	NO
$\boldsymbol{UG_{j,t}}$	-0.001	0.001	-0.001	0.001
	(-0.84)	(0.90)	(-0.98)	(1.25)
$\boldsymbol{UG2_{j,t}}$	0.002	-0.006**	0.002	-0.002
	(0.31)	(-2.02)	(0.41)	(-0.85)
$\boldsymbol{DG_{j,t}}$	-0.011***	-0.002*	-0.008***	-0.001
	(-7.24)	(-1.75)	(-7.12)	(-1.30)
$\boldsymbol{DG2_{j,t}}$	0.015***	0.008***	0.008***	0.004***
	(5.72)	(5.70)	(4.14)	(3.83)
$\boldsymbol{UG_{j,t}}$ * $NAIC_{j,t-1}$	0.000	-0.001	0.000	-0.001**
	(0.52)	(-1.22)	(0.58)	(-1.97)
$\boldsymbol{UG2_{j,t}}$* $NAIC_{j,t-1}$	-0.001	0.003***	-0.001	0.001*
	(-0.58)	(2.60)	(-0.65)	(1.73)
$\boldsymbol{DG_{j,t}}$* $NAIC_{j,t-1}$	0.008***	0.001**	0.006***	0.001**
	(10.02)	(2.41)	(9.58)	(2.19)
$\boldsymbol{DG2_{j,t}}$* $NAIC_{j,t-1}$	-0.009***	-0.002***	-0.006***	-0.001
	(-6.87)	(-2.58)	(-6.02)	(-1.24)
$NAIC_{j,t-1}$	0.000	0.002***	0.000	0.000
	(0.48)	(3.92)	(0.00)	(0.43)
$\boldsymbol{Rating_{j,t-1}}$	-0.000	-0.000	0.000	0.000**
	(-0.17)	(-0.36)	(0.50)	(2.40)
Observations	32,498	199,467	32,498	199,467
R-squared	0.011	0.005	0.008	0.003
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Test of Coefficients for $\boldsymbol{DG2_{j,t}}$*$NAIC_{j,t-1}$	χ2 (p-value) 0.52 (0.472)		χ2 (p-value) 1.08 (0.299)	

Panel C: Liquidity Measure by Risk Category

NAIC Category 1	Mean	p25	p50	p75	sd
$Roll_{j,t}$	0.006	0.003	0.005	0.008	0.005
$IQR\ Range_{j,t}$	0.005	0.002	0.004	0.007	0.005
NAIC Category 2	Mean	p25	p50	p75	sd
$Roll_{j,t}$	0.008	0.004	0.007	0.011	0.006
$IQR\ Range_{j,t}$	0.006	0.003	0.005	0.008	0.006
NAIC Category 3	Mean	p25	p50	p75	sd
$Roll_{j,t}$	0.008	0.004	0.007	0.011	0.005
$IQR\ Range_{j,t}$	0.008	0.004	0.006	0.009	0.007
NAIC Category 4	Mean	p25	p50	p75	sd
$Roll_{j,t}$	0.008	0.004	0.007	0.010	0.007
$IQR\ Range_{j,t}$	0.009	0.004	0.006	0.010	0.011
NAIC Category 5	Mean	p25	p50	p75	sd
$Roll_{j,t}$	0.020	0.005	0.007	0.011	0.114

IQR Range$_{j,t}$	0.021	0.005	0.010	0.017	0.064
NAIC Category 6	Mean	p25	p50	p75	sd
Roll$_{j,t}$	0.041	0.007	0.012	0.021	0.201
IQR Range$_{j,t}$	0.034	0.011	0.016	0.029	0.084

Panel D: Pearson Correlation between Liquidity Measures and Risk Category

	(1) *NAIC*$_{j,t-1}$	(2) *Roll*$_{j,t}$	(3) *IQR Range*$_{j,t}$
NAIC$_{j,t-1}$	1.00		
Roll$_{j,t}$	0.12***	1.00	
IQR Range$_{j,t}$	0.20***	0.70***	1.00

Panel E: The Effect of Illiquidity on Sales Decision upon a Dual Downgrade

Dependent Variable =	(1) *FireSale[0,10]*	(2) *FireSale[0,5]*	(3) *FireSale[0,10]*	(4) *FireSale[0,5]*
UG$_{j,t}$	0.001	0.000	-0.000	-0.000
	(1.34)	(0.49)	(-0.15)	(-0.42)
UG2$_{j,t}$	0.003***	0.002**	0.005***	0.003**
	(2.85)	(2.06)	(3.71)	(2.54)
DG$_{j,t}$	0.001	0.000	0.001	0.000
	(1.40)	(1.54)	(0.98)	(0.64)
DG2$_{j,t}$	0.005***	0.002***	0.005***	0.002***
	(7.16)	(4.73)	(6.47)	(4.41)
UG$_{j,t}$ * *IQR Range*$_{j,t}$	-0.164**	-0.040		
	(-2.40)	(-0.86)		
UG2$_{j,t}$* *IQR Range*$_{j,t}$	-0.057	0.005		
	(-0.39)	(0.05)		
DG$_{j,t}$* *IQR Range*$_{j,t}$	0.059	0.066**		
	(1.25)	(2.07)		
DG2$_{j,t}$* *IQR Range*$_{j,t}$	-0.078	-0.064*		
	(-1.56)	(-1.88)		
UG$_{j,t}$ * *Roll*$_{j,t}$			-0.079	0.007
			(-1.03)	(0.13)
UG2$_{j,t}$* *Roll*$_{j,t}$			-0.305*	-0.108
			(-1.77)	(-0.90)
DG$_{j,t}$* *Roll*$_{j,t}$			0.070	0.094**
			(1.20)	(2.31)
DG2$_{j,t}$* *Roll*$_{j,t}$			-0.087	-0.085**
			(-1.55)	(-2.18)
IQR Range$_{j,t}$	-0.004	-0.017		
	(-0.18)	(-1.12)		
Roll$_{j,t}$			0.015	-0.007
			(0.59)	(-0.37)
Rating$_{j,t-1}$	0.000***	0.000***	0.000***	0.000***
	(7.75)	(7.57)	(7.29)	(7.00)
Observations	249,564	249,564	217,655	217,655
R-squared	0.006	0.004	0.007	0.005
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES

Table 5: The Probability and Magnitude of Impairment,

and the Change in Fair Value Estimate upon a Dual Downgrade

Table 5 provides results on the probability and the magnitude of impairment upon a dual downgrade. The columns of Panel A (B) report OLS regression results using $OTTI_{i,j,t}$ ($\Delta FV\ Difference_{i,j,t}$) as a dependent variable, respectively, and a Logit regression result using $Dum\_OTTI_{i,j,t}$. The Appendix B provides variable definitions. ***, **, * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: The Probability and Magnitude of Impairment upon a Dual Downgrade

Dependent Variable =	(1) $OTTI_{i,j,t}$	(2) $OTTI_{i,j,t}$	(3) $Dum\_OTTI_{i,j,t}$
	Whole Sample	*Impairment Sample*	*Whole Sample*
$UG_{j,t}$	0.394***	-4.308	0.007***
	(11.87)	(-0.80)	(6.14)
$UG2_{j,t}$	0.860***	9.995	0.033***
	(6.70)	(0.65)	(7.05)
$DG_{j,t}$	-0.270***	4.285	-0.007***
	(-7.98)	(1.14)	(-5.75)
$DG2_{j,t}$	0.419***	16.835***	0.007***
	(7.12)	(3.96)	(3.43)
$UG_{j,t} * NAIC_{j,t-1}$	-0.170***	1.038	-0.003***
	(-9.60)	(0.64)	(-5.02)
$UG2_{j,t} * NAIC_{j,t-1}$	-0.217***	-5.293	-0.010***
	(-5.04)	(-1.39)	(-6.24)
$DG_{j,t} * NAIC_{j,t-1}$	0.122***	2.884**	0.004***
	(6.67)	(2.51)	(5.85)
$DG2_{j,t} * NAIC_{j,t-1}$	-0.392***	-0.850	-0.005***
	(-14.43)	(-0.69)	(-5.06)
$NAIC_{j,t-1}$	-0.338***	8.670***	-0.008***
	(-8.50)	(4.05)	(-5.46)
$Rating_{j,t-1}$	-0.191***	-1.317**	-0.003***
	(-15.86)	(-1.97)	(-6.98)
Observations	305,805	1,388	306,910
R-squared	0.488	0.398	0.275
Year FE	YES	YES	YES
Firm FE	YES	NO	NO

Panel B: The Change in FV Estimate upon a Dual Downgrade

Dependent Variable =	(1) $\Delta FV\ Difference$	(2) $\Delta FV\ Difference$	(3) $\Delta FV\ Difference$
$UG_{j,t}$	0.004	0.002	-0.124*
	(0.23)	(0.08)	(-1.67)
$UG2_{j,t}$	0.042	0.046	-0.141
	(0.57)	(0.62)	(-0.56)
$DG_{j,t}$	-0.011	-0.009	0.846***
	(-0.58)	(-0.48)	(12.33)
$DG2_{j,t}$	-0.113***	-0.109***	-0.920***
	(-3.26)	(-3.14)	(-8.39)
$UG_{j,t} * NAIC_{j,t-1}$	0.012	0.012	0.128***
	(1.15)	(1.22)	(3.10)

$UG2_{j,t}$* $NAIC_{j,t-1}$	-0.024	-0.025	-0.035
	(-0.98)	(-1.01)	(-0.39)
$DG_{j,t}$* $NAIC_{j,t-1}$	0.009	0.007	-0.537***
	(0.85)	(0.69)	(-13.88)
$DG2_{j,t}$* $NAIC_{j,t-1}$	0.072***	0.072***	0.491***
	(4.47)	(4.49)	(8.38)
$UG_{j,t}$ * $NAIC_{j,t-1}$*$Level2_{i,j,t}$			-0.121***
			(-2.91)
$UG2_{j,t}$* $NAIC_{j,t-11}$*$Level2_{i,j,t}$			0.007
			(0.08)
$DG_{j,t}$* $NAIC_{j,t-1}$*$Level2_{i,j,t}$			0.568***
			(14.62)
$DG2_{j,t}$* $NAIC_{j,t-1}$*$Level2_{i,j,t}$			-0.438***
			(-7.42)
$UG_{j,t}$ * $NAIC_{j,t-1}$*$Level3_{i,j,t}$		-0.376*	-0.507**
		(-1.93)	(-2.55)
$UG2_{j,t}$* $NAIC_{j,t-1}$*$Level3_{i,j,t}$		-0.056	0.051
		(-0.10)	(0.09)
$DG_{j,t}$* $NAIC_{j,t-1}$*$Level3_{i,j,t}$		1.339***	1.869***
		(6.03)	(8.31)
$DG2_{j,t}$* $NAIC_{j,t-1}$*$Level3_{i,j,t}$		1.184***	0.769**
		(3.65)	(2.34)
$NAIC_{j,t-1}$* $Level2_{i,j,t}$			-0.023
			(-1.16)
$NAIC_{j,t-1}$* $Level3_{i,j,t}$		-0.647***	-0.669***
		(-5.19)	(-5.30)
$UG_{j,t}$ * $Level2_{i,j,t}$			0.132*
			(1.77)
$UG2_{j,t}$ * $Level2_{i,j,t}$			0.199
			(0.79)
$DG_{j,t}$ * $Level2_{,j,t}$			-0.892***
			(-13.03)
$DG2_{j,t}$ * $Level2_{i,j,t}$			0.848***
			(7.80)
$UG_{j,t}$ * $Level3_{i,j,t}$		2.796***	2.948***
		(6.08)	(6.33)
$UG2_{j,t}$ * $Level3_{i,j,t}$		-1.017**	*(omitted)*
		(-2.28)	
$DG_{j,t}$ * $Level3_{,j,t}$		-7.079***	-1.852***
		(-9.19)	(-4.11)
$DG2_{j,t}$ * $Level3_{i,j,t}$		1.154***	-6.275***
		(4.71)	(-8.07)
$Level2_{i,j,t}$			-0.010
			(-0.21)
$Level3_{i,j,t}$		0.034	1.144***
		(1.51)	(4.59)
$NAIC_{j,t-1}$	0.035	0.008	0.060**
	(1.55)	(1.20)	(2.01)
$Rating_{j,t-1}$	0.008	-0.008***	0.008
	(1.13)	(-26.68)	(1.22)
$\Delta Mode_{j,t}$	-0.008***	2.638***	-0.008***
	(-26.84)	(54.85)	(-26.91)
Observations	323,626	323,626	323,626
R-squared	0.141	0.142	0.143
Year FE	YES	YES	YES

Firm FE	YES	YES	YES

Table 6: The Cross-Sectional Analysis

Table 6 reports OLS regression results using $FireSale[0,5]_{i,j,t}$, $\Delta FV\ Difference_{i,j,t}$, $OTTI_{i,j,t}$, as a dependent variable, respectively, and a Logit regression result using $Dum\_OTTI_{i,j,t}$ as a dependent variable. The Appendix B provides variable definitions. ***, **, * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: MTM State

Dependent Variable =	(1) $FireSale[0,5]_{i,j,t}$	(2) $\Delta FV\ Difference_{i,j,t}$	(3) $OTTI_{i,j,t}$	(4) $OTTI_{i,j,t}$	(5) $Dum\_OTTI_{i,j,t}$
Sample Size	*Whole Sample*	*Whole Sample*	*Whole Sample*	*Impairment Sample*	*Whole Sample*
$UG_{j,t}$	0.001	0.007	0.407***	-15.903	-1.412**
	(1.00)	(0.39)	(10.73)	(-1.31)	(-2.57)
$UG2_{j,t}$	-0.007***	-0.044	0.794***	16.227	0.615
	(-3.38)	(-0.69)	(5.43)	(0.77)	(0.53)
$DG_{j,t}$	-0.002***	0.017	-0.337***	6.482	0.917***
	(-4.13)	(0.96)	(-8.78)	(1.02)	(2.87)
$DG2_{j,t}$	0.004***	-0.043	0.477***	16.580***	1.954***
	(4.09)	(-1.50)	(7.26)	(2.72)	(5.96)
$UG_{j,t}$ * $NAIC_{j,t-1}$	-0.000	0.010	-0.177***	3.980	0.340**
	(-0.42)	(1.04)	(-8.75)	(1.25)	(2.31)
$UG2_{j,t}$ *$NAIC_{j,t-1}$	0.003***	0.005	-0.181***	-6.067	-0.318
	(4.04)	(0.22)	(-3.67)	(-1.18)	(-1.13)
$DG_{j,t}$* $NAIC_{j,t-1}$	0.002***	-0.010	0.177***	2.873	-0.010
	(6.56)	(-1.06)	(8.47)	(1.62)	(-0.11)
$DG2_{j,t}$* $NAIC_{j,t-11}$	-0.002***	0.024*	-0.452***	-1.488	-0.152
	(-3.50)	(1.65)	(-14.58)	(-0.89)	(-1.60)
$UG_{j,t}$ * $NAIC_{j,t-1}$*$HighMTM_{i,t}$	-0.001**	0.016	0.017	-3.042	-0.140
	(-2.50)	(1.13)	(0.71)	(-0.77)	(-0.66)
$UG2_{j,t}$* $NAIC_{j,t-1}$ * $HighMTM_{i,t}$	-0.003**	0.009	-0.082	-3.430	0.147
	(-2.56)	(0.26)	(-1.51)	(-0.39)	(0.26)
$DG_{j,t}$* $NAIC_{j,t-1}$* $HighMTM_{i,t}$	-0.002***	0.032**	-0.135***	-0.105	0.338**
	(-3.56)	(2.18)	(-5.51)	(-0.04)	(2.23)
$DG2_{j,t}$ *$NAIC_{j,t-1}$* $HighMTM_{i,t}$	**0.002***	**-0.024**	**0.156*****	**3.837**	**0.434*****
	(1.91)	(-1.03)	(4.03)	(1.48)	(2.76)
$NAIC_{j,t-1}$* $HighMTM_{i,t}$	0.001***	-0.024***	0.014	5.553***	-1.068***
	(2.82)	(-3.62)	(1.20)	(3.38)	(-11.87)
$UG_{j,t}$ * $HighMTM_{i,t}$	0.001	-0.042	-0.030	13.303	0.872
	(1.29)	(-1.56)	(-0.68)	(0.97)	(1.28)

*$UG2_{j,t}$ * $HighMTM_{i,t}$*	0.010***	-0.016	0.150	-0.947	-1.128
	(3.02)	(-0.17)	(0.97)	(-0.03)	(-0.54)
*$DG_{j,t}$ * $HighMTM_{i,t}$*	0.002**	-0.067**	0.165***	-4.950	-1.242***
	(2.34)	(-2.53)	(3.84)	(-0.62)	(-2.81)
*$DG2_{j,t}$ * $HighMTM_{i,t}$*	0.000	-0.001	-0.156**	-6.060	-1.066**
	(0.10)	(-0.01)	(-2.14)	(-0.72)	(-2.25)
$HighMTM_{i,t}$	-0.001	0.008	0.079	-12.473**	3.035***
	(-0.66)	(0.18)	(1.12)	(-2.57)	(12.79)
$NAIC_{j,t-1}$	-0.000	0.008	-0.345***	6.852***	1.215***
	(-0.98)	(1.10)	(-8.64)	(3.10)	(9.73)
$Rating_{j,t-1}$	0.000***	-0.005***	-0.191***	-1.561**	0.183***
	(3.56)	(-2.91)	(-15.86)	(-2.32)	(4.65)
$\Delta Mode_{j,t}$		-0.008***			
		(-30.23)			
Observations	334,227	324,991	305,805	1,388	306,910
R-squared	0.004	0.043	0.488	0.423	0.287
Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	NO	NO

Panel B: Impairment Risk

Dependent Variable =	(1) *$FireSale[0,5]_{i,j,t}$*	(2) *$\Delta FV\ Difference_{i,j,t}$*	(3) *$OTTI_{i,j,t}$*	(4) *$OTTI_{i,j,t}$*	(5) *$Dum\_OTTI_{i,j,t}$*
Sample Size	*Whole Sample*	*Whole Sample*	*Whole Sample*	*Impairment Sample*	*Whole Sample*
$UG_{j,t}$	0.001*	-0.005	0.493***	-2.884	-0.794**
	(1.80)	(-0.23)	(13.42)	(-0.52)	(-2.03)
$UG2_{j,t}$	-0.006***	0.108	0.774***	9.267	0.186
	(-3.35)	(1.35)	(5.48)	(0.54)	(0.17)
$DG_{j,t}$	-0.001**	-0.022	0.147***	5.752	0.056
	(-2.33)	(-1.01)	(3.81)	(1.36)	(0.20)
$DG2_{j,t}$	0.002	-0.090**	0.575***	10.249*	0.687*
	(1.60)	(-2.18)	(7.98)	(1.75)	(1.82)
*$UG_{j,t}$ * $NAIC_{j,t-1}$*	-0.001**	0.018	-0.240***	1.446	0.186
	(-2.19)	(1.58)	(-11.86)	(0.88)	(1.55)
*$UG2_{j,t}$ *$NAIC_{j,t-1}$*	0.003***	-0.052*	-0.130***	-4.791	-0.266
	(4.72)	(-1.90)	(-2.66)	(-1.11)	(-0.98)
$DG_{j,t}$ $NAIC_{j,t-1}$*	0.001***	0.010	-0.183***	0.113	0.176*

	(3.56)	(0.76)	(-8.25)	(0.09)	(1.93)
$DG2_{j,t}$ $NAIC_{j,t-11}$*	0.001*	0.034	-0.647***	0.935	0.260**
	(1.78)	(1.50)	(-16.25)	(0.55)	(2.18)
*$UG_{j,t}$ * $NAIC_{j,t-1}$*$HImpair_{i,j,t}$*	-0.000	-0.025	0.180***	0.002	0.097
	(-0.36)	(-1.43)	(5.81)	(0.00)	(0.46)
$UG2_{j,t}$ $NAIC_{j,t-1}$ *$HImpair_{i,j,t}$*	-0.004***	0.111***	-0.059	-1.358	1.000*
	(-3.56)	(2.67)	(-0.82)	(-0.18)	(1.86)
$DG_{j,t}$ $NAIC_{j,t-1}$*$HImpair_{i,j,t}$*	0.000	-0.013	0.666***	6.779***	0.077
	(0.52)	(-0.74)	(21.78)	(3.12)	(0.54)
$DG2_{j,t}$ *$NAIC_{j,t-1}$*$HImpair_{i,j,t}$	**-0.003*** **	**0.034**	**0.182*** **	**-3.858**	**-0.288***
	(-4.12)	**(1.18)**	**(3.72)**	**(-1.65)**	**(-1.84)**
*$NAIC_{j,t-1}$*$HImpair_{i,j,t}$*	0.000	0.011	-0.011	-0.086	-0.440***
	(1.40)	(1.32)	(-0.69)	(-0.06)	(-5.01)
*$UG_{j,t}$ * $HImpair_{i,j,t}$*	0.001	0.025	-0.259***	-5.637	-0.035
	(0.78)	(0.75)	(-4.44)	(-0.45)	(-0.05)
*$UG2_{j,t}$ * $HImpair_{i,j,t}$*	0.010***	-0.307**	-0.058	-1.291	-3.966*
	(2.84)	(-2.44)	(-0.27)	(-0.04)	(-1.77)
*$DG_{j,t}$ * $HImpair_{i,j,t}$*	-0.000	0.040	-0.978***	-11.353	0.026
	(-0.32)	(1.22)	(-17.18)	(-1.59)	(0.06)
*$DG2_{j,t}$ * $HImpair_{i,j,t}$*	0.004**	0.023	0.089	5.864	0.829*
	(2.56)	(0.41)	(0.94)	(0.73)	(1.65)
$HImpair_{i,j,t}$	-0.000	0.069***	0.037	15.463***	1.526***
	(-1.11)	(4.27)	(1.27)	(3.80)	(6.28)
$NAIC_{j,t-1}$	-0.000	0.041*	-0.425***	10.117***	1.048***
	(-0.11)	(1.83)	(-10.59)	(4.89)	(8.31)
$Rating_{j,t-1}$	0.000***	0.010	-0.184***	-1.777***	0.133***
	(3.52)	(1.52)	(-15.20)	(-2.93)	(3.39)
$\Delta Mode_{j,t}$		-0.009***	2.270***	2.201	-8.632***
		(-30.28)	(32.79)	(0.78)	(-46.23)
Observations	329,838	322,564	305,738	1,379	306,823
R-squared	0.004	0.127	0.490	0.520	0.278
Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	NO	NO

Panel C: RBC Ratio

Dependent Variable =	(1) *FireSale[0,5]$_{i,j,t}$*	(2) *ΔFV Difference$_{i,j,t}$*	(3) *OTTI$_{i,j,t}$*	(4) *OTTI$_{i,j,t}$*	(5) *Dum_OTTI$_{i,j,t}$*
Sample Size	*Whole Sample*	*Whole Sample*	*Whole Sample*	*Impairment Sample*	*Whole Sample*
$UG_{j,t}$	0.001**	0.028	0.407***	-6.638	0.138
	(2.12)	(1.33)	(11.44)	(-1.05)	(0.33)
$UG2_{j,t}$	-0.003	0.086	0.804***	-6.127	-1.344
	(-1.45)	(1.07)	(5.86)	(-0.20)	(-0.56)
$DG_{j,t}$	-0.002***	0.005	-0.228***	8.630**	-0.650**
	(-3.55)	(0.25)	(-6.33)	(2.15)	(-2.48)
$DG2_{j,t}$	0.005***	-0.107***	0.278***	14.700***	1.269***
	(5.55)	(-2.90)	(4.45)	(3.18)	(4.53)
$UG_{j,t}$ * $NAIC_{j,t-1}$	-0.001***	0.002	-0.178***	2.844	-0.198
	(-2.67)	(0.21)	(-9.30)	(1.07)	(-1.08)
$UG2_{j,t}$* $NAIC_{j,t-1}$	0.001**	-0.038	-0.182***	-2.522	0.062
	(1.99)	(-1.40)	(-3.91)	(-0.29)	(0.09)
$DG_{j,t}$* $NAIC_{j,t-1}$	0.001***	0.002	0.090***	0.620	0.659***
	(4.96)	(0.16)	(4.64)	(0.44)	(6.73)
$DG2_{j,t}$* $NAIC_{j,t-1}$	-0.001***	0.070***	-0.307***	1.012	0.090
	(-2.90)	(4.07)	(-10.49)	(0.72)	(1.00)
$UG_{j,t}$ * $NAIC_{j,t-1}$* $LowRBC_{i,t-1}$	0.000	0.039**	0.028	0.699	0.545**
	(0.55)	(2.42)	(1.06)	(0.16)	(2.28)
$UG2_{j,t}$* $NAIC_{j,t-1}$* $LowRBC_{i,t-1}$	0.001	0.033	-0.115*	-3.065	-0.734
	(1.07)	(0.90)	(-1.90)	(-0.31)	(-0.96)
$DG_{j,t}$* $NAIC_{j,t-1}$* $LowRBC_{i,t-1}$	-0.000	0.035**	0.124***	3.047	-0.658***
	(-0.35)	(2.09)	(4.45)	(1.12)	(-4.33)
$DG2_{j,t}$* $NAIC_{j,t-11}$* $LowRBC_{i,t-1}$	**0.001**	**-0.001**	**-0.332*****	**-2.480**	**-0.286***
	(0.61)	(-0.04)	(-7.52)	(-0.91)	(-1.81)
$NAIC_{j,t-1}$*$LowRBC_{i,t-1}$	-0.000	-0.033***	0.071***	-7.485***	1.159***
	(-0.27)	(-4.17)	(5.28)	(-4.48)	(12.38)
$UG_{j,t}$ * $LowRBC_{i,t-1}$	0.000	-0.089***	-0.045	-5.745	-1.493**
	(0.16)	(-2.95)	(-0.91)	(-0.40)	(-2.09)
$UG2_{j,t}$ * $LowRBC_{i,t-1}$	-0.000	-0.093	0.176	19.308	3.340
	(-0.01)	(-0.88)	(1.02)	(0.53)	(1.26)
$DG_{j,t}$ * $LowRBC_{i,t-1}$	0.001	-0.083***	-0.170***	-8.288	1.108**

	(1.17)	(-2.76)	(-3.43)	(-0.87)	(2.25)
$DG2_{j,t}$ * $LowRBC_{i,t-1}$	-0.003*	-0.005	0.551***	-3.388	0.899*
	(-1.67)	(-0.10)	(6.61)	(-0.35)	(1.71)
$LowRBC_{i,t-1}$	0.000	0.350***	-0.149***	16.298***	-2.006***
	(0.31)	(20.14)	(-5.07)	(3.17)	(-7.93)
$NAIC_{j,t-1}$	0.000	0.045**	-0.359***	12.270***	0.139
	(0.31)	(1.98)	(-9.01)	(5.51)	(1.02)
$Rating_{j,t-1}$	0.000***	0.007	-0.192***	-1.192*	0.179***
	(3.55)	(0.94)	(-15.88)	(-1.83)	(4.52)
$\Delta Mode_{j,t}$		-0.008***			
		(-26.84)			
Observations	333,128	322,678	305,315	1,388	306,418
R-squared	0.004	0.144	0.488	0.462	0.302
Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	NO	NO

Panel D: Insurer Rating

Dependent Variable =	(1) *FireSale[0,5]*$_{i,j,t}$	(2) Δ*FV Difference* $_{i,j,t}$	(3) $OTTI_{i,j,t}$	(4) $OTTI_{i,j,t}$	(5) $Dum\_OTTI_{i,j,t}$
Sample Size	*Whole Sample*	*Whole Sample*	*Whole Sample*	*Impairment Sample*	*Whole Sample*
$UG_{j,t}$	0.001*	-0.006	0.389***	-2.287	0.007***
	(1.72)	(-0.31)	(11.12)	(-0.41)	(5.72)
$UG2_{j,t}$	-0.001	0.077	0.920***	8.822	0.036***
	(-0.67)	(0.97)	(6.78)	(0.55)	(7.12)
$DG_{j,t}$	-0.001***	-0.058***	-0.226***	4.237	-0.007***
	(-2.92)	(-2.78)	(-6.34)	(1.07)	(-4.96)
$DG2_{j,t}$	0.005***	-0.088**	0.180***	17.005***	0.003
	(5.74)	(-2.39)	(2.89)	(3.73)	(1.37)
$UG_{j,t}$ * $NAIC_{j,t-1}$	-0.001**	0.016	-0.169***	0.436	-0.003***
	(-2.49)	(1.46)	(-9.04)	(0.26)	(-4.61)
$UG2_{j,t}$* $NAIC_{j,t-1}$	0.001*	-0.037	-0.234***	-4.880	-0.011***
	(1.87)	(-1.40)	(-5.13)	(-1.24)	(-6.35)
$DG_{j,t}$* $NAIC_{j,t-1}$	0.001***	0.039***	0.095***	2.468**	0.004***
	(4.58)	(3.51)	(4.89)	(2.04)	(5.03)
$DG2_{j,t}$* $NAIC_{j,t-1}$	-0.001***	0.048***	-0.215***	-0.355	-0.002
	(-2.60)	(2.79)	(-7.38)	(-0.27)	(-1.59)

$UG_{j,t}$ * $NAIC_{j,t-1}$* $LowWeissRating_{i,t-1}$	0.000	-0.016	-0.005	6.771	-0.001
	(0.11)	(-0.89)	(-0.17)	(1.06)	(-0.72)
$UG2_{j,t}$* $NAIC_{j,t-1}$* $LowWeissRating_{i,t-1}$	0.003**	0.051	0.095	-2.099	0.004
	(2.12)	(1.20)	(1.37)	(-0.46)	(1.44)
$DG_{j,t}$* $NAIC_{j,t-1}$* $LowWeissRating_{i,t-1}$	0.001	-0.141***	-0.031	0.164	-0.001
	(0.86)	(-7.77)	(-1.05)	(0.04)	(-0.52)
$DG2_{j,t}$* $NAIC_{j,t-1}$* $LowWeissRating_{i,t-1}$	**-0.000**	**0.101*** **	**-0.473*** **	**-2.945**	**-0.012*** **
	(-0.24)	(3.49)	(-10.12)	(-0.77)	(-6.90)
$NAIC_{j,t-1}$* $LowWeissRating_{i,t-1}$	0.000	0.016*	-0.011	3.004	-0.002***
	(0.71)	(1.86)	(-0.74)	(1.13)	(-2.90)
$UG_{j,t}$ * $LowWeissRating_{i,t-1}$	0.001	0.041	0.011	-19.237	0.001
	(0.93)	(1.23)	(0.20)	(-0.84)	(0.64)
$UG2_{j,t}$ * $LowWeissRating_{i,t-1}$	-0.009**	-0.131	-0.243		-0.009
	(-2.23)	(-1.10)	(-1.26)		(-1.31)
$DG_{j,t}$ * $LowWeissRating_{i,t-1}$	-0.000	0.225***	0.044	2.389	0.000
	(-0.31)	(7.04)	(0.84)	(0.20)	(0.20)
$DG2_{j,t}$ * $LowWeissRating_{i,t-1}$	-0.003*	-0.132**	0.562***	0.352	0.014***
	(-1.88)	(-2.47)	(6.44)	(0.03)	(4.21)
$LowWeissRating_{i,t-1}$	-0.000	-0.096***	0.037	-2.630	0.004***
	(-0.17)	(-4.56)	(1.05)	(-0.39)	(3.07)
$NAIC_{j,t-1}$	0.000	0.027	-0.378***	8.504***	-0.008***
	(0.02)	(1.20)	(-9.45)	(3.91)	(-5.70)
$Rating_{j,t-1}$	0.000***	0.008	-0.184***	-1.303*	-0.003***
	(3.54)	(1.20)	(-15.23)	(-1.95)	(-6.94)
$\Delta Mode_{j,t}$		-0.008***			
		(-26.89)			
Observations	328,300	318,302	300,382	1,375	300,486
R-squared	0.004	0.144	0.494	0.405	0.278
Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	NO	NO

Panel E: Investment Commonality

Dependent Variable =	(1) *FireSale[0,5]*$_{i,j,t}$	(2) Δ*FV Difference* $_{i,j,t}$	(3) *OTTI*$_{i,j,t}$	(4) *OTTI*$_{i,j,t}$	(5) Logit *Dum_OTTI*$_{i,j,t}$
Sample Size	*Whole Sample*	*Whole Sample*	*Whole Sample*	*Impairment Sample*	*Whole Sample*
$UG_{j,t}$	0.001	-0.063*	0.782***	-0.670	-1.027*
	(1.45)	(-1.71)	(12.47)	(-0.06)	(-1.67)
$UG2_{j,t}$	0.000	0.117	1.354***	-2.385	-3.701**
	(0.02)	(0.72)	(4.73)	(-0.04)	(-2.25)
$DG_{j,t}$	-0.003***	0.022	-0.190***	17.373**	-0.509
	(-3.82)	(0.58)	(-2.96)	(2.56)	(-1.24)
$DG2_{j,t}$	0.010***	-0.397***	0.256**	43.330***	2.224***
	(6.32)	(-5.75)	(2.22)	(5.68)	(4.91)
$UG_{j,t}$ * $NAIC_{j,t-1}$	-0.001	0.041**	-0.419***	-1.536	0.223
	(-1.52)	(2.12)	(-12.63)	(-0.52)	(1.29)
$UG2_{j,t}$* $NAIC_{j,t-1}$	0.001	-0.033	-0.108	-3.868	0.596*
	(0.46)	(-0.64)	(-1.22)	(-0.34)	(1.65)
$DG_{j,t}$* $NAIC_{j,t-1}$	0.003***	0.009	0.123***	-2.880	0.488***
	(5.77)	(0.44)	(3.64)	(-1.58)	(4.34)
$DG2_{j,t}$* $NAIC_{j,t-1}$	-0.004***	0.140***	-0.490***	-5.440***	-0.276**
	(-6.37)	(4.61)	(-9.66)	(-2.76)	(-2.26)
$UG_{j,t}$ * $NAIC_{j,t-1}$*$Commonality_{i,t-1}$	-0.002	-1.352	13.516***	233.961	6.257
	(-0.08)	(-1.52)	(8.87)	(1.44)	(0.68)
$UG2_{j,t}$* $NAIC_{j,t-1}$*$Commonality_{i,t-1}$	0.074	-0.898	-5.725	83.280	-27.815*
	(1.30)	(-0.34)	(-1.20)	(0.15)	(-1.68)
$DG_{j,t}$* $NAIC_{j,t-1}$*$Commonality_{i,t-1}$	-0.073***	-0.501	0.734	513.398***	-25.210***
	(-3.49)	(-0.56)	(0.47)	(4.66)	(-4.09)
$DG2_{j,t}$* $NAIC_{j,t-1}$*$Commonality_{i,t-1}$	**0.205*** **	**-1.213**	**6.285** **	**-146.716**	**21.343*** **
	(5.68)	**(-0.77)**	**(2.36)**	**(-1.03)**	**(3.04)**
$NAIC_{j,t-1}$*$Commonality_{i,t-1}$	-0.010	-3.210***	32.697***	-283.596***	0.303
	(-1.19)	(-3.36)	(18.81)	(-4.35)	(0.08)
$UG_{j,t}$ *$Commonality_{i,t-1}$	-0.002	3.089**	-21.627***	-357.418	-4.985
	(-0.07)	(2.02)	(-8.26)	(-0.67)	(-0.18)
$UG2_{j,t}$ *$Commonality_{i,t-1}$	-0.177	-0.345	-25.008*	63.850	130.249**
	(-1.13)	(-0.04)	(-1.79)	(0.03)	(2.12)
$DG_{j,t}$ *$Commonality_{i,t-1}$	0.099***	-0.575	-4.453*	-1,033.415***	48.647***

	(2.91)	(-0.38)	(-1.71)	(-3.86)	(3.20)
$DG2_{j,t}$ *$Commonality_{i,t-1}$	-0.309***	8.728***	8.190*	-588.595*	-44.696**
	(-5.04)	(3.16)	(1.76)	(-1.69)	(-2.50)
$Commonality_{i,t-1}$	0.017	4.594**	-52.703***	533.952***	2.806
	(1.18)	(2.27)	(-14.66)	(3.19)	(0.32)
$NAIC_{j,t-1}$	0.000	0.089***	-0.952***	12.764***	0.830***
	(0.89)	(3.05)	(-18.44)	(5.65)	(6.33)
$Rating_{j,t-1}$	0.000***	0.008	-0.171***	-1.562**	0.160***
	(3.53)	(1.08)	(-14.05)	(-2.40)	(4.04)
$\Delta Mode_{j,t}$		-0.008***			
		(-26.85)			
Observations	334,232	323,630	305,805	1,388	306,910
R-squared	0.004	0.141	0.489	0.438	0.273
Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	NO	NO

Panel F: State Holding Restriction

Dependent Variable =	(1) $FireSale[0,10]_{i,j,t}$	(2) $FireSale[0,5]_{i,j,t}$	(3) $FireSale[0,10]_{i,j,t}$	(4) $FireSale[0,5]_{i,j,t}$
Sample Size	*Whole Sample*	*Whole Sample*	*Whole Sample*	*Whole Sample*
Holding Restriction Measure	*Restriction*		*Restriction_Alt*	
$UG_{j,t}$	0.001	0.001	0.001	0.001
	(1.00)	(1.31)	(0.80)	(0.92)
$UG2_{j,t}$	-0.006**	-0.002	-0.006**	-0.002
	(-2.14)	(-0.88)	(-2.16)	(-0.87)
$DG_{j,t}$	-0.002*	-0.001	-0.002***	-0.001**
	(-1.90)	(-1.37)	(-2.58)	(-1.99)
$DG2_{j,t}$	0.008***	0.004***	0.009***	0.004***
	(6.02)	(3.98)	(6.62)	(4.16)
$UG_{j,t}$ * $NAIC_{j,t-1}$	-0.001	-0.001**	-0.001	-0.001*
	(-1.33)	(-2.08)	(-1.31)	(-1.79)
$UG2_{j,t}$* $NAIC_{j,t-1}$	0.003***	0.001*	0.003***	0.001*
	(2.76)	(1.82)	(2.86)	(1.83)
$DG_{j,t}$* $NAIC_{j,t-1}$	0.001**	0.001**	0.002***	0.001***
	(2.55)	(2.28)	(3.61)	(3.24)
$DG2_{j,t}$* $NAIC_{j,t-1}$	-0.002***	-0.001	-0.002***	-0.001*

	(-2.71)	(-1.27)	(-3.38)	(-1.71)
$UG_{j,t}$ * $NAIC_{j,t-1}$* $Restriction_{i,t}$	-0.000	-0.000	-0.000	-0.000
	(-0.01)	(-0.11)	(-0.10)	(-0.72)
$UG2_{j,t}$* $NAIC_{j,t-1}$* $Restriction_{i,t}$	0.000	0.001	0.000	0.001
	(0.26)	(1.05)	(0.24)	(1.21)
$DG_{j,t}$* $NAIC_{j,t-1}$* $Restriction_{i,t}$	0.002***	0.002***	0.000	0.001**
	(2.88)	(3.53)	(1.42)	(2.31)
$DG2_{j,t}$* $NAIC_{j,t-1}$* $Restriction_{i,t}$	**-0.002**	**-0.002***	**-0.000**	**-0.001**
	(-1.33)	**(-1.91)**	**(-0.45)**	**(-1.38)**
$NAIC_{j,t-1}$* $Restriction_{i,t}$	-0.001**	-0.000	-0.000	-0.000
	(-2.15)	(-0.48)	(-1.58)	(-0.08)
$UG_{j,t}$ * $Restriction_{i,t}$	0.001	0.001	0.001	0.001*
	(0.45)	(0.93)	(0.85)	(1.73)
$UG2_{j,t}$* $Restriction_{i,t}$	-0.001	-0.003	-0.000	-0.002
	(-0.13)	(-0.93)	(-0.23)	(-1.09)
$DG_{j,t}$* $Restriction_{i,t}$	-0.003**	-0.002**	-0.001	-0.001
	(-2.15)	(-2.32)	(-1.23)	(-1.49)
$DG2_{j,t}$* $Restriction_{i,t}$	0.002	0.001	0.000	0.000
	(0.91)	(0.63)	(0.30)	(0.57)
$Restriction_{i,t}$	0.001	0.001	0.000	0.000
	(0.64)	(0.75)	(0.48)	(0.60)
$NAIC_{j,t-1}$	0.002***	0.000	0.002***	0.000
	(5.03)	(0.38)	(4.82)	(0.22)
$Rating_{j,t-1}$	-0.000	0.000***	-0.000	0.000***
	(-0.49)	(3.53)	(-0.48)	(3.54)
Observations	334,227	334,227	333,675	333,675
R-squared	0.006	0.004	0.006	0.004
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES

Table 7: Additional Analyses

Table 7 Panel A (B) reports OLS regression results using $OTTI_{i,j,t}$, ($FireSale[0,10]_{i,j,t}$, $FireSale[0,5]_{i,j,t}$, $\Delta FV\ Difference_{i,j,t}$, $OTTI_{i,j,t}$)as a dependent variable, respectively, and a Logit regression result using $Dum\_OTTI_{i,j,t}$. The Appendix B provides variable definitions. ***, **, * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: The Impairment upon a Dual Downgrade during the Period between t and t+1

Dependent Variable =	(1) $OTTI_{i,j,[t,t+1]}$	(2) $Dum\_OTTI_{i,j,[t,t+1]}$
$UG_{j,t}$	0.095	0.004*
	(1.64)	(1.92)
$UG2_{j,t}$	-0.108	-0.007
	(-0.51)	(-0.89)
$DG_{j,t}$	-0.114**	0.002
	(-1.97)	(0.86)
$DG2_{j,t}$	0.727***	-0.003
	(7.14)	(-0.84)
$UG_{j,t}$ * $NAIC_{j,t-1}$	-0.053*	-0.001
	(-1.65)	(-1.03)
$UG2_{j,t}$* $NAIC_{j,t-1}$	0.159**	0.007**
	(1.98)	(2.43)
$DG_{j,t}$* $NAIC_{j,t-1}$	0.037	-0.002
	(1.15)	(-1.47)
$DG2_{j,t}$* $NAIC_{j,t-1}$	-0.584***	-0.001
	(-11.48)	(-0.33)
$NAIC_{j,t-1}$	-0.436***	-0.016***
	(-5.86)	(-6.08)
$Rating_{j,t-1}$	-0.063***	-0.002*
	(-2.69)	(-1.85)
Observations	174,587	174,590
R-squared	0.428	0.311
Year FE	YES	YES
Firm FE	YES	YES

Panel B: Do Insurers Engage in Disposals and Valuation Decisions for Securities that are Expected to Experience Dual Downgrades?

VARIABLES	(1) $FireSale[0,10]_{i,j,t}$	(2) $FireSale[0,5]_{i,j,t}$	(3) $\Delta FV\ Difference_{i,j,t}$	(4) $OTTI_{i,j,t}$	(5) $Dum\_OTTI_{i,j,t}$
$UG_{j,t}$	0.001*	0.002***	0.017	0.103***	0.004***
	(1.90)	(3.51)	(0.78)	(2.65)	(2.87)
$UG2_{j,t}$	-0.005**	-0.004**	0.083	1.484***	0.044***
	(-2.12)	(-2.44)	(1.07)	(11.02)	(8.89)
$DG_{j,t}$	-0.003***	-0.002***	-0.019	-0.019	-0.004***
	(-4.13)	(-4.32)	(-0.88)	(-0.50)	(-3.02)
$DG2_{j,t}$	0.009***	0.005***	-0.127***	0.005	0.001
	(8.63)	(6.43)	(-3.38)	(0.08)	(0.55)
$UG_{j,t} * NAIC_{j,t-1}$	-0.001**	-0.001***	0.004	-0.011	-0.001*
	(-2.31)	(-4.20)	(0.31)	(-0.54)	(-1.69)
$UG2_{j,t} * NAIC_{j,t-1}$	0.003***	0.003***	-0.036	-0.493***	-0.015***
	(3.14)	(4.26)	(-1.33)	(-10.57)	(-8.50)
$DG_{j,t} * NAIC_{j,t-1}$	0.002***	0.002***	0.013	-0.017	0.002***
	(5.66)	(6.67)	(1.08)	(-0.85)	(2.99)
$DG2_{j,t} * NAIC_{j,t-1}$	-0.003***	-0.002***	0.076***	-0.173***	-0.002*
	(-5.08)	(-4.38)	(4.30)	(-5.69)	(-1.74)
$Close\_to\_UG2_{j,t-1}$	-0.002*	0.002***	-0.160***	-0.380***	-0.015***
	(-1.86)	(2.65)	(-3.92)	(-5.36)	(-5.89)
$Close\_to\_DG2_{j,t-1}$	0.001	0.000	-0.038	0.320***	0.001
	(1.01)	(0.04)	(-1.55)	(7.69)	(0.96)
$Close\_to\_UG2_{j,t-1} * NAIC_{j,t-1}$	0.000	-0.001***	0.053***	0.252***	0.008***
	(0.81)	(-3.96)	(3.14)	(8.55)	(7.33)
$Close\_to\_DG2_{j,t-1} * NAIC_{j,t-1}$	0.000	0.000	0.015	-0.238***	-0.001
	(1.15)	(1.38)	(1.29)	(-11.68)	(-0.97)
$NAIC_{j,t-1}$	0.003***	0.001***	0.035	-0.754***	-0.013***
	(5.92)	(3.29)	(0.82)	(-10.30)	(-4.91)
$Rating_{j,t-1}$	-0.001***	-0.000	0.005	-0.066***	-0.002**
	(-3.94)	(-0.70)	(0.40)	(-2.96)	(-2.51)
$\Delta Mode_{j,t}$			-0.008***		
			(-26.94)		
Observations	334,227	334,227	323,626	305,805	306,910
R-squared	0.006	0.004	0.141	0.488	0.275
Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	NO