Betting on Bond Ratings Disagreement

Hwagyun Kim* Ju Hyun Kim Nan Yang

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Abstract

We examine insurers' response to credit rating splits. Contrary to conventional expectation, rating disagreements do not reliably predict subsequent rating changes, clouding risk assessment. Insurers rebalance to reduce uncertainty on average, yet paradoxically increase holdings of riskier bonds as rating dispersion widens. Among the lowest-rated bonds, a one standard deviation rise in rating dispersion boosts insurer holdings by 0.8% (∼13% of the mean). Controlling for rating transitions and yields with granular fixed effects, we find this result persists and is stronger among financially constrained insurers. Despite stringent regulatory requirements, insurers take on heightened risk when credit assessments are ambiguous.

Keywords: Corporate Bond, Ratings Dispersion, Ambiguity, Insurance Companies, Bond Holdings, Reaching for Uncertainty

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*Hwagyun (Hagen) Kim (hkim@mays.tamu.edu) is affiliated with the Adam C. Sinn '00 Department of Finance at Mays Business School, Texas A&M University. Ju Hyun Kim (jhkim0902@ajou.ac.kr) is with the School of Business, Ajou University. Nan Yang (nyang@polyu.edu.hk) is with the School of Accounting and Finance at Hong Kong Polytechnic University.

1 Introduction

This paper examines the investment behavior of insurance companies in the corporate bond market when credit ratings diverge.[1] When multiple credit rating agencies disagree on the survival likelihoods of corporate bonds, several channels of risk and uncertainty can influence investment decisions.

Firstly, such divergence may only be temporary, indicating a process of converging to a new rating. In this situation, investors are likely to update their prior beliefs to incorporate new information and subsequently adjust their holdings based on the anticipated direction of change. Secondly, conservative investors, such as insurance companies, often seek to avoid risks, including downgrade risks. If split ratings signal potential risks associated with corporate bonds, they could have an impact on bond holdings. However, data reveal that credit rating disagreements do not predict future rating directions, and the degree of credit rating dispersion tends to remain persistent over time and across credit rating groups. This information implies that these risk channels may be weak or insufficient as the primary economic mechanism to explore. Thirdly, the presence of multiple default probabilities resulting from differing credit ratings introduces uncertainty about credit risk, prompting investors to reassess the perceived probabilities of default. Investors must form an opinion on the probability of a bond's survival likelihood and consider this credit information uncertainty alongside conventional credit risks.

The regulatory features of the insurance industry help to further distinguish the effects of uncertainty from risk. The National Association of Insurance Commissioners (NAIC),

[1]Insurance companies are the largest investor group in the U.S. corporate bond market, and corporate bonds account for more than half of their fixed income investments. Source: NAIC Capital Markets Bureau Special Reports - "U.S. Insurance Industry's Cash and Invested Assets Surpass $8 Trillion at Year-End 2021" (https://content.naic.org/sites/default/files/capital-markets-special-reports-asset-mix-ye2021.pdf).

founded in 1871, comprises insurance regulators from the 50 states, the District of Columbia, and the five U.S. territories. This regulatory body sets the standards for the U.S. insurance industry, making the incorporation of NAIC rules an essential factor in any study of the insurance sector. Relevant to our study is the way the NAIC classifies the riskiness of corporate bonds and sets risk-based capital (RBC) requirements: credit ratings determine the risk categories for bonds. When ratings diverge for a given bond, the NAIC has clear rules for designating risk groups, and insurers need to comply with these rules to define and assess their risk exposures related to credit rating dispersion.[2] Therefore, by including NAIC-based risk groups as well as other market-based bond risk measures, divergent credit ratings can capture additional economic channels, such as uncertainty related to credit risk assessment.

To build testable hypotheses, we construct a simple two-period model. In this model, fund managers aim to maximize total wealth subject to a linear-quadratic preference function by allocating given initial amounts between two credit-risky bonds. There are two rating agencies, and each bond receives a shock to its survival probability at the beginning of the first period. Compared with fund managers, rating agencies have better information about the shock, albeit with varying degrees of noise. We first show that multiple ratings can improve the informativeness of the shock by reducing its posterior variance. Yet, how ratings affect the posterior probability of survival not only depends on the size and direction of the ratings realized, but also on each agency's information precision, which in turn affects the extent to which the managers update their information set upon observing the ratings.

When fund managers know the distribution of the shock (i.e., no credit information

[2] If a bond is rated by two rating agencies, the NAIC assigns it the lower rating; if the bond is rated by all three rating agencies, the NAIC assigns it the middle rating (Purposes & Procedures Manual of the NAIC Investment Analysis Office, December 2021).

ambiguity exists from the managers' perspective), the model shows that rating dispersion yields no information update on the posterior probability of survival of the affected bond. In the case with credit information ambiguity, we assume that the managers only know the quality bounds of the information possessed by rating agencies.[3] If a certain manager is ambiguity averse and acts based on the max-min principle, ambiguity aversion prevails via disagreement in credit ratings. This result is important as it provides theoretical justification for the rating dispersion measure in empirical tests that follow. In addition, we show that ambiguity aversion negatively affects the posterior probability of survival.

Provided that a given proportion of fund managers are ambiguity averse, the model provides closed-form solutions on the relation between a bond's credit rating dispersion and the proportion of its total outstanding amount held by the funds. On average, aggregate fund holdings decrease with a bond's credit information ambiguity. Most interestingly, this relation varies with the riskiness of a bond. As survival probabilities are bound between 0 and 1, asymmetric effects of uncertainty should prevail at the extremes, an intuition that Figure 1 illustrates. For a safe bond with survival probability close to 1, any uncertainty regarding its credit quality suggests that adverse shocks will be perceived as being more likely than favorable ones, and managers will seek to avoid rating dispersion, as is standard in the ambiguity aversion literature. However, for risky bonds with limited downside, managers' expectations of the worst case stemming from rating dispersion is also bounded, and they may actually lean toward uncertainty in this case.[4] If there are no ambiguity-averse fund managers, there is no such asymmetry, and the average asset allocation effect of rating

[3]Empirically, this assumption can be linked to the annual default studies of the major credit rating agencies. Each year, the realized default rates for each credit rating fluctuate, illustrating the difficulty of knowing the exact distribution.

[4]Asymmetric price reactions to good and bad news have been explained with the weights investors assign to signal precision (e.g. Kim et al. (2022a)). Our study adds a quantity channel in which uncertainty influences investor decisions, with contrasting effects caused by bounded probability distributions.

dispersion is zero.

[Insert Figure 1 About Here]

Motivated by the theory, we move on to empirically test the asymmetric attitudes toward uncertainty for varying degrees of risk. In line with the model, the degree of ambiguity regarding credit information is quantified as rating dispersion, constructed in the spirit of the Fano (1947) factor, which measures the dispersion of a probability distribution. As a normalized standard deviation measure, rating dispersion is set to zero if all credit opinions concur.[5] Even when credit ratings do not diverge, inherent uncertainties about the rating itself still remain; therefore, our measure is conservative relative to the true size of ambiguity.

Our initial task is to verify that rating dispersion is not simply an indicator of imminent credit quality adjustment. First, in line with the extant literature (e.g., Livingston et al. (2008)), we observe that ratings are very sticky. Only a small proportion of bonds experience a rating change in the following quarter, and the numbers do not vary greatly between bonds with concurrent or split ratings. Cross-sectional rating dispersion has weak links to either a downgraded risk or an upgraded prospect in general, whether bonds are examined by the degree of credit risk or rating dispersion. Second, random draws of the sample show that the majority of bonds with rating dispersion continue to maintain their split status after 16 quarters; that is, disagreement in credit opinions is far from a temporary mismatch in the timing of rating agencies' information updates. Therefore, any relation between rating dispersion and insurers' bond holdings cannot be justified based on fund managers acting on anticipated rating changes; it instead stems from fundamental and persistent uncertainty.

Regression analyses formally test the portfolio decisions of insurance companies facing

[5] Other works that employ dispersion in forecasts or professional opinions include Diether et al. (2002), Epstein and Schneider (2008), Anderson et al. (2009), Ilut and Schneider (2014), Kim (2016), and Kim et al. (2022a).

credit information ambiguity. The dependent variable is the aggregate proportion of a bond's outstanding amount held by insurers, drawn from Refinitive eMAXX holdings data from 2002 to 2022.[6] Results show that the average effect of rating dispersion on one-quarter-ahead insurers' bond holdings is negative, or that they generally shy away from bonds with divergent credit ratings. However, the coefficient estimate of rating dispersion turns positive for the riskiest bonds (NAIC groups 4–6).[7] A one standard deviation increase in credit information ambiguity in the safest bonds decreases insurers' holdings by 1.3%, whereas in the riskiest bonds, the same change *increases* the mentioned holdings by 0.7%. The economic significance of the effect is non-trivial, as insurers hold 10.7% of NAIC group 4 bonds and 6.2% of NAIC 5 bonds on average, despite stringent related regulations. As all regressions include rating-by-quarter fixed effects and industry-by-quarter fixed effects, the findings are robust to any rating- or industry-level shocks.

The results remain significant with a host of bond-level controls, including the bond yield spread. That is, the "betting on disagreement" phenomenon we document is distinct from the "reaching for yield" behavior reported by Becker and Ivashina (2015). Whereas reaching for yield is unilateral and explained in the framework of regulatory arbitrage, betting on disagreement is related to the asymmetric nature of uncertainty in safe versus risky investments. What is surprising in our result is that ambiguity-chasing behavior can occur, despite the existence of ambiguity aversion for conservative investors such as insurance companies. We also test specifications with bond fixed effects to ensure that observed and unobserved time-invariant bond characteristics do not drive our findings. In particular, the specification with bond fixed effects ties in well with our theoretical setup, in which credit information am-

[6]eMAXX contains detailed fixed-income holdings for insurance companies, mutual funds, pension funds, and other investors at the quarterly level.

[7]For reporting, we group NAIC risk category 6 together with group 5, because of the small sample size.

biguity arises from two rating agencies receiving credit shocks to a given bond with varying levels of noise.

Last but not least, we explore how attitudes toward rating dispersion may vary with the investor's existing exposure to risk. Financial firms, including insurers, face fundamental risks related to leverage or capital requirements, and our model states that bonds held by high leverage or low intermediary capital funds are subject to stronger effects from credit rating disagreement. To test this conjecture, we sort funds into terciles by leverage, and compute the proportion of a bond held by top (high leverage) and bottom (low leverage) decile insurers separately. Results with the new regressands show that high leverage insurance funds are mainly responsible for both ambiguity aversion in safe bonds and betting on rating disagreement in risky bonds. The analysis is repeated for capital surplus terciles, and funds with low capital surplus are the main drivers behind the asymmetric attitudes toward uncertainty. Such phenomena raise possible concerns over social welfare, as insurers with the least buffer to absorb adverse credit shocks have the greatest exposures to risky bonds with rating dispersion.

The rest of the paper is organized as follows. Section 2 sets out the literature on insurance companies' corporate bond investments and uncertainty aversion. Section 3 presents the model and related hypotheses. Section 4 describes the data and documents the empirical results. Section 5 concludes.

2 Literature

Extant literature on the determinants of insurers' bond investments highlights the role of regulation. Regulatory pressure imposed on insurance companies can induce fire sales of downgraded bonds in corporate bond markets (Ellul et al. (2011)), and their highly correlated strategies exacerbate fire sale risk (Nanda et al. (2019)). Conditional on regulatory risk classification, Becker and Ivashina (2015) find that insurers favor corporate bonds with higher issuance spreads; that is, there is "reaching for yield." Central to how regulators classify risk, credit ratings often act as a bar to investment for many types of funds. Using a Lehman Brothers 2005 index redefinition as a natural experiment, Chen et al. (2014) find that rating-based bond market segmentation exists, and it is distinct from that of reputation, regulation, indexation, and liquidity.[8]

Our paper is related to the literature exploring the relation between uncertainty and investors' investment decisions. Dimmock et al. (2016) measure individual investor ambiguity aversion via Ellsberg-urn type questions, documenting cross-sectional evidence that higher ambiguity aversion decreases household stock market participation, the proportion of financial assets held in stocks, and foreign stock ownership. In a study of French investors, Bianchi and Tallon (2019) document that ambiguity-averse households tend to be underdiversified and keep portfolio weights more stable over time. Using proprietary German data, Kostopoulos et al. (2021) find that individual investors respond to increases in aggregate ambiguity about volatility of the European stock market (i.e., volatility-of-volatility) by trading more and reducing their holdings of risky securities.[9]

Unlike the prior works, our study focuses on ambiguity in credit markets and provides evidence of sophisticated investors' (i.e., insurance companies) reaction to uncertainty about security-specific credit information quality. We also highlight the contrasting reactions to

[8]Dass and Massa (2014) posit institutional investors favor issuers of various maturities owing to lower information costs. Timmer (2018) finds disparate reactions to past holding returns by investor type.

[9]Regarding corporate decisions, Johnson et al. (2021) find that when ambiguity about credit quality differs across the maturity spectrum, firms adjust their debt maturity structures away from the tenor with more ambiguity. Izhakian et al. (2021) relate historical equity return-based ambiguity to capital structure decisions.

ambiguity in the extreme risk categories. In a closely related work, Kim et al. (2022b) study holdings data to find that bond funds are averse to ambiguity in credit information, but learning can attenuate such behavior. Ben-Rephael et al. (2022) also study how ambiguity affects sophisticated investors, but with a focus on option trading.

3 Theory and Hypothesis

Suppose that there exist two periods, two credit-risky bonds denoted as A and B, and two credit rating agencies $k = 1, 2$. Risk-averse insurance companies in the interval of $[0, 1]$ are given an existing allocation and select portfolio weights to purchase bonds. An insurer has a linear-quadratic preference function for the company wealth x, defined as $EU(x) = E(x) - \frac{\psi}{2}Var(x)$, where $\psi > 0$ is the degree of risk aversion. The survival probability of each bond type $i = A$, B is given as $\phi_i = \phi_i^* + \eta_i$, where $\eta_i \sim N(0, \sigma_i^2)$ describes the shocks to credit risk, and σ_i^2 satisfies the condition that the probability ϕ_i being outside the bound of $[0, 1]$ is negligible.[10] That is, $(1 - \phi_i)$ is the default probability for bond i.

The model assigns values V_A and V_B with no default and (δ_A, δ_B) for the case of default per unit of the bond. $V_i > \delta_i > 0$ holds for both types of debt. For simplicity, we normalize the total number of units of each bond to be 1. To introduce credit information and learning by the manager, assume that in each period, the two rating agencies $k = 1$ and 2 provide new credit information $z_{k,i}$ about an issue i's future default probability, and the manager updates their own assessment after observing that information. For example, rating agency k may have better information than the fund manager about each bond's default probability shock: $z_{k,i} = \eta_i + \varepsilon^z_{k,i}$, where $\varepsilon^z_{k,i} \sim N(0, (\sigma^z_{k,i})^2)$ measures the level of noise in information

[10] Alternatively, we can assume $\phi_i = \mathcal{S}(\bar{\phi} + \eta_i)$, where $\mathcal{S}$ is a logistic function. Then, the survival probability is written in terms of a logarithmic odds ratio $(log(\phi/(1 - \phi)))$. Theoretical implications are identical.

for the credit risk of bond issue i by rating agency k.[11] Then, the updated probability of a survival shock $(E(\eta_i|z_{1,i}, z_{2,i}))$ is derived as follows:

$$E(\eta_i|z_{1,i}, z_{2,i}) = \gamma_{1,i}z_{1,i} + \gamma_{2,i}z_{2,i}, \tag{1}$$

$$\gamma_{k,i} = \frac{(\sigma^z_{k,i})^{-2}}{\sigma_i^{-2} + (\sigma^z_{1,i})^{-2} + (\sigma^z_{2,i})^{-2}} \tag{2}$$

Similarly, we can also compute the conditional variance $Var(\eta_i|z_i)$ as

$$Var(\eta_i|z_{1,i}, z_{2,i}) = \frac{1}{\sigma_i^{-2} + (\sigma^z_{1,i})^{-2} + (\sigma^z_{2,i})^{-2}}. \tag{3}$$

Multiple ratings (e.g., $\sigma_i^{-2} + (\sigma^z_{1,i})^{-2} + (\sigma^z_{2,i})^{-2}$ in lieu of $\sigma_i^{-2} + (\sigma^z_{1,i})^{-2}$) improve the informativeness of signals by lowering the posterior variance. However, the posterior mean, $E(\eta_i|z_{1,i}, z_{2,i})$, depends upon both the sensitivities to the information $(\gamma_{k,i})$ and the size and direction of the shocks realized $(z_{k,i})$.

Note that disagreements between credit rating agencies occur whenever $z_{1,i}$ and $z_{2,i}$ differ. In particular, we assume that for bond i, $z_{1,i} = z_i + \Delta_i$ and $z_{2,i} = z_i - \Delta_i$. Then, the size of credit rating disagreement is proportionate to $|\Delta_i|$. The predictions of major credit rating agencies are much more comparable in terms of their accuracy than those of equity analysts forecasts.[12] However, to study the effect of different information quality across rating agencies on the belief-updating equation (Equation 1), we temporarily assume that agency 1 is more

[11] Alternatively, credit information ambiguity could come from uncertainty in credit risk modeling, which should generate similar implications on investment decisions as the current model. For instance, the more significant the misspecification in credit rating models, the deeper the rating disagreements, and the more likely that insurance companies will seek to hold bonds that offer greater robustness against this uncertainty.

[12] Bongaerts et al. (2012) document that Moody's ratings perform best, followed by S&P and then by Fitch in forecasting default in one-year horizon over 2000–2008. To address this, in a robustness test reported in the Online Appendix, we use rating agency fixed effects or variations of that to account for the accuracy in predictions.

accurate than agency 2, or $\gamma_{1,i} = \gamma_i + \upsilon$, $\gamma_{2,i} = \gamma_i$ with $\upsilon > 0$. Then, Equation (1) given Δ_i becomes

$$E\left(\eta_i | z_{1,i}, z_{2,i}, \Delta_i\right) = (2\gamma_i + \upsilon) z_i + \upsilon \Delta_i \tag{4}$$

Equation (4) implies that if the more accurate agency—agency 1 in this example—has positive news (i.e., $\Delta_i > 0$ holds), then the posterior mean increases as dispersion increases. In contrast, if agency 1 has negative news (i.e., $\Delta_i < 0$ holds), then the posterior mean decreases as rating dispersion increases. If agencies 1 and 2 are comparable in their accuracy (i.e., $\upsilon \approx 0$), then credit rating dispersion has little effect on the updated probability. Furthermore, even if accuracies differ across agencies in a persistent manner, the overall result depends on the chance of positive and negative news. If the probability of good and bad news in survival likelihood is the same, the dispersion of credit rating does not affect the updated survival probability, as shown below.

$$E\left(\eta_i | z_{1,i}, z_{2,i}\right) = (2\gamma_i + \upsilon) z_i \tag{5}$$

The following claim summarizes the results.

Claim 1 *If credit rating agencies vary in their forecasting accuracy and investors are aware of the distribution of information quality, rating dispersion will influence how investors update their beliefs only when the probabilities of receiving positive and negative news differ significantly. However, if all rating agencies have the same probability distribution of information quality, rating dispersion does not have an impact on how investors update their probability assessments.*

The results indicate that the information updating channel offers limited insights into the role of credit rating dispersion unless credit rating changes are significantly skewed in either a positive or a negative direction. This finding allows us to indirectly test the validity of this channel by investigating the predictive power of rating dispersion onto future rating changes. In addition, it is important to control for an average rating to measure credit rating dispersion.

We now introduce ambiguity in credit information by assuming that the manager knows only the bounds of the information quality: $\sigma^z_{k,i} \in \left[\underline{\sigma}^z_{k,i}, \bar{\sigma}^z_{k,i}\right]$ holds for $k = 1, 2$; $i = A$, B; and $0 < \underline{\sigma}^z_{k,i} < \bar{\sigma}^z_{k,i}$. Denote $\bar{\gamma}_{k,i}$ for the case with $\sigma^z_{k,i} = \underline{\sigma}^z_{k,i}$ and $\underline{\gamma}_{k,i}$ for the case of $\sigma^z_{k,i} = \bar{\sigma}^z_{k,i}$ for $i = A$, B and $k = 1, 2$. Thus, $\underline{\gamma}_{k,i}$ refers to the case of highly uncertain quality, and $\bar{\gamma}_{k,i}$ is the information update with the most accurate signal. To focus on the ambiguity channel, we assume that both credit rating agencies have the same degree of information uncertainty, or $\underline{\sigma}^z_{1,i} = \underline{\sigma}^z_{2,i}$, and $\bar{\sigma}^z_{1,i} = \bar{\sigma}^z_{2,i}$ for both $i = A, B$. In addition, we assume for bond i, $z_{1,i} = \Delta_i$ and $z_{2,i} = -\Delta_i$ with $\Delta_i > 0$, without loss of generality.

Suppose that a fraction $(0 < \lambda < 1)$ of the insurance companies dislike ambiguity and act based on the max-min principle. Intuitively, this means that the long-position managers choose $\underline{\gamma}_i$ when credit information is favorable $(z_i > 0)$, and $\bar{\gamma}_i$ when credit news is bad $(z_i \leq 0)$. That is, an ambiguity-averse manager perceives good (bad) news as noisy (accurate). Furthermore, in order to facilitate comparison, we assume that only bond A is subject to this credit information uncertainty in that $\sigma^2_{z,A} \in \left[\underline{\sigma}^2_{z,A}, \bar{\sigma}^2_{z,A}\right]$ with $0 < \underline{\sigma}^z_A < \bar{\sigma}^z_A$. The investor knows the value of σ^z_B for bond B. Rewriting the posterior of survival probability with disagreement, $2\Delta_A$, we have the following:

Claim 2 *Under the ambiguity in credit information described above and ambiguity aversion, the subjective posterior becomes*

$$E\left(\phi_A | \Delta_A, -\Delta_A\right) \quad = \quad \phi^*_i - (\bar{\gamma}_A - \underline{\gamma}_A)\Delta_A.$$

That is, when credit information ambiguity exists, ambiguity aversion prevails via disagreement in credit ratings and negatively affects the investors' update of the posterior probability of survival.

In the beginning of period 0, the ambiguity-averse decision maker has a bond portfolio worth W_0 and makes a decision θ_A for bond A and $(1-\theta_A)$ for bond B after observing a signal. The bond values will be realized in the next period. We first compute the expected value of fund W_1 in the following period, conditional on the credit information $z = (z_A, z_B)$ as

$$\begin{aligned} E(W_1(\theta_A)|z) = & \left\{ (\phi_A^* + \gamma_{1,A} z_{1,A} + \gamma_{2,A} z_{2,A}) V_A + (1 - (\phi_A^* + \gamma_{1,A} z_{1,A} + \gamma_{2,A} z_{2,A})) \delta_A \right\} \theta_A \\ & + \left\{ (\phi_B^* + \gamma_{1,B} z_{1,B} + \gamma_{2,B} z_{2,B}) V_B + (1 - (\phi_B^* + \gamma_{1,B} z_{1,B} + \gamma_{2,B} z_{2,B})) \delta_B \right\} (1 - \theta_A) . \end{aligned} \tag{6}$$

The conditional variance of W_1 is computed as

$$Var(W_1(\theta_A)|z) = (V_A - \delta_A)^2 \theta_A^2 \sum_{k=1}^{2} \gamma_{k,A} (\sigma_{k,A}^z)^2 + (V_B - \delta_B)^2 (1-\theta_A)^2 \sum_{k=1}^{2} \gamma_{k,B} (\sigma_{k,B}^z)^2. \tag{7}$$

A higher level of information precision (i.e., a lower value of $\sigma_{z,i}^2$) increases the learning sensitivity of the informative signal (γ_i) in Equation (6) and lowers the posterior variance in Equation (7) by lowering $\gamma_i \sigma_{z,i}^2$, and vice versa. Thus, information ambiguity affects both Equation (6) and Equation (7).

Now, we consider the ambiguity-averse and risk-averse bond fund manager's problem upon receiving new but noisy information,

$$\max_{\theta_A} \min_{\sigma_{z,i}^2 \in \left[\underline{\sigma}_{z,i}^2, \bar{\sigma}_{z,i}^2\right]_{i=A}} \left(E(W_1(\theta_A)|z) - \frac{\psi}{2} Var(W_1(\theta_A)|z) \right) \tag{8}$$

subject to Equations (6) and (7). Given a choice of γ_i (or $\sigma^2_{z,i}$), the solution to problem (8) is readily available from the first-order condition.

Claim 3a *Portfolio weight for a bond with ambiguous signal (bond A) for an ambiguity-averse manager is given as*

$$\theta_A = \frac{\left(\phi^*_A + \sum_k \gamma_A z_A\right)(V_A - \delta_A) + \delta_A - \left(\phi^*_B + \sum_k \gamma_B z_B\right)(V_B - \delta_B) - \delta_B + \psi\,(V_B - \delta_B)^2 \sum_k \gamma_B \sigma^2_{z,B}}{\psi\left((V_A - \delta_A)^2 \sum_k \gamma_A \sigma^2_{z,A} + (V_B - \delta_B)^2 \sum_k \gamma_B \sigma^2_{z,B}\right)}. \tag{9}$$

To better identify the ambiguity channel, we make bonds differ only in terms of credit information ambiguity.

Claim 3b *Assume that $\phi^*_A = \phi^*_B = \phi^*$, $V_A = V_B = V$, $\delta_A = \delta_B = \delta$, and $\sigma_A = \sigma_B = \sigma$. Then, Equation (9) becomes*

$$\theta_A = \frac{\left(\sum_k \gamma_A z_A - \sum_k \gamma_B z_B\right)(V - \delta) + \psi\,(V - \delta)^2 \sum_k \gamma_B \sigma^2_{z,B}}{\psi\,(V - \delta)^2 \left(\sum_k \gamma_A \sigma^2_{z,A} + \sum_k \gamma_B \sigma^2_{z,B}\right)}. \tag{10}$$

To expound Equation (10), we separately consider a case with only good news (i.e., $z_A = \Delta_A > 0$) and a case with only bad news (i.e., $z_A = -\Delta_A < 0$).

Claim 4a *When credit information ambiguity exists with only good news ($z_A = \Delta_A > 0$), the manager chooses the most noisy case $\bar{\sigma}^2_{z,A}$:*

$$\theta_A^{z_A \geq 0} = \frac{\left(2\underline{\gamma}_A \Delta_A - \gamma_B z_B\right)(V-\delta) + \psi (V-\delta)^2 \gamma_B \sigma_{z,B}^2}{\psi (V-\delta)^2 \left(2\underline{\gamma}_A \bar{\sigma}_{z,A}^2 + \gamma_B \sigma_{z,B}^2\right)}. \tag{11}$$

Note that if $\bar{\sigma}_{z,A}^2$ increases, $\underline{\gamma}_A$ decreases and $\underline{\gamma}_A \bar{\sigma}_{z,A}^2$ increases. This claim implies that the effect of good news on a bond's portfolio weight is positive, although it is weakened owing to ambiguity aversion.

Claim 4b *When credit information ambiguity exists with only bad news ($z_A = -\Delta_A < 0$), the manager chooses the most accurate case $\underline{\sigma}_{z,A}^2$:*

$$\theta_A^{z_A < 0} = \frac{\left(-2\bar{\gamma}_A \Delta_A - \gamma_B z_B\right)(V-\delta) + \psi (V-\delta)^2 \gamma_B \sigma_{z,B}^2}{\psi (V-\delta)^2 \left(2\bar{\gamma}_A \underline{\sigma}_{z,A}^2 + \gamma_B \sigma_{z,B}^2\right)}. \tag{12}$$

In this case, an effective increase in ambiguity refers to a lower value of $\underline{\sigma}_{z,A}^2$, which in turn implies a higher value of $\bar{\gamma}_A$ (a lower value of $(-\bar{\gamma}_A)$) and a lower value of $\bar{\gamma}_A \underline{\sigma}_{z,A}^2$. The effect of bad news on portfolio weight is negative. In terms of interpretation for the two preceding cases, we can think of one agency as not changing their ratings while the other modifies theirs. Therefore, ambiguity in signals affects portfolio decisions via disagreement, even if the direction of the shock is less uncertain. The next result pertains to the case in which the signs of news differ as well.

Claim 4c *When credit information ambiguity exists with both good and bad news, the* *average effect on bond holdings is negative.*

$$\theta_A^{Disp} \quad = \quad \frac{\left(-(\bar{\gamma}_A - \underline{\gamma}_A)\Delta_A - \gamma_B z_B\right)(V-\delta) + \psi\,(V-\delta)^2\,\gamma_B \sigma_{z,B}^2}{\psi\,(V-\delta)^2\left(\bar{\gamma}_A \underline{\sigma}_{z,A}^2 + \underline{\gamma}_A \bar{\sigma}_{z,A}^2 + \gamma_B \sigma_{z,B}^2\right)} \tag{13}$$

Equation (13) states that when ratings disagree with different signs, the average effect of credit information ambiguity ($(\bar{\gamma}_A - \underline{\gamma}_A)\Delta_A$) on bond holdings is negative. Multiple ratings may help investors update information, but ambiguity aversion and rating dispersion lead to a reduction in holdings. **Claim 4c** suggests that the average effect of ambiguity tends to negatively affect bond holdings, unless good news is more frequent in rating disagreement.

One important implication of this model is that this result may be sensitive to the unconditional survival probability of the bond A. If the bond is very safe (i.e., $\phi^* \approx 1$), then disagreement in ratings will be prevalent only toward the downside direction. That is, within the current example, $\Delta_A > 0$ is virtually truncated and only the part of $-\Delta_A < 0$ prevails. Then, for an extreme case with complete truncation on the upside, we can obtain

$$\theta_{Safe}^{Disp} \quad = \quad \frac{\left(-(\bar{\gamma}_A)\Delta_A - \gamma_B z_B\right)(V-\delta) + \psi\,(V-\delta)^2\,\gamma_B \sigma_{z,B}^2}{\psi\,(V-\delta)^2\left(\bar{\gamma}_A \underline{\sigma}_{z,A}^2 + \underline{\gamma}_A \bar{\sigma}_{z,A}^2 + \gamma_B \sigma_{z,B}^2\right)}. \tag{14}$$

Similarly, for a very risky bond with $\phi^* \approx 0$ where the downside disagreement disappears, we have the opposite result in that

$$\theta_{Risky}^{Disp} \quad = \quad \frac{\left((\underline{\gamma}_A)\Delta_A - \gamma_B z_B\right)(V-\delta) + \psi\,(V-\delta)^2\,\gamma_B \sigma_{z,B}^2}{\psi\,(V-\delta)^2\left(\bar{\gamma}_A \underline{\sigma}_{z,A}^2 + \underline{\gamma}_A \bar{\sigma}_{z,A}^2 + \gamma_B \sigma_{z,B}^2\right)}. \tag{15}$$

Equations (14) and (15) imply that the relations between ratings disagreement and bond holdings vary significantly depending on how safe (or risky) the bonds are. For very safe bonds, credit information uncertainty works mostly on the downside, hence conservative investors tend to reduce their holdings. In contrast, for highly risky bonds, credit information uncertainty can lead to increases in holdings because the good news aspect of credit information uncertainty prevails. Note that the above results do not arise without ambiguity aversion. The remaining $(1-\lambda)$ fraction of insurance companies have $\bar{\gamma}_A = \underline{\gamma}_A \equiv \gamma_A^*$, and denoting the total insurance company holdings for bond A with ratings disagreement by Θ_A^{Disp}, we obtain the following testable implications.

Claim 5 *For each group of assets, the total insurers' holdings are computed as follows:*

$$\begin{aligned}
\Theta_A^{Disp} &= \frac{-\lambda(\bar{\gamma}_A - \underline{\gamma}_A)\Delta_A (V-\delta) + \psi (V-\delta)\left(\gamma_B \sigma_{z,B}^2 (V-\delta) - \gamma_B z_B\right)}{\psi (V-\delta)^2 \left(\bar{\gamma}_A \underline{\sigma}_{z,A}^2 + \underline{\gamma}_A \bar{\sigma}_{z,A}^2 + \gamma_B \sigma_{z,B}^2\right)} \\
\Theta_{Safe}^{Disp} &= \frac{-(\lambda\bar{\gamma}_A + (1-\lambda)\gamma_A^*)\Delta_A (V-\delta) + \psi (V-\delta)\left(\gamma_B \sigma_{z,B}^2 (V-\delta) - \gamma_B z_B\right)}{\psi (V-\delta)^2 \left(\bar{\gamma}_A \underline{\sigma}_{z,A}^2 + \underline{\gamma}_A \bar{\sigma}_{z,A}^2 + \gamma_B \sigma_{z,B}^2\right)} \qquad (16) \\
\Theta_{Risky}^{Disp} &= \frac{(\lambda\underline{\gamma}_A + (1-\lambda)\gamma_A^*)\Delta_A (V-\delta) + \psi (V-\delta)\left(\gamma_B \sigma_{z,B}^2 (V-\delta) - \gamma_B z_B\right)}{\psi (V-\delta)^2 \left(\bar{\gamma}_A \underline{\sigma}_{z,A}^2 + \underline{\gamma}_A \bar{\sigma}_{z,A}^2 + \gamma_B \sigma_{z,B}^2\right)}.
\end{aligned}$$

Equations (16) imply that interactions between risk and uncertainty help identify the channels of ambiguous credit information onto bond holdings, provided ambiguity-averse asset managers exist. The first equation shows that insurers will reduce bonds with increases in credit rating disagreement $(\bar{\gamma}_A - \underline{\gamma}_A)$, and the effect grows with ambiguity in credit ratings (Δ_A).

If there is no ambiguity-averse insurer $(\lambda = 0)$, the average effect of credit rating disagreement on portfolio holdings should be zero.

Finally, it could be argued that risk aversion can explain the results in **Claim 5**. Relatedly, risk aversion and ambiguity aversion can interact with each other to affect portfolio decisions. To shed light on this issue, we note that financial intermediaries such as insurance companies face fundamental risks related to leverage or intermediary capital constraints.[13] In our model, we can introduce leverage by setting asset B as the risk-free debt with payoff R_F. An insurer's portfolio payoff is $\theta_A V_A + (1-\theta_A) R_F$ if there is no default, and $\theta_A \delta_A + (1-\theta_A) R_F$ if a credit event occurs. Then, a leveraged investment refers to the condition of $\theta_A > 1$, and a larger value of θ_A implies higher leverage. With this information in hand, we rewrite Equations (16) as follows.

$$\begin{aligned}
\Theta_A^{Disp} &= \frac{-\lambda(\bar{\gamma}_A - \underline{\gamma}_A)\Delta_A (V-\delta) + (\delta - R_F)}{\psi (V-\delta)^2 \left(\bar{\gamma}_A \underline{\sigma}^2_{z,A} + \underline{\gamma}_A \bar{\sigma}^2_{z,A}\right)} \\
\Theta_{Safe}^{Disp} &= \frac{-(\lambda\bar{\gamma}_A + (1-\lambda)\gamma_A^*)\Delta_A (V-\delta) + (\delta - R_F)}{\psi (V-\delta)^2 \left(\bar{\gamma}_A \underline{\sigma}^2_{z,A} + \underline{\gamma}_A \bar{\sigma}^2_{z,A}\right)} \\
\Theta_{Risky}^{Disp} &= \frac{(\lambda\underline{\gamma}_A + (1-\lambda)\gamma_A^*)\Delta_A (V-\delta) + (\delta - R_F)}{\psi (V-\delta)^2 \left(\bar{\gamma}_A \underline{\sigma}^2_{z,A} + \underline{\gamma}_A \bar{\sigma}^2_{z,A}\right)}.
\end{aligned} \tag{17}$$

From equations (17), if a bond is held by insurers with a high leverage ratio, Θ should be larger than otherwise. If R_F is low or risk aversion ψ is low, insurance companies borrow to finance their bond purchases. Therefore, we can infer that bonds held by insurers with low (high) leverage ratios represent bonds invested by risk-averse (risk-tolerant) investors. According to our model, the effects of credit ratings disagreement on bond holdings via ambiguity aversion strengthen as leverage is higher (i.e., risk aversion (ψ) is lower). Thus, high risk aversion is unlikely to explain our findings, and if anything, the effect of informational obscurity becomes more pronounced as the leverage ratio of insurers increases. This implication is somewhat surprising in that it defies a popular prior that posits that risk

[13]Extant literature on intermediary asset pricing emphasizes the specialness and importance of intermediary leverage ratio (e.g., He and Krishnamurthy (2013)). Regulatory requirements on intermediary capital can affect the risk exposure and intermediary performance (e.g., Bouwman et al. (2024) and references therein).

aversion is positively linked to ambiguity aversion. While this result cannot fully disentangle risk preferences from uncertainty preferences, we believe that this hypothesis helps to shed light on the differences between the two key aspects of investor preferences. Similarly, bonds held by insurance companies with low intermediary capital will feature larger effects from a credit rating disagreement. Since bond holdings function Θ is decreasing and convex in risk aversion ψ, under sufficiently high risk aversion, or low leverage ratio, the effect of credit rating disagreement can disappear.

Claim 6 *Bonds held by insurers with higher leverage or lower intermediary capital are subject to stronger effects of bond holdings with respect to credit rating disagreements than those with lower leverage or higher intermediary capital.*

4 Empirical Analysis

Section 4.1 describes the data, followed by the main empirical results in Section 4.2.

4.1 Data and Variables

The sample consists of debentures and medium-term notes issued by public firms from Mergent's Fixed Income Securities Database.[14] We require sample bonds to be denominated in U.S. dollars; pay fixed or zero coupons; and be non-convertible, non-exchangeable, and non-putable. Bonds with less than one year to maturity and those without ratings are excluded. The insurance company quarterly bond holdings data are from Refinitive eMAXX (formerly

[14]We thank Chuck Fang for providing the historical link between bond cusip and Compustat GVKEY. We downloaded the data from his website on January 23, 2024: https://www.chuckfang.finance/

Lipper eMAXX).[15] Secondary market transaction data are from Enhanced TRACE provided by Wharton Research Data Services (WRDS). Our sample starts in Q4 of 2002 because the TRACE data needed to construct a few variables begin in July 2002. Our sample ends in Q4 of 2022, the latest coverage by our eMAXX data.

4.1.1 Insurers' Holdings

The dependent variable in our study, *Insurers' holdings*, is the fraction of bonds held by insurers at the issue level, defined as the total holdings by insurance companies for each bond in a given quarter-end, scaled by its amount outstanding at the beginning of the quarter.

4.1.2 NAIC Score and Group

NAIC specifies how to report credit ratings when an issue is covered by multiple rating agencies. While the conversion of credit ratings into numerical scores—discrete numbers starting with 1 for bonds of the highest credit quality (Aaa for Moody's and AAA for S&P and Fitch) and increasing ordinally as ratings move down the alphanumeric credit rating scale[16]—is standard in corporate bond studies, the credit indicators used are typically averages of the ratings. However, the NAIC standards for insurers are different. Specifically, when there are two ratings, the inferior rating determines the credit risk category, and when there are three ratings, the second lowest rating does. The second lowest rating rule applies

[15] In addition to insurance companies, eMAXX also contains bond holdings by mutual funds, pension funds, and other investors. As noted in previous studies (e.g., Dass and Massa (2014), Becker and Ivashina (2015)), the holdings information comes from regulatory disclosure to the NAIC for insurance companies; the Securities and Exchange Commission for mutual funds, asset managers, and public pension funds; and voluntary disclosures by the major private pension funds. However, the coverage of eMAXX for banks and hedge funds is quite limited.

[16] Our numerical rating scale follows Mergent's Fixed Income Securities Database.

even if the bottom two ratings are equivalent. Our *NAIC_score* variable is the numerical equivalent of the NAIC definition of credit quality.

The NAIC scores are further grouped into *NAIC_group*, again following the association's rules and guidelines. NAIC group 1 consists of the highest quality bonds—those with AAA, AA, or A ratings. BBB bonds belong to NAIC group 2, and BB bonds to group 3. Single-B bonds are placed into NAIC group 4, and CCC bonds into group 5. Bonds with CC ratings or lower belong to NAIC group 6. NAIC groups 1 and 2 are investment-grade bonds, and the others are non-investment-grade.[17] For our analyses, we group NAIC 6 bonds together with NAIC 5, since the number of bond issues in NAIC group 6 is very small.

NAIC groups are designed for the RBC requirements, which are imposed to ensure that insurance companies fulfill their obligations to policyholders. For each firm, the RBC is a statutory minimum level of capital, based on the insurance company's size and the riskiness of its assets and operations.[18] High-quality bonds incur low capital charges in the calculation of RBC. However, as bond ratings decline, the capital charges for insurers increase (see details in Table A. 16). If an insurer's capital ratio falls below the statutory minimum requirement, regulators have the authority to take actions ranging from requiring the submission of corrective action plans to mandating a management takeover.

By using both *NAIC_score* and *NAIC_group* together, we can better identify how insurers assign ratings during a rating split, as these factors help control for the impact of credit rating

[17] As of year-end 2021, the NAIC moved toward a more granular specification of risk categories (investments.metlife.com/insights/insurance-am/a-very-long-engagement/). Our results are unchanged with the exclusion of the affected data period. Moreover, we control for rating-by-quarter fixed effects in all regression analyses.

[18] Before the implementation of the RBC standard in 1993, regulators used fixed capital standards, which imposed the same amount of minimum capital requirement for each insurance company regardless of its size or risk profile. The inherent shortcomings of the fixed capital standard led to many insurance company insolvencies in the 1980s, and the RBC standard was a response to this outcome. (https://content.naic.org/insurance-topics/risk-based-capital)

risks. Consequently, with this added control, our measure of rating dispersion is more likely to effectively explain the associated uncertainty channel.

4.1.3 Rating Dispersion

Rating-based dispersion, our proxy for credit information uncertainty, is calculated as the standard deviation of a bond's credit rating scores scaled by the square root of its NAIC score. It is constructed in the spirit of the Fano factor (Fano (1947)), which is a measure of the dispersion of probability distribution in electronic particle detection.

Alphanumeric ratings may not be equivalent through time,[19] raising the concern that rating dispersion is driven by something other than the uncertainty about the underlying credit information across rating agencies. An alternative, probability-based dispersion measure addresses this issue. As the three major credit rating agencies publish annual default studies around February to March, we match the latest historical survival probabilities to each rating, rolling the probability curves as of March in each year to avoid look-ahead bias. For example, rating dispersion measures constructed in December 2013 use the 2012 survival probability curve, and measurements in March of 2014 use the (updated) 2013 curve. The published default rates are realized numbers and the corporate clientele are not identical across the agencies. Therefore, we average the three-year cumulative default rates from the three credit rating agencies in constructing the survival probability curve.[20] *Probability-based dispersion* is calculated as the standard deviation of a bond's average survival probabilities scaled by the square root of the average survival probability corresponding to the NAIC

[19]For example, Dimitrov et al. (2015) find that the quality of credit ratings deteriorates after the Dodd-Frank Act, and Becker and Milbourn (2011) find that the material entry of Fitch into the credit rating industry lowers the power of ratings to predict default.

[20]Because we use historical rates, in a given year, some ratings may have higher default rates than their adjacent inferior rating. In this case, we remove those observations and fit the curve with a piece-wise linear interpolation method.

score. Both rating-based and probability-based dispersion measures are set to zero if there is only one rating agency assessing the bond's credit quality.

Due to normalization, a riskier bond will have a higher value of uncertainty if the standard deviation of its average survival probability is identical to that of a safer bond. While intuitively appealing in the sense that uncertainty regarding credit quality grows more important as that quality deteriorates, there may be concerns about intentionally inflating uncertainty in the lower quality bonds driving our empirical results. In contrast, the credit rating-based measure penalizes the size of uncertainty in the opposite way (the denominator being larger in riskier bonds). Our results are robust to both ways of measuring uncertainty, showing that they do not depend on normalization of rating dispersion. Moreover, our empirical analysis includes rating-by-quarter fixed effects, which effectively compares bonds with different rating variation within the same regulatory rating category at a given point in time. We will also show that the main findings are robust to a few other alternative measures of credit rating dispersion.

4.1.4 Other Characteristics

We employ several bond-specific variables that may affect insurances' investment behavior, largely following Becker and Ivashina (2015).[21] They document "reaching for yield" behavior in investing in corporate bond by insurers. To ensure that our rating dispersion effects are distinct from those caused by insurers simply seeking bonds with higher yields within a risk category, we accordingly control for *Yield spread*, which is the corporate bond yield minus its maturity-matched treasury yield.[22] Because bonds with only one rating have zero dispersion

[21] As bond offering amount loads insignificantly in our cross-sectional specification, or is subsumed by bond fixed effects, we do not include it as a control variable.

[22] Treasury yield data is from Liu and Wu (2021): https://sites.google.com/view/jingcynthiawu/yield-data?pli=1.

by construction, we include the *Single rating dummy* to isolate any effect of such bonds. We also control for bond duration (*Duration*), measured in years.

A possible concern is that rating dispersion contains information regarding future rating changes, and it is such information, rather than credit information ambiguity, that drives insurers' portfolio decisions.To address this concern, we control for rating upgrades (*Upgrade*) and downgrades (*Downgrade*). *Upgrade* (*Downgrade*) is a dummy that is set to one if a bond is upgraded (downgraded) from the previous quarter based on *NAIC_score*.

We include a number of measures to control for bond liquidity in the secondary market, using the Enhanced TRACE database. These measures include the bid-ask spread at the bond level (*Bid-ask spread*), the log of a bond's total trading volume in a given quarter scaled by its amount outstanding (ln*(Trading volume)*), and the log of the number of investors reporting a change in holdings (i.e., ln*(Number of trades)*). We control for potential investment cyclicality in bonds (Timmer, 2018) by including the average monthly returns in a quarter (*Bond return*). We further control for bond risk by *Bond volatility*, which is computed as the standard deviation of monthly bond returns over the past 36 months, requiring at least three non-missing return observations.

Upgrade and *Downgrade* are measured contemporaneously to the dependent variable at the end of each quarter. All other independent variables are measured at the beginning of the quarter. All the independent variables are winsorized at the 1% and 99% levels (except for log-transformed and indicator variables). We provide detailed definitions and data sources for our variables in Appendix A.

4.1.5 Descriptive Statistics

The descriptive statistics for the variables of interest are presented in Table 1. Panel A shows figures for the full sample. On average, insurance companies collectively own more than 34% of the total outstanding amount of our sample bonds. The average size of uncertainty regarding credit rating quality is 0.196 for the rating-based measure and 0.006 for the probability-based, the standard deviations of which are 0.188 and 0.015, respectively. The majority of bonds have split ratings, as evidenced by the positive median rating dispersion. The mean credit rating score is close to 8.5, which is in line with most insurance bond holdings being investment-grade (with numerical scores of 10 or smaller). The average score translates to a historical survival probability of 97.3%. The existence of multiple credit ratings is the norm, with only 1.4% of sample bonds having a single rating. Credit rating changes are infrequent, with a downgrade slightly more likely (3.6%) than an upgrade (2.7%). The mean yield spread and the duration of the bond are 2.3% and 6.6 years, respectively.

Panel B further tabulates representative characteristics of the data by NAIC group (with NAIC group 6 bonds being classified together with group 5, owing to the small number of observations). The numbers reported are means, with medians in parentheses below. The majority of the samples are in the NAIC 1 or NAIC 2 categories (investment grade). However, insurers also hold 10.7% and 6.2%, respectively, of the NAIC 4 and NAIC 5 category bonds, which is non-trivial. In particular, rating-based ambiguity does not show a monotonic pattern across NAIC groups, but probability-based ambiguity increases as credit quality deteriorates. Yield spreads are highest for NAIC group 5 bonds, in line with risk compensation, and return volatility also increases with the level of credit risk. The proportion of bonds experiencing rating changes is very similar for both directions in NAIC groups 2, 3, and 4. The safest group of bonds is nearly three times as likely to be downgraded as upgraded. The riskiest bonds face somewhat more negative credit shocks than favorable ones.[23]

[Insert Table 1 About Here]

4.1.6 Rating Dispersion and Future Rating Changes

Our goal is to understand how rating dispersion affects insurers' bond holdings across the different risk categories. To do this, we first reflect on what rating dispersion means for credit risk. While our theory focuses on uncertainty generated by credit rating dispersion, an alternative hypothesis would be that such rating inconsistencies may signal upcoming rating downgrades or upgrades, and insurers simply adjust their holdings of these split-rated bonds based on the anticipated change of risk profiles.

For the alternative hypothesis to hold, first, rating adjustments must be directional *and* related to rating divergence, and second, the divergence must be short-lived. Our analysis of rating split persistence and rating change direction shows that neither case holds. To briefly reiterate the descriptive statistics, the majority of sample bonds have split ratings, and rating changes (upgrade or downgrade) happen only in single-digit percentages each quarter. In addition to the initial counter-evidence, Figures 2 and 3 add more perspective.

Figure 2 discusses in detail the directionality of rating changes and their relation to rating dispersion. One-quarter ahead downgrade and upgrade probabilities are presented for bonds of differing credit risk grouped by the degree of rating dispersion, using both the rating-based and probability-based dispersion measures. The low and high dispersion groups are defined each quarter by the median number among bonds with positive rating dispersion.[24]

[23]In Table A.2 of the Appendix, we also report summary statistics of the data by the degree of credit rating dispersion.

[24]Note that by construction, observations with zero dispersion are exactly the same using either a rating-based or a probability-based dispersion measure. This is also the case in Figure 3 below.

The main, and perhaps unexpected, takeaway from this figure is that bonds with concurrent ratings face overwhelmingly higher odds of a downgrade than an upgrade. If managers are making portfolio decisions based on rating change expectations, they should avoid bonds with zero dispersion because such bonds are riskier. Thus, from the standpoint of downgrade risk, the overall effect of rating dispersion on bond holdings could be *positive*, diametric to our theoretical prediction, which is a testable implication.

Among safe bonds (NAIC group 1 and 2), bonds with high rating-based dispersion face significantly higher probability of a downgrade than an upgrade; while for bonds with low raing-based dispersion, downgrade probability is slightly smaller than upgrade probability. However, using probability-based dispersion, the differences in upgrade/downgrade probability are comparable between low- and high-dispersion bonds. It seems to be a valid concern when using the rating-based dispersion measure that anticipated rating changes may lead fund managers to divest safe bonds with high dispersion., which we will address in our empirical analysis reported below. Probability-based dispersion is, nevertheless, not subject to the same concern.

Among risky bonds (NAIC groups 4 to 6), the difference in upgrade / downgrade probability is slightly higher for high rating-based dispersion bonds than for low rating-based dispersion bonds. However, using probability-based dispersion leads to a different view: Low-dispersion bonds are more likely to be upgraded than downgraded, whereas high-dispersion bonds have similar chances of a downgrade and an upgrade. Thus, if we are to find any significant positive effects of the rating dispersion measure on quantity decisions for NAIC group 4–6 bonds, it is highly unlikely to be from anticipated rating changes.

[Insert Figure 2 About Here]

Rating divergence may simply be caused by non-synchronous rating changes across rating agencies or by random errors in rating agency prediction (Ederington, 1986). This outcome suggests that rating divergence is a short-lived process and ratings would converge in the near future. To investigate this possibility, we conduct a time-series analysis examining the rating convergence of a given bond over the next 16 quarters. First, from 2002 Q4 to 2018 Q4, we randomly draw 25% unique quarters as the beginning quarter (i.e., 20 quarters).[25] Second, for each beginning quarter, we divide all bonds with at least two ratings into three groups based on their rating dispersion status, using rating-based and probability-based dispersion, separately. Group 1 consists of bonds with zero rating dispersion, and group 2 (3) is composed of bonds with rating dispersion below (above) the median dispersion among bonds with positive rating dispersion. Third, we create a dummy for each bond that stays zero (one) if the initial rating dispersion is positive (zero). This dummy changes to one (zero) once ratings converge (diverge) for the first time for groups 2 and 3 (group 1), after which the dummy's value remains unchanged until the end of the 16th quarter. This approach is valid because our goal is to examine how long the initial rating dispersion status lasts.

Figure 3 presents the rating convergence rates one, two, three, and four years after the beginning quarter, averaged across the 20 random draws.[26] Panel A reports the results based on rating-based dispersion. More than 70% of zero-dispersion bonds continue to maintain consistent ratings across rating agencies after one year, but this proportion drops well below 40% after four years. For bonds with low dispersion, a steadily increasing fraction of them have ratings converging over time, but the majority continue to have a positive rating dispersion after four years. We observe a much slower rating convergence rate for bonds with

[25] We exclude bonds that leave the sample before reaching the 16th quarter, but this requirement has little impact on our results.

[26] Corresponding numbers are reported in Panel B of Table A.4 and A.5 of the Online Appendix.

high dispersion, with over 70% of them having their ratings failing to converge after four years.[27] Panel B reports results using probability-based dispersion, where the convergence rate is similar between low- and high-dispersion bonds, with more than 60% of both types of bonds still having a positive rating dispersion after four years.

[Insert Figure 3 About Here]

Taken together, the evidence invalidates the story of fund managers responding to rating splits as harbingers of imminent rating changes. Further, it highlights the persistent, ambiguous nature of credit assessment divergence. Rating dispersion, rather than being temporary, is more persistent than it would be expected if it is only caused by non-synchronous rating changes or random errors in prediction across rating agencies. The evidence of the persistence in rating dispersion is more consistent with the view that rating dispersion tends to arise from credit information ambiguity, either about the underlying credit risk distribution faced by rating agencies and/or the different credit risk modeling that they employ.

4.2 Empirical Results

This section tests the theory by verifying whether credit rating dispersion affects insurers' bond investment behavior. We first introduce our baseline empirical specification. We then discusses the results.

[27] Related, Livingston et al. (2008) find that for new bonds rating divergence is also quite persistent, with 70% still having split ratings four years after the issuance.

4.2.1 Empirical Specification

We use the following specification to identify the rating dispersion channel:

$$\begin{aligned}\theta_{i,t} &= \beta_1 * \textit{Rating dispersion}_{i,t-1} + \beta_2 * \textit{Rating dispersion}_{i,t-1} * NAIC\_group_{i,t-1} \\ &+ Controls_{i,t-1} + \textit{Fixed effects} + \epsilon_{i,t}, \end{aligned} \tag{18}$$

where $\theta_{i,t}$ is the fraction of a bond outstanding held by insurers at time t, and *Rating dispersion*$_{i,t-1}$ denotes bond i's rating dispersion, gauged by either the credit rating-based or survival probability-based dispersion measure. Recall that our rating dispersion measures are normalized by either the NAIC credit score or the corresponding average survival probability (i.e., credit risk). We lag dispersion and NAIC categories by one quarter, to prevent the results from being contaminated by the possibility of contemporaneous trading decisions affecting ratings and rating dispersion. As trades can be executed at any time during a given quarter t, the use of lagged dispersion measures also rules out the possibility of trades executed before the investor observes the magnitude of credit rating dispersion across rating agencies. β_1 estimates the average predictive power of rating dispersion on one-quarter ahead fraction of bonds held by insurers, and β_2 the differential effects of rating dispersion pertaining to distinct NAIC risk categories.

Controls contain a vector of bond characteristics that we introduced in Section 4.1.4: *Single rating dummy*, *Yield spread*, *Duration*, *Bid-ask spread*, ln*(Trading volume)*, ln*(Number of trades)*, *Bond return*, *Bond volatility*, *Upgrade*, and *Downgrade*. As discussed below, for some specifications, we also interact some of these control variables with *NAIC_group*.

For the baseline specification, we include rating-by-quarter and industry-by-quarter fixed effects, where rating is based on *NAIC_score* and industry follows Fama-French 48 definition.

These fixed effects account for the influence of any rating- or industry-level characteristics and/or changes to them that may be correlated with rating dispersion. Also note that the stand-alone $NAIC\_group_{i,t-1}$ variable is absorbed by rating-by-quarter fixed effects. For another, more stringent specification, we further add bond fixed effects, fully controlling for the impact of time-invariant observed and unobserved bond-level heterogeneities. With the full set of fixed effects, we are able to observe how within-bond changes in credit rating dispersion affect insurers' holding of a given bond, netting out any static and/or time-varying effects of credit ratings and industry features that may affect the degree of disagreement in credit quality assessments. We estimate the models using OLS and cluster standard errors at both the issuer and time (year-quarter) levels, ensuring our inference is robust to heteroscedasticity and arbitrary serial and contemporaneous cross-sectional correlation in $\epsilon_{i,t}$.

4.2.2 Baseline Analysis

We present the baseline OLS regression results of the relation between rating dispersion and insurers' bond holdings in Table 2. Panel A presents the results with dispersion measures based on credit rating scores. We start with a parsimonious specification that includes *Rating dispersion* and its interaction with NAIC risk group (*NAIC_group*), and the set of control variables except for *Upgrade* and *Downgrade*. Column (1) reports the results with rating-by-quarter and industry-by-quarter fixed effects.

The effect of *Rating dispersion* on the one-quarter-ahead fraction of insurers' bond holdings is negative, suggesting that insurance companies generally shy away from bonds with ratings disagreement. The results are in line with **Claim 5**, which posits that the average effect of ambiguity on bond holdings should be negative (unless good news is dominant). In contrast, the interaction term between *Rating dispersion* and *NAIC_group* loads significantly positive, suggesting that the effect of dispersion differs significantly across the NAIC groups.

We discuss the economic magnitude of the varying effects of rating dispersion on insurers' bond holdings across NAIC groups. A one-standard-deviation increase in rating dispersion in a bond belonging to NAIC group 1 category *decreases* insurers' holdings by 1.3% $((-0.095+0.026\times 1)\times 0.188)$ on average. However, for a bond in NAIC group 5, an equivalent change in rating dispersion leads to an *increase* in insurer's bond holdings by 0.66% $((-0.095+0.026\times 5)\times 0.188)$ in the following quarter. That is, an asymmetric reaction to rating dispersion exists across different bond risk categories.

It is also worthwhile to note that the degree of change in response to rating dispersion is much larger for the risky bonds. In particular, 1.3% is only 3.5% of the average proportion of NAIC 1 bonds held by insurers, which is 37.4%. However, the 0.66% adjustment in NAIC group 5 bonds is more than 10% of the mean insurers' holdings of 6.2%. Given the large position of NAIC group 1 category bonds in insurers' portfolios, the 1.3% holding reduction, although seemingly small, could release enough capital for insurers to bet on risky bonds with rating dispersion, based on a back-of-the-envelope calculation. The proceeds from selling the mentioned percentage in NAIC group 1 are $9 million, which can amply cover the $3.5 million cost needed to increase holdings by 0.7% in NAIC group 5 bonds.[28]

The relations between rating dispersion and insurers' holdings may be influenced by some omitted issue- or issuer-level factors, such as bond covenants. To mitigate this concern, column (2) presents OLS regression results with additional bond fixed effects. The prior

[28]The $9 million is from .013*700*(1+.0039), where $700 million is the unreported average amount outstanding at the beginning of the quarter when selling takes place, and .0039 is the RBC rate for NAIC group 1 bonds. Similarly, $3.5 million is from .0066*437*(1+.2231), where $437 million is the unreported average amount outstanding at the beginning of the quarter when buying takes place, and .2231 is the RBC rate for NAIC group 5 bonds.

cross-sectional results still hold under this alternative identification strategy. The results indicate that following a positive change in rating dispersion of a given bond, insurers tend to reduce their holdings if it is safe, but increase their holdings if it is risky.

With respect to control variables, *Yield spread* loads negatively (positively) in column (1) ((2)), although both are statistically indistinguishable from zero.[29] We find strong evidence suggesting that insurance companies lean toward bonds with longer duration. There is some evidence that echoes the extant findings that insurance companies invest countercyclically (Timmer, 2018), as insurers' holdings are negatively associated with past bond return when bond fixed effects are included. While the bid-ask spread loads negatively in the cross-sectional specification, the coefficient becomes indistinguishable from zero once the bond fixed effects are controlled for. In contrast, the other two liquidity proxies, ln($Trading$ $volume$) and ln($Number\ of\ trades$), load negatively and are statistically significant at the 1% level in specifications with or without bond fixed effects. Lastly, we find a positive relation between bond return volatility and insurers' holdings. This outcome suggests that conditional on credit ratings, insurance portfolios are systematically biased toward bonds with more volatile past returns.

Credit rating dispersion is positively and significantly associated with expected bond returns (Kim et al., 2022a). To the extent that insurers reach for yield within the same NAIC regulatory requirements (Becker and Ivashina (2015)), the positive coefficient on the interaction term between rating dispersion with *NAIC_group* could be driven by insurers reaching for yield among risky bonds.[30] To mitigate this concern, we add to Equation (18) the interaction term between yield spread and *NAIC_group*. Columns (3) and (4) report

[29] We do find significant evidence of reaching for yield in insurers' corporate bond holdings among bonds with short duration, as shown in Table A.12 in the Online Appendix.

[30] Note, however, that Becker and Ivashina (2015) find that reaching for yield exists among investment-grade rather than speculative-grade bonds.

the results for specifications without and with bond fixed effects, separately. The economic and statistical significance of the coefficients on both the rating dispersion measure and its interaction term with *NAIC_group* change little. The coefficients on both yield spread and its interaction term with *NAIC_group* are statistically indistinguishable from zero.

We also test whether the impact of rating dispersion on insurers' corporate bond holdings is driven by insurers' anticipation of upcoming rating changes. We add to the above specifications two dummy variables, *Downgrade* and *Upgrade*, that capture whether a bond is downgraded or upgraded in the same quarter when the holding is measured; we also interact each dummy with *NAIC_group*. The results are reported in columns (5) and (6), which differ only by the added bond fixed effects in the latter. The coefficient estimates of rating dispersion and its interaction with *NAIC_group* are identical to those in the prior columns. The results highlight that the effects of credit rating dispersion are not driven by how insurers react to future rating changes signaled (if any) from rating dispersion. With respect to *Downgrade*, *Upgrade*, and their interaction terms with *NAIC_group*, the evidence indicates that insurers reduce (increase) holdings of downgraded (upgraded) issues (especially once issue-level heterogeneity are controlled for), and such effects vary little across NAIC groups.

Panel B of Table 2 shows that the results discussed in Panel A still hold when rating dispersion is measured from survival probabilities. Note that the coefficient estimates on dispersion and its interaction term with NAIC group in Panel B are much larger than those in Panel A. This is because the mean of probability-based dispersion is only about 3% of that of rating-based dispersion (see Table 1). Again, the results indicate that for safe bonds, the effect of credit rating dispersion on insurers' holdings is negative, but for risky bonds, it is positive.

[Insert Table 2 About Here]

It is evident that the portfolio effects of rating dispersion are little driven by insurers' reaching for yield or reacting to incoming rating changes. To keep the empirical model parsimonious, in the rest of the paper, we report results based on the specifications as in columns (1) and (2) of Table 2. That is, we use specifications that exclude *Upgrade*, *Downgrade*, and the interaction terms of *NAIC_group* with *Yield spread*, *Upgrade*, or *Downgrade*. In unreported analysis, however, we ensure that all of our results still hold even after controlling for these interaction terms.

4.2.3 Robustness Tests of the Primary Finding

To strengthen the inferences from our primary finding of a negative (positive) effect of rating dispersion on insurers' investment in safe (risky) bonds, we perform a battery of robustness tests.

4.2.3.1 Additional Alternative Explanations We discuss additional tests that show that alternative stories are unlikely to drive our main findings.

Recall that zero-dispersion bonds are far more likely to be downgraded than upgraded, in comparison with bonds of positive dispersion (Figure 2), which might explain our findings. For example, the positive relation between dispersion and holding for risky bonds may be driven by insurers investing less in bonds with zero dispersion because of their dominant downgrade probability, while reacting little to bonds with positive dispersion. To address this concern and other potential heterogeneity between the two types of bonds, we create a dummy that captures bonds with zero rating dispersion (*Zero dispersion*); we then expand the baseline specification by including *Zero dispersion* and its interaction term with *NAIC_group*. We rerun the model and report the results in Table 3. The results show that, after controlling for the heterogeneity between zero- and positive-dispersion bonds, the primary findings still hold.[31]

[Insert Table 3 About Here]

Downgrade and *Upgrade* above are ex post proxies for insurers' anticipation of upcoming rating changes when observing ratings diverging. Alternatively, we use two ex ante measures to capture such expectations. For one measure, we define *Concurrent downgrade* and *Concurrent upgrade*, two dummies that separately capture whether any of the three rating agencies downgrade or upgrade a bond in the same quarter when rating dispersion is measured. To the extent that insurers update their prior beliefs to incorporate new information when observing that any of the rating agencies changes their ratings first, these two dummies plausibly represent the anticipated direction of future rating change of the remaining agencies. We include both variables and their interaction terms with *NAIC_group* in Equation (18) and rerun the model. As Table A.6 reports, the results are consistent with our baseline analysis.

For the other measure, we compute the probabilities of downgrade (*Downgrade probability*) and upgrade (*Upgrade probability*) for each bond before the quarter when the rating dispersion is measured. First, for each NAIC group in a given quarter, we classify bonds into three categories (i.e., ciargroup) according to the size of rating-based dispersion: zero, low, or high, where the low and high subgroups are defined relative to each NAIC group's median rating dispersion among bonds with positive rating dispersion. Next, for each NAIC group-ciargroup-quarter triple, we compute the mean probabilities of upgrade and down-

[31] Alternatively, we expand the baseline specification by interacting *Single rating dummy* and *NAIC_group*. Unreported results show that our main findings are little affected.

grade using all the issue-level rating change data in the past, where we use *NAIC_score* to determine upgrade and downgrade. By explicitly controlling for the upgrade and downgrade probabilities that vary over time and across credit risk and rating dispersion, we alleviate the concern that investors simply react to these rating change probabilities behind rating dispersion (as discussed in Figure 2). We include both variables and their interaction terms with *NAIC_group* in Equation (18) and rerun the model. The results, as reported in Table A.7, are again consistent with our baseline analysis.

Claim 1 in Section 3 (see Eqn.(4)) shows that if the accuracy of the forecast across credit rating agencies varies significantly, rating dispersion can influence how investors update their beliefs even without ambiguity in credit information.[32] Because Bongaerts et al. (2012) document that rating agencies differ in their ratings' predictive power of future one-year default, it is important for us to rule out this alternative channel driving our main findings on rating dispersion. To this end, we expand our baseline specification (Equation (18)) by including fixed effects for the rating agency to control for any time-invariant agency characteristics that could drive the difference in forecast precision between agencies. In more stringent specifications, we also allow these fixed effects to vary across quarters (i.e., agency-by-quarter fixed effects), which controls for agency-specific shocks that could affect forecast accuracy. In unreported analysis, we also allowed these fixed effects to vary by NAIC groups (i.e., agency-by-NAIC fixed effects), addressing the possibility that the difference in forecast accuracy between agencies varies with credit risk. The main findings are still valid.

Table A.8 reports the results, which are quantitatively similar to those reported in Table

[32]An alternative but related explanation is that, rating dispersion may be caused by one rating agency allowing ratings shopping and producing inflated rating, such as Fitch (Bongaerts et al., 2012). Insurers are likely to divest these bonds with a positive rating dispersion because they are low quality rather than ambiguous credit information. Our approach here–including rating agency fixed effects–also controls for this possibility.

2. This outcome indicates that this alternative channel, as stated in **Claim 1**, offers little insight into the role that credit rating dispersion plays in insurers' asset allocation decisions in the corporate bond market.

Lastly, Table A.9 also tests the interaction of yield spread and rating dispersion and yields insubstantial results.

4.2.3.2 Alternative Rating Dispersion Measures We employ alternative measures of credit rating dispersion and report the results in Table A.10.

Recall that our main rating-based dispersion measure is calculated as the standard deviation of credit rating scores scaled by the square root of the NAIC score. Instead of the NAIC score, we use the average credit rating score in the denominator. For ease of comparison, columns (1) and (2) of Panel A replicate the baseline results in columns (1) and (2) of Panel A in Table 2, and columns (3) and (4) present results with this alternative dispersion measure. Regardless of which denominator is used, credit rating dispersion has similar effects on insurers' bond holdings.

In Panel B, we report the results using three alternative probability-based dispersion measures. Similar to Panel A, the first two columns reproduce the baseline results in columns (1) and (2) of Panel B in Table 2. Columns (3) and (4) report the results using an alternative measure that is similar to the main probability-based dispersion measure, but the denominator is the average survival probability corresponding to the average credit score instead of the NAIC score. The results are similar to those of the results using the main probability-based dispersion measure.

For the numerator of the main probability-based measure, recall that for each given rating, we map it separately to the three agencies' survival probability curves, take the average of these probabilities, and assign it to the rating. Then we compute the standard deviation of the averaged survival probabilities that correspond to the ratings of a bond. Thus, a bond would only have a positive probability-based dispersion if it received different ratings from different rating agencies.

Alternatively, we directly take the individual survival probability that corresponds to each agency's rating and compute the standard deviation. In this way, the dispersion is typically positive even when an issue has the same ratings between agencies. We scale it by either the individual survival probability corresponding to the NAIC score or the average of individual survival probabilities corresponding to each agency's rating. Columns (5) to (8) report results using the two alternative probability-based dispersion measures. Across the board, the results using these alternative dispersion measures are qualitatively similar to our baseline results.

In unreported tests, we also use the following unscaled dispersion measures: the standard deviation of credit rating scores, the standard deviation of averaged survival probabilities, and the standard deviation of individual survival probabilities. Our results are robust to these alternate specifications.

4.2.4 Asymmetric Reaction to Rating Dispersion by Risk Category

The baseline evidence is consistent with the existence of differences in insurer attitudes toward rating dispersion for different NAIC risk categories. Using the interaction term of rating dispersion and NAIC group, however, does not allow for a clear picture on the contrasting investment effect of rating dispersion when rating moves from one bounded extreme to the other. It could be that issues with rating in particular risk categories (e.g., NAIC 2 vs. NAIC 3) are the only ones to experience the contrasting effects of rating dispersion. Therefore, we utilize an alternative specification that allows the coefficient on rating dispersion to vary across risk categories.

First, we group bonds into three categories: (1) the group of investment-grade bonds (NAIC groups 1 and 2); (2) the middle risk category (NAIC 3); and (3) risky bonds (NAIC groups 4–6). We also report results in Table A.11 of the Online Appendix for a more granular version of Equation (19) using the five NAIC risk categories, where again we group NAIC 6 into NAIC 5. The results show that the negative effect of rating dispersion resides mainly in NAIC 1 and 2 categories, while the positive effect is found in NAIC 4 and 5. Therefore, to be parsimonious, we group NAIC 1 and 2 together and NAIC 4 and 5 together. Then we define *Rating dispersion n*, which equals the rating dispersion for a bond belonging to group n, and zero for those belonging to the other two groups. For example, a bond in risk group 1 will have *Rating dispersion 1* equal to its rating dispersion, and *Rating dispersion 2* and *Rating dispersion 3* zero. To facilitate comparison across groups, we further standardize these new dispersion measures within each group and multiply their coefficient estimates by 100. We run the following specification:

$$\begin{aligned}\theta_{i,t} &= \alpha_1 * \mathit{Rating\ dispersion\ 1}_{i,t-1} + \alpha_2 * \mathit{Rating\ dispersion\ 2}_{i,t-1} \\ &+ \alpha_3 * \mathit{Rating\ dispersion\ 3}_{i,t-1} + \mathit{Controls}_{i,t-1} + \mathit{Fixed\ effects} + \epsilon_{i,t}, \end{aligned} \tag{19}$$

where $Controls_{i,t-1}$ including the same set of control variables as Equation (18). Similar to the baseline analysis, we report results for two specification: one including rating-by-quarter and industry-by-quarter fixed effects, and the other incrementing bond fixed effects. Note that instead of measuring the differences between the slopes, α_1, α_2, and α_3 estimate the slopes themselves. Thus, the analysis would clearly illustrate the asymmetry in quantity decisions made by insurers with regard to rating dispersion for different risk categories. We estimate the models using OLS and cluster standard errors at both the issuer and time (year-quarter) levels, ensuring that our inference is robust to heteroscedasticity and arbitrary serial and contemporaneous cross-sectional correlation in $\epsilon_{i,t}$.

Table 4 reports the results, using rating-based dispersion in column (1) and (2) and probability-based dispersion in (3) and (4). For safe bonds in risk group 1, rating dispersion is negatively related to future bond holdings. However, in risk group 2, the effect of rating dispersion is indistinguishable from zero, and for the riskiest bonds in group 3, the relation becomes significantly positive. We also note that the estimates using rating-based dispersion (column (2)) are somewhat noisy and hence have low statistical power when we include bond fixed effects. However, unreported Wald tests show that the coefficient estimates of *Rating dispersion 1* and *Rating dispersion 3* are jointly significant at the 10% level, and they are statistically different from each other at the 5% level.

The results are consistent with **Claim 5**, which states that insurers will decrease holdings of safe bonds with credit rating ambiguity because the positive area of their perceived probability distribution is truncated, but they will increase investment of risky bonds with such ambiguity because of larger positive potential of the distribution. In the middle ratings, both up- and down-sides are open, and ratings dispersion in this region can result in inaction.

[Insert Table 4 About Here]

4.2.5 Leverage and Capital Surplus

Claim 6 (Eqn. (17)) posits that the fraction of a bond held by insurers (Θ) is more sensitive to credit rating disagreement if it is held by those with high leverage or low intermediary capital. We test these cross-sectional predictions in this section.

Information on leverage and regulatory capital surplus for insurance companies is extracted from S&P's Capital IQ. The former is defined as the ratio of assets to equity, and the latter measures the difference between required and reported capital, normalized by book value of assets. Each quarter, we sort the sample by leverage and classify the bottom 33% as low leverage and the top 33% as high leverage funds. *Low Lev* refers to the fraction of a corporate bond amount outstanding held by low leverage funds, and *High Lev* is the proportion held by high leverage funds. A similar process is repeated for capital surplus, and the variables *Low Cap* and *High Cap* are calculated accordingly.

First we run Equation (19) using *Low Lev* and *High Lev* as dependent variables, separately.[33] Table 5 reports the results, using rating-based dispersion in Panel A and probability-based dispersion in Panel B. In both panels, columns (1) and (2) report the results for *Low Lev*, and (3) and (4) report the results for *High Lev*. The odd-numbered columns control for rating-by-quarter and industry-by-quarter fixed effects, and the even-numbered columns further include bond fixed effects.

First and foremost, the asymmetry in attitudes toward disagreement in credit risk assessments only shows up in high-leverage funds, especially after accounting for the heterogeneity across bonds. That is, the proportion of a safe bond held by high-leverage funds decreases with its rating dispersion (*Rating dispersion* 1), while that of a risky bond increases with its rating dispersion (*Rating dispersion* 3) (column (4)).[34] Unreported Wald tests show that the coefficients of *Rating dispersion 1* and *Rating dispersion 3* are significantly different from each other at the 5% level. In contrast, for low-leverage funds (column (2)), the coefficient

[33]Unreported analyses show that using the interaction specification of Equation (18) yields consistent results.

[34]Unreported Wald test shows that the coefficient estimates of *Rating dispersion 1* and *Rating dispersion 3* are jointly significant at the 10% level when using rating-based dispersion and bond fixed effects.

estimates on both *Rating dispersion 1* and *Rating dispersion 3* are small and statistically indistinguishable from zero.

Second, we note that cross-sectionally, low-leverage funds also show an asymmetry in their attitudes toward disagreement in credit risk assessments, but to a lower extent than high-leverage funds (column (1) vs. (3)). Furthermore, columns (1) and (3) indicate that, to invest in speculative grade bonds by 1% more of their outstanding amount, high-leverage funds must sell more than 1.7% of the outstanding amount of investment-grade bonds in their portfolio (0.816/0.474 = 1.722 in Panel A). In contrast, for low-leverage funds the counterpart number is only 0.54% (0.096/0.178 = 0.539 in Panel A).[35] This outcome is consistent with expectations that, to increase their holding of speculative grade bonds by the same amount, low-leverage funds can afford to divest a smaller fraction of their holding of investment-grade bonds than high-leverage funds.

[Insert Table 5 About Here]

Next, we repeat the same analysis, using *Low Cap* and *High Cap* as dependent variables, separately. We present the results in Table 6. Low- (high-) capital funds produce a pattern similar to that of high- (low-) leverage funds. After accounting for the heterogeneity across bonds, we find that the group of low-capital funds drives the asymmetry in attitudes toward disagreement in credit risk assessments. The cross-sectional results suggest that high-capital funds exhibit such an asymmetry but with much smaller magnitude than low-capital funds; when increasing their holding of speculative-grade bonds by the same amount, high-capital funds also need only to divest a smaller fraction of their holding of investment-grade bonds

[35] We assume that the bonds transacted by both types of funds are the same. Using coefficient estimates in Panel B leads to a similar conclusion.

than low-capital funds.

To summarize, our empirical evidence supports **Claim 6** and reveals an interesting pattern that helps distinguish between risk aversion and ambiguity aversion as explanatory mechanisms. We find that insurers with high leverage and low capital surplus (indicators of low risk aversion) actually decrease their holdings of safe bonds with high credit rating dispersion and increase holdings of risky bonds with lower downside risks. This behavior contradicts what we would expect if risk aversion were the primary driver, since less risk-averse investors should prefer more risky assets [which is safe bonds with high dispersion (more downside risk) and risky bonds with no rating dispersion(more downside risk)? Please clarify.]. Instead, the results align with our model's prediction that the effects of ambiguity aversion on bond holdings become stronger when risk aversion is lower. Therefore, we conclude that risk aversion alone cannot explain our main findings.

[Insert Table 6 About Here]

5 Conclusion

Proxying for the size of ambiguity by the degree of rating dispersion from the multiple credit rating companies, we find "betting on bond ratings disagreement" in risky bonds by insurance funds. On average, the average effect of rating disagreement is to reduce the holdings of bonds with a greater degree of rating dispersion, which is in line with the ambiguity aversion literature. However, insurers reduce their holdings of safe bonds with increases in dispersion, while the opposite is true for risky bonds. Anticipation of future credit rating changes cannot explain this behavior.

We explain the "betting on dispersion" behavior with bond survival probability assessments being bounded. At the lower and upper ends of the probability boundary, uncertainty can only point in opposite directions. Categorical risk classifications (NAIC groups) can act as defining regions for this asymmetry as well. In safe bonds, rating dispersion portends unfavorable developments, and investors adjust their bond holdings away from such uncertainty. However, in bonds with very low credit quality, the perception of limited downside emphasizes the upside potential in such disagreement, and insurance companies tilt their investments toward bonds with rating dispersion. With ambiguity aversion, the average effect of credit rating dispersion on holdings of the affected bonds should be negative, and the absolute size of adjustment in risky bonds will be smaller than that in safe bonds.

This novel finding of an asymmetric reaction to credit rating disagreement depending on the level of risk is robust to the inclusion of stringent fixed effects and a host of controls for bond and trading characteristics. Whereas the preference for bonds with higher yields within a rating category is attributed to imperfect risk classification and regulatory arbitrage, the empirical results suggest that betting on ratings disagreement stems from uncertainty regarding credit quality assessments and the nature of probability distributions that are truncated at the extremes. Despite explicit regulatory controls to limit their risk exposure, insurers lean toward risky bonds with rating dispersion, and this is most evident in those with low capital surplus and high leverage. Such a concentration of risk in the bonds that are the most vulnerable to adverse shocks can have negative implications for social welfare.

Our analysis focuses on total insurers' holdings per bond. Therefore, in equilibrium, other investors, such as mutual funds and pension funds, should have opposite positions. According to our model, heterogeneous investors can have different degrees of ambiguity aversion or risk aversion. For example, if some institutions are highly optimistic about a corporate bond, they will increase holdings when ratings disagree because they select the best-case scenario. In this vein, our empirical results suggest that insurance companies tend to be averse to uncertainty relative to other investors, yet this tendency to avoid ambiguity leads to making riskier investment choices because they have a decreased degree of uncertainty.

Appendix A: Variable Definitions

Variable	Definition (Source)
Insurers' holdings	Total holdings of a bond by insurance company funds scaled by amount outstanding (eMAXX and WRDS). Quarterly.
NAIC_score	The numeric credit rating of a bond following NAIC rules: if the bond is rated by two rating agencies, use the lowest rating; if the bond is rated by all three rating agencies, use the middle rating. Credit rating scores range from 1 (AAA) to 19 (CCC-) in our sample.
Rating-based dispersion	Bond ratings dispersion based on credit rating scores, defined as *std_score* scaled by $\sqrt{NAIC\_score}$. *std_score* is the standard deviation of rating scores for a bond and is set to zero if there is only one rating (Mergent's Fixed Income Securities Database).
Probability-based dispersion	Bond ratings dispersion based on historical survival probabilities, defined as *std_sp* scaled by $\sqrt{NAIC\_sp}$. *NAIC_sp* is the historical survival probability for a bond corresponding to *NAIC_score*, and the survival probability curves are updated as of March each year. *std_sp* is the standard deviation of survival probabilities and is set to zero if there is only one rating (Annual default studies are from S&P, Moody's, and Fitch).
NAIC_group	A bond's NAIC risk category based on *NAIC_score*: 1 for bonds with scores from 1 to 7, 2 for bonds with scores from 8 to 10, 3 for bonds with scores from 11 to 13, 4 for bonds with scores from 14 to 16, 5 for bonds with scores from 17 to 19, and 6 for bonds with scores of 20 and above.
Single rating dummy	One if an issue is only covered by one rating agency, zero otherwise.
Downgrade	One if a bond's *NAIC_score* increases, zero otherwise
Upgrade	One if a bond's *NAIC_score* decreases, zero otherwise
Duration	Bond duration (WRDS).
Bid-ask spread	Average trade-weighted bid-ask spread in the month prior to the quarter (WRDS).
Bond return	Monthly bond return prior to the quarter.(WRDS).
Bond volatility	Standard deviation of monthly bond return over the past 36 months. Three non-missing monthly returns are required (WRDS).
Yield spread	A bond's yield minus maturity-matched treasury yield (WRDS and Liu and Wu (2021)).
Trading volume	$\frac{bond\_volume}{amount\_outstanding}$, where *bond_volume* is total bond trading volume in the previous quarter (WRDS).
Number of trades	The number of investors reporting a changed position in a quarter (eMAXX)

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Figure 1: **Asymmetric Uncertainty Associated With Rating Dispersion**

This figure shows the asymmetric nature of uncertainty associated with rating dispersion. Survival probability (1, default probability) is denoted by ϕ_i for bond i, which is bounded between 0 and 1. For very safe bonds, uncertainty associated with rating dispersion is likely to be more negative, making investors avoid it. Conversely, for very risky bonds, uncertainty associated with rating dispersion is likely to be more positive, causing investors to lean toward such uncertainty. In the middle region, uncertainty does not point in a certain way and may lead to inaction on the part of investors.

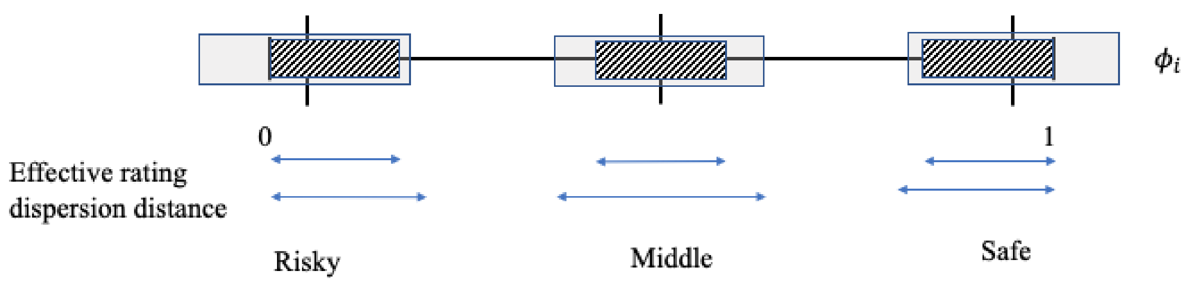

Figure 2: **Rating Dispersion and Rating Changes**

This figure presents the relation between credit rating dispersion and future rating changes. Panel A reports the mean likelihood of one-quarter ahead rating changes in safe bonds (NAIC groups 1 and 2) with different magnitudes of credit rating dispersion. Panel B shows the patterns for risky bonds (NAIC groups 4–6). *Rating-based dispersion* (R-b) is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score, and *Probability-based dispersion* (P-b) is the standard deviation of historical survival probabilities matched to alphanumeric ratings scaled by the square root of the NAIC score-equivalent survival probability. Historical survival probability curves are rolled each year to avoid look-ahead bias. Rating dispersion is measured at the end of the prior quarter, and rating changes happen in the current quarter. Zero dispersion bonds are those for which all available ratings concur, and bonds with discordant ratings are placed into low and high groups by the median credit rating dispersion each quarter. The sample period is from Q4 of 2002 to Q4 of 2022.

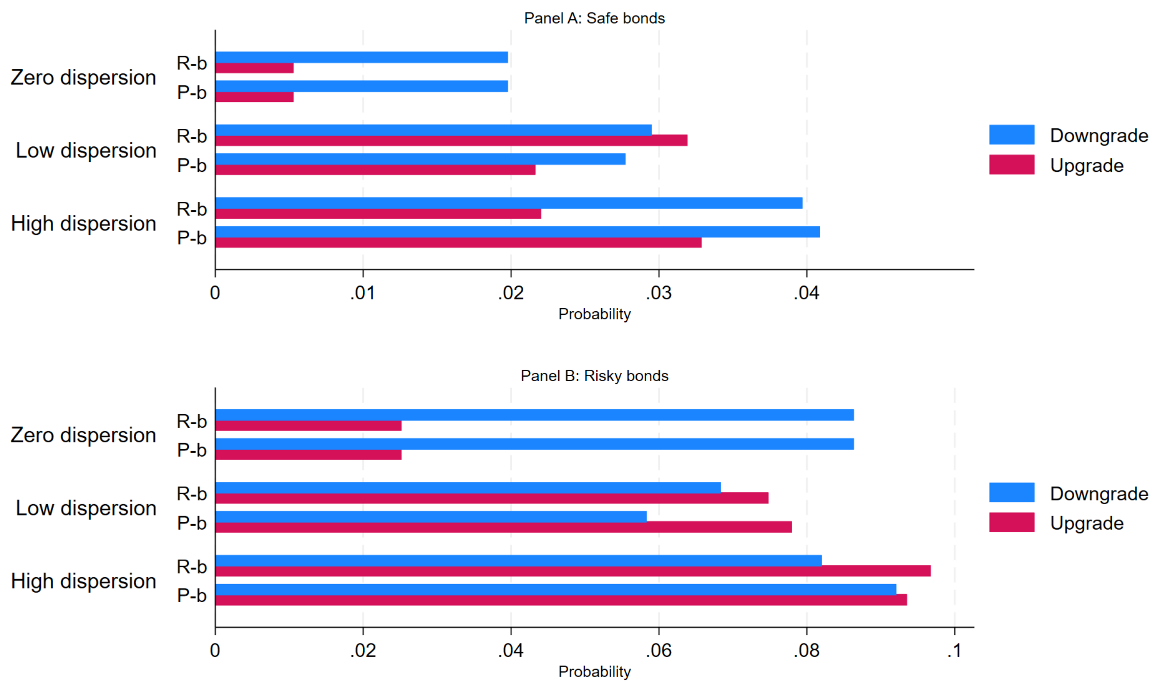

Figure 3: **Rating Dispersion and Convergence**

This figure presents the relation between credit rating dispersion and future rating convergence. Panel A tracks the mean likelihood of rating convergence up to 16 quarters for different rating-based dispersion groups, from 20 rounds of random sampling. Panel B shows results for probability-based dispersion groups. *Rating-based dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score, and *Probability-based dispersion* is the standard deviation of historical survival probabilities matched to alphanumeric ratings scaled by the square root of the NAIC score-equivalent survival probability. Historical survival probability curves are rolled each year to avoid look-ahead bias. Rating dispersion is measured at the end of the prior quarter, and rating changes happen in the current quarter and beyond. Zero dispersion bonds are those for which all available ratings concur, and bonds with discordant ratings are placed into low and high groups by the median credit rating dispersion each quarter. The sample period is from Q4 of 2002 to Q4 of 2022.

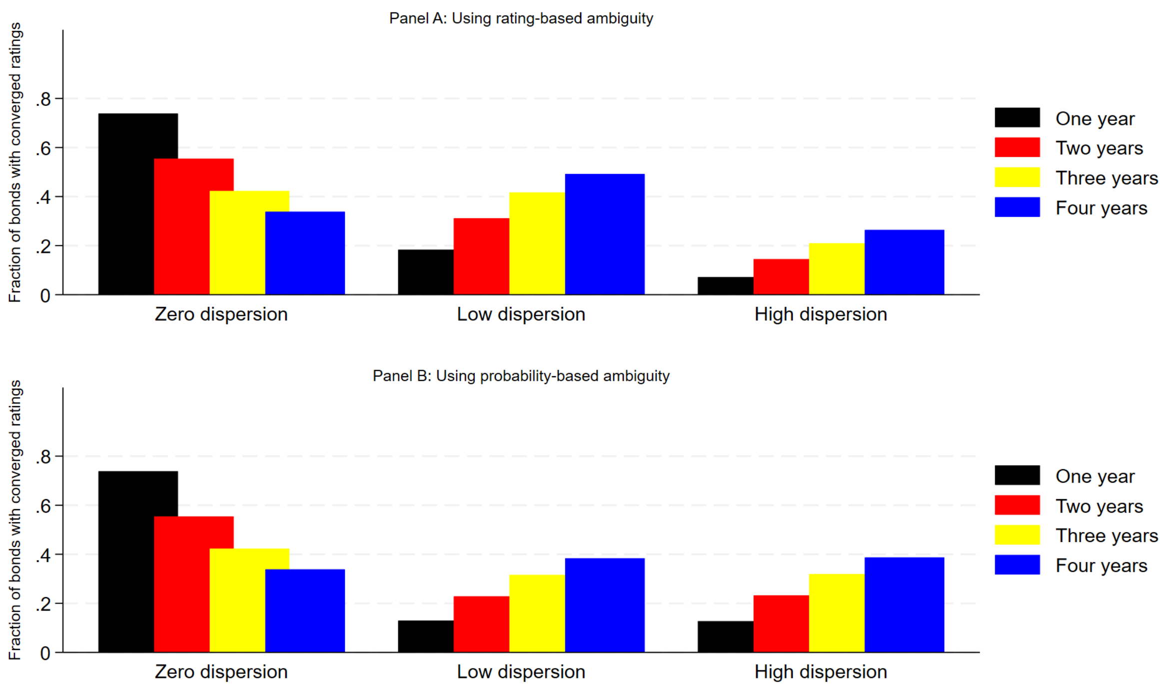

Table 1: **Descriptive Statistics**

This table reports descriptive statistics of main variables used in this study. Panel A reports detailed statistics for the full sample, while Panel B reports means (medians below in parentheses) by NAIC group, where NAIC group 6 bonds are included in NAIC group 5, owing to the small number of observations. *Number of bonds* refers to the unique number of issues per quarter. *Insurers' holdings*, the dependent variable of this study, is the fraction of each bond held by insurers scaled by its total amount outstanding as of each quarter. *Rating-based dispersion* is the standard deviation in credit ratings scores of a bond, scaled by the square root of its NAIC score. *Probability-based dispersion* is measured in the same way as its rating-based counterpart, with historical survival probabilities matched to the relevant credit rating scores. Other variable definitions are as in Appendix A. The sample period is from Q4 of 2002 to Q4 of 2022.

Panel A	Mean	P25	Median	P75	Std.Dev.	N
Number of bonds	4,970	4,031	5,312	5,873	1,004	384,908
Insurers' holdings	0.342	0.152	0.310	0.502	0.226	384,908
Rating-based ambiguity	0.196	0.000	0.192	0.289	0.188	384,908
Probability-based ambiguity	0.006	0.000	0.001	0.004	0.015	384,908
Credit rating	8.472	6	8	10	3.228	384,908
Survival probability	0.973	0.981	0.993	0.996	0.052	384,908
Single rating dummy	0.014	0	0	0	0.117	384,908
Offering amount ($ Mil)	622	250	450	750	629	384,908
Time to maturity	10.124	3.671	6.592	13.964	9.703	384,908
Bond age	5.461	1.904	3.926	7.274	4.992	384,908
Duration	6.598	3.269	5.391	8.950	4.344	384,908
Upgrade	0.027	0.000	0.000	0.000	0.162	384,573
Downgrade	0.036	0.000	0.000	0.000	0.186	384,383
Yield spread	0.023	0.010	0.016	0.027	0.023	384,908
Bond return	0.001	-0.008	0.002	0.012	0.029	384,908
Bid-ask spread	0.006	0.002	0.004	0.007	0.006	384,908
Bond volatility	0.028	0.014	0.022	0.034	0.022	384,908
ln(Trading volume)	4.499	3.844	4.720	5.410	1.398	384,908
ln(Number of trades)	2.475	1.609	2.639	3.367	1.210	384,908

Table 1: **Descriptive Statistics - Continued**

Panel B	NAIC 1	NAIC 2	NAIC 3	NAIC 4	NAIC 5
Number of bonds	1,958 (2,003)	2,249 (2,428)	431 (444)	341 (364)	126 (124)
Insurers' holdings	0.374 (0.350)	0.397 (0.376)	0.190 (0.148)	0.107 (0.078)	0.062 (0.028)
Rating-based ambiguity	0.235 (0.236)	0.152 (0.183)	0.201 (0.174)	0.215 (0.183)	0.243 (0.171)
Probability-based ambiguity	0.001 (0.000)	0.003 (0.001)	0.013 (0.010)	0.030 (0.022)	0.057 (0.053)
Credit rating	6 (6)	9 (9)	12 (12)	15 (15)	17 (17)
Survival probability	0.997 (0.997)	0.988 (0.990)	0.948 (0.952)	0.864 (0.878)	0.681 (0.726)
Single rating dummy	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Offering amount ($ Mil)	704 (500)	597 (425)	531 (400)	460 (350)	498 (350)
Time to maturity	11.183 (7.005)	10.423 (6.959)	7.403 (5.882)	6.788 (5.874)	6.605 (5.208)
Bond age	5.704 (4.153)	5.504 (4.036)	5.110 (3.627)	4.302 (2.995)	5.278 (3.992)
Duration	7.278 (5.897)	6.740 (5.767)	5.049 (4.754)	4.676 (4.520)	3.947 (3.703)
Upgrade	0.012 (0.000)	0.025 (0.000)	0.056 (0.000)	0.068 (0.000)	0.083 (0.000)
Downgrade	0.033 (0.000)	0.024 (0.000)	0.060 (0.000)	0.069 (0.000)	0.104 (0.000)
Yield spread	0.013 (0.011)	0.020 (0.017)	0.039 (0.034)	0.054 (0.048)	0.094 (0.086)
Bond return	0.001 (0.001)	0.001 (0.001)	0.002 (0.004)	0.004 (0.005)	0.003 (0.007)
Bid-ask spread	0.006 (0.004)	0.006 (0.004)	0.007 (0.004)	0.007 (0.004)	0.011 (0.008)
Bond volatility	0.023 (0.019)	0.026 (0.022)	0.034 (0.025)	0.040 (0.028)	0.074 (0.064)
ln(Trading volume)	4.244 (4.489)	4.384 (4.618)	5.195 (5.367)	5.352 (5.469)	5.771 (5.910)
ln(Number of trades)	2.297 (2.485)	2.453 (2.639)	2.940 (3.178)	2.990 (3.135)	2.680 (2.833)

Table 2: **Rating Dispersion and Insurers' Holdings**

This table reports estimates of panel regression results of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, with rating-by-quarter and industry-by-quarter fixed effects. *Rating-based dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score, and *NAIC_group* is the credit rating category defined by NAIC. Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Dependent Variable:	*Panel A: Rating-based Dispersion*					
Insurers' Holdings	(1)	(2)	(3)	(4)	(5)	(6)
Rating dispersion	-0.095***	-0.027***	-0.095***	-0.026***	-0.094***	-0.026***
	(0.019)	(0.009)	(0.019)	(0.009)	(0.019)	(0.009)
Dispersion × NAIC_group	0.026***	0.012***	0.026***	0.012***	0.026***	0.012***
	(0.007)	(0.004)	(0.007)	(0.004)	(0.007)	(0.004)
Single rating dummy	-0.030**	-0.010	-0.030**	-0.010	-0.029**	-0.012
	(0.013)	(0.009)	(0.013)	(0.009)	(0.013)	(0.009)
Yield spread	-0.231	0.029	-0.392	-0.030	-0.319	-0.010
	(0.151)	(0.083)	(0.476)	(0.178)	(0.481)	(0.177)
Yield spread × NAIC_group			0.053	0.020	0.026	0.027
			(0.119)	(0.043)	(0.121)	(0.044)
Downgrade					-0.020***	-0.009***
					(0.007)	(0.002)
Downgrade × NAIC_group					0.009***	0.001
					(0.002)	(0.001)
Upgrade					-0.008	0.009**
					(0.009)	(0.004)
Upgrade × NAIC_group					0.005*	0.002
					(0.003)	(0.001)
Duration	0.006***	0.021***	0.006***	0.021***	0.006***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.038	-0.055*	0.036	-0.056*	0.037	-0.054*
	(0.047)	(0.029)	(0.048)	(0.028)	(0.048)	(0.028)
Bid-ask spread	-1.302***	-0.039	-1.296***	-0.039	-1.294***	-0.033
	(0.263)	(0.067)	(0.259)	(0.067)	(0.260)	(0.067)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.034***	-0.006***	-0.034***	-0.006***	-0.034***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.353***	0.099*	0.353***	0.099*	0.349***	0.100*
	(0.111)	(0.054)	(0.111)	(0.054)	(0.111)	(0.054)
Bond FE		Yes		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230	384,380	383,710
Adj. R^2	0.496	0.900	0.496	0.900	0.497	0.901

Table 2: **Rating Dispersion and Insurers' Holdings - Continued**

Dependent Variable:	*Panel B: Probability-based Dispersion*					
Insurers' Holdings	(1)	(2)	(3)	(4)	(5)	(6)
Rating dispersion	-3.164***	-1.335***	-3.147***	-1.332***	-3.141***	-1.308***
	(0.583)	(0.318)	(0.584)	(0.318)	(0.587)	(0.315)
Dispersion × NAIC_group	0.769***	0.333***	0.766***	0.332***	0.763***	0.324***
	(0.132)	(0.073)	(0.132)	(0.072)	(0.133)	(0.072)
Single rating dummy	-0.026*	-0.011	-0.025*	-0.011	-0.025*	-0.012
	(0.013)	(0.008)	(0.013)	(0.008)	(0.013)	(0.008)
Yield spread	-0.226	0.038	-0.435	-0.019	-0.357	0.001
	(0.152)	(0.083)	(0.481)	(0.178)	(0.486)	(0.177)
Yield spread × NAIC_group			0.069	0.019	0.040	0.026
			(0.121)	(0.043)	(0.123)	(0.044)
Downgrade					-0.021***	-0.009***
					(0.007)	(0.002)
Downgrade × NAIC_group					0.010***	0.002
					(0.002)	(0.001)
Upgrade					-0.013	0.009**
					(0.009)	(0.004)
Upgrade × NAIC_group					0.006**	0.002
					(0.003)	(0.001)
Duration	0.006***	0.021***	0.006***	0.021***	0.006***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.039	-0.053*	0.036	-0.055*	0.037	-0.053*
	(0.048)	(0.028)	(0.049)	(0.028)	(0.049)	(0.028)
Bid-ask spread	-1.313***	-0.038	-1.305***	-0.037	-1.303***	-0.032
	(0.264)	(0.067)	(0.260)	(0.067)	(0.261)	(0.067)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.034***	-0.006***	-0.034***	-0.006***	-0.034***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.384***	0.109**	0.384***	0.109**	0.379***	0.109**
	(0.113)	(0.054)	(0.112)	(0.054)	(0.112)	(0.053)
Bond FE		Yes		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	384908	384230	384908	384230	384380	383710
Adj. R^2	0.495	0.901	0.495	0.901	0.496	0.901

Table 3: **Zero Dispersion Indicator**

This table reports estimates of panel regression results of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, with rating-by-quarter and industry-by-quarter fixed effects. *Rating-based dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score, and *NAIC_group* is the credit rating category defined by NAIC. *Zero dispersion* is an indicator variable that equals 1 if there is no rating dispersion. Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Dependent Variable:	Rating-based		Probability-based	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion	-0.138***	-0.030**	-2.354***	-1.535***
	(0.028)	(0.013)	(0.624)	(0.353)
Dispersion × NAIC_group	0.042***	0.012**	0.584***	0.349***
	(0.009)	(0.005)	(0.140)	(0.079)
Zero dispersion	-0.024**	-0.001	0.015*	0.004
	(0.012)	(0.005)	(0.009)	(0.004)
Zero dispersion × NAIC_group	0.009**	-0.000	-0.004	-0.004**
	(0.004)	(0.002)	(0.004)	(0.002)
Yield spread	-0.239	0.029	-0.237	0.045
	(0.151)	(0.084)	(0.151)	(0.083)
Duration	0.006***	0.021***	0.006***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.038	-0.055*	0.038	-0.053*
	(0.047)	(0.029)	(0.047)	(0.028)
Bid-ask spread	-1.293***	-0.039	-1.306***	-0.038
	(0.263)	(0.067)	(0.263)	(0.067)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.034***	-0.006***	-0.033***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.356***	0.100*	0.376***	0.112**
	(0.111)	(0.054)	(0.113)	(0.054)
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.496	0.900	0.495	0.901

Table 4: **Block-Diagonal Specification**

This table reports estimates of panel regression results of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, with a block-diagonal specification. *Rating dispersion N* equals a bond's *Rating dispersion* if the bond belongs to group N and zero otherwise, where $N = 1$ (NAIC groups 1 and 2), 2 (NAIC group 3), and 3 (NAIC groups 4–6). Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Various fixed effects are included, and standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Dependent Variable:	Rating-based		Probability-based	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion 1	-1.227***	-0.156	-1.065***	-0.388***
	(0.243)	(0.108)	(0.167)	(0.086)
Rating dispersion 2	0.069	0.161	-0.157	-0.123
	(0.338)	(0.259)	(0.362)	(0.219)
Rating dispersion 3	0.901***	0.397*	0.706***	0.443**
	(0.295)	(0.227)	(0.267)	(0.187)
Single rating dummy	-0.029**	-0.010	-0.026*	-0.011
	(0.013)	(0.009)	(0.013)	(0.008)
Yield spread	-0.226	0.028	-0.210	0.040
	(0.150)	(0.084)	(0.150)	(0.083)
Duration	0.006***	0.021***	0.006***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.039	-0.055*	0.042	-0.053*
	(0.047)	(0.028)	(0.047)	(0.028)
Bid-ask spread	-1.310***	-0.040	-1.313***	-0.039
	(0.263)	(0.066)	(0.263)	(0.066)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.034***	-0.006***	-0.034***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.345***	0.099*	0.373***	0.106*
	(0.110)	(0.054)	(0.112)	(0.054)
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.496	0.900	0.496	0.901

Table 5: **Insurers' Holdings by Leverage**

This table reports panel regression estimates of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, classified by insurers' leverage. Low (high) leverage is defined as the bottom (top) 33% of the total sample sorted by leverage (assets scaled by equity) in each quarter. *Low Lev* and *High Lev* are the fractions of corporate bonds held by insurance funds with low and high leverage, respectively. *Rating dispersion N* equals a bond's *Rating dispersion* if the bond belongs to group N and zero otherwise, where $N = 1$ (NAIC groups 1 and 2), 2 (NAIC group 3), and 3 (NAIC groups 4–6). Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Various fixed effects are included, and standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Panel A: Rating-based Dispersion

Dependent Variable:	Low Lev		High Lev	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion 1	-0.096**	-0.012	-0.816***	-0.081
	(0.040)	(0.039)	(0.183)	(0.102)
Rating dispersion 2	0.344	0.082	-0.407	-0.021
	(0.249)	(0.118)	(0.325)	(0.178)
Rating dispersion 3	0.178***	0.027	0.474**	0.364**
	(0.041)	(0.064)	(0.222)	(0.177)
Controls	Yes	Yes	Yes	Yes
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.201	0.693	0.436	0.862

Panel B: Probablity-based Dispersion

Dependent Variable:	Low Lev		High Lev	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion 1	-0.051	-0.000	-0.676***	-0.219***
	(0.044)	(0.029)	(0.135)	(0.074)
Rating dispersion 2	0.209	-0.033	-0.470	-0.111
	(0.154)	(0.041)	(0.304)	(0.183)
Rating dispersion 3	0.137***	0.024	0.386**	0.366**
	(0.044)	(0.053)	(0.190)	(0.150)
Controls	Yes	Yes	Yes	Yes
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.201	0.693	0.435	0.862

Table 6: **Insurers' Holdings by Capital Surplus**

This table reports panel regression estimates of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, classified by insurers' capital surplus. Low (high) capital surplus is defined as the bottom (top) 33% of the total sample sorted by capital surplus in each quarter. *Low Cap* and *High Cap* are the fraction of corporate bonds held by insurance funds with low and high capital surplus, respectively. *Rating dispersion N* equals a bond's *Rating dispersion* if the bond belongs to group N and zero otherwise, where $N = 1$ (NAIC groups 1 and 2), 2 (NAIC group 3), and 3 (NAIC groups 4–6). Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Various fixed effects are included, and standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Panel A: Rating-based Dispersion

Dependent Variable:	Low Cap		High Cap	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion 1	-0.803***	-0.076	-0.097**	-0.017
	(0.176)	(0.100)	(0.042)	(0.040)
Rating dispersion 2	-0.374	-0.033	0.341	0.087
	(0.323)	(0.175)	(0.250)	(0.120)
Rating dispersion 3	0.452**	0.400**	0.183***	0.033
	(0.217)	(0.184)	(0.043)	(0.063)
Controls	Yes	Yes	Yes	Yes
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.437	0.857	0.203	0.693

Panel B: Probablity-based Dispersion

Dependent Variable:	Low Cap		High Cap	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion 1	-0.639***	-0.228***	-0.058	-0.002
	(0.125)	(0.072)	(0.044)	(0.029)
Rating dispersion 2	-0.418	-0.104	0.205	-0.031
	(0.299)	(0.179)	(0.155)	(0.041)
Rating dispersion 3	0.387**	0.403***	0.143***	0.031
	(0.187)	(0.148)	(0.046)	(0.053)
Controls	Yes	Yes	Yes	Yes
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.436	0.857	0.203	0.693

Online Appendix to
"Betting on Bond Ratings Disagreement"

Hwagyun (Hagen) Kim (Texas A&M University, hkim@mays.tamu.edu), Ju Hyun Kim (Ajou University, jhkim0902@ajou.ac.kr), and Nan Yang (Hong Kong Polytechnic University, nyang@polyu.edu.hk).

Table A.1: **Correlation Table**

This table reports correlations of main variables used in this study. *Insurers' holdings*, the dependent variable of this study, is the fraction of each bond held by insurers scaled by its total amount outstanding as of each quarter. *Rating-based dispersion* is the standard deviation in credit ratings scores of a bond, scaled by the square root of its NAIC score. *Probability-based dispersion* is measured in the same way as its rating-based counterpart, with historical survival probabilities matched to the relevant credit rating scores. Other variable definitions are as in Appendix A. The sample period is from Q4 of 2002 to Q4 of 2022.

Panel A: Pairwise correlation

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Insurers' holdings	1.000					
(2) Rating-based ambiguity	-0.080***	1.000				
(3) Probability-based ambiguity	-0.290***	0.303***	1.000			
(4) Credit rating	-0.302***	-0.076***	0.641***	1.000		
(5) Survival probability	0.367***	-0.028***	-0.770***	-0.814***	1.000	
(6) Yield spread	-0.245***	0.039***	0.568***	0.645***	-0.692***	1.000

Panel B: Lisewise correlation

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Insurers' holdings	1.000					
(2) Rating-based ambiguity	-0.080***	1.000				
(3) Probability-based ambiguity	-0.290***	0.303***	1.000			
(4) Credit rating	-0.302***	-0.076***	0.641***	1.000		
(5) Survival probability	0.367***	-0.028***	-0.770***	-0.814***	1.000	
(6) Yield spread	-0.245***	0.039***	0.568***	0.645***	-0.692***	1.000

Table A.2: **Descriptive Statistics by Rating Dispersion**

This table reports descriptive statistics of main variables used in this study by the degree of dispersion in credit rating scores. Zero dispersion includes bonds with a single rating, and bonds with nonzero rating-based dispersion are grouped by the median positive dispersion each quarter. Variable definitions are as in Table 1 and Appendix A. The numbers reported are means for each group, with medians below in parentheses. The sample period is from Q4 of 2002 to Q4 of 2022.

	Zero dispersion	Low dispersion	High dispersion
Number of bonds	1,828	1,597	1,573
	(1,827)	(1,658)	(1,674)
Insurers' holdings	0.364	0.345	0.315
	(0.340)	(0.311)	(0.272)
Credit rating	8	9	8
	(8)	(9)	(7)
Survival probability	0.979	0.966	0.970
	(0.993)	(0.990)	(0.995)
Single rating dummy	0.038	0.000	0.000
	(0)	(0)	(0)
Offering amount ($ Mil)	593	577	703
	(450)	(400)	(500)
Time to maturity	10.019	9.898	10.479
	(6.633)	(6.586)	(6.545)
Bond age	5.094	5.470	5.879
	(3.619)	(4.011)	(4.329)
Duration	6.608	6.454	6.742
	(5.483)	(5.327)	(5.356)
Upgrade	0.007	0.040	0.035
	(0.000)	(0.000)	(0.000)
Downgrade	0.026	0.037	0.046
	(0.000)	(0.000)	(0.000)
Yield spread	0.020	0.026	0.023
	(0.015)	(0.019)	(0.014)
Bond return	0.001	0.001	0.002
	(0.001)	(0.002)	(0.002)
Bid-ask spread	0.006	0.006	0.006
	(0.004)	(0.004)	(0.004)
Bond volatility	0.026	0.029	0.029
	(0.021)	(0.023)	(0.022)
ln(Trading volume)	4.471	4.537	4.488
	(4.681)	(4.781)	(4.704)
ln(Number of trades)	2.488	2.512	2.423
	(2.639)	(2.639)	(2.565)

Table A.3: **Descriptive Statistics by Probability-Based Dispersion**

This table reports descriptive statistics of main variables used in this study by the degree of dispersion in survival probabilities. Zero dispersion includes bonds with a single rating, and bonds with nonzero probability-based dispersion are grouped by the median positive dispersion each quarter. Variable definitions are as in Table 1 and Appendix A. The numbers reported are means for each group, with medians below in parentheses. The sample period is from Q4 of 2002 to Q4 of 2022.

	Zero dispersion	Low dispersion	High dispersion
Number of bonds	1,828	1,646	1,524
	(1,827)	(1,719)	(1,463)
Insurers' holdings	0.364	0.373	0.287
	(0.340)	(0.347)	(0.224)
Credit rating	8	6	11
	(8)	(6)	(10)
Survival probability	0.980	0.995	0.944
	(0.993)	(0.996)	(0.976)
Single rating dummy	0.038	0.000	0.000
	(0)	(0)	(0)
Offering amount ($ Mil)	593	738	539
	(450)	(500)	(400)
Time to maturity	10.019	11.558	8.802
	(6.633)	(7.378)	(6.126)
Bond age	5.094	5.892	5.447
	(3.619)	(4.384)	(3.956)
Duration	6.608	7.513	5.674
	(5.483)	(6.172)	(4.872)
Upgrade	0.007	0.024	0.052
	(0.000)	(0.000)	(0.000)
Downgrade	0.026	0.029	0.054
	(0.000)	(0.000)	(0.000)
Yield spread	0.020	0.014	0.034
	(0.015)	(0.012)	(0.026)
Bond return	0.001	0.000	0.003
	(0.001)	(0.001)	(0.003)
Bid-ask spread	0.006	0.005	0.007
	(0.004)	(0.003)	(0.005)
Bond volatility	0.026	0.023	0.035
	(0.021)	(0.020)	(0.026)
ln(Trading volume)	4.471	4.175	4.852
	(4.681)	(4.441)	(5.082)
ln(Number of trades)	2.488	2.368	2.569
	(2.639)	(2.565)	(2.773)

Table A.4: **Rating-Based Dispersion and Future Rating Changes**

This table reports the relation between credit rating dispersion and future rating changes. Panel A reports the mean likelihood of one-quarter ahead rating changes in bond subsamples with different magnitudes of credit rating dispersion. Panel B tracks the mean likelihood (with medians below in parentheses) of rating convergence up to 16 quarters for different rating dispersion groups, from 20 rounds of random sampling. *Rating-based dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score. Rating dispersion is measured at the end of the prior quarter, and rating changes happen in the current quarter and beyond. Zero dispersion bonds are those for which all available ratings concur, and bonds with discordant ratings are placed into low and high groups by the median credit rating dispersion each quarter. The sample period is from Q4 of 2002 to Q4 of 2022.

Panel A: Rating Changes (Next Quarter)	Downgrade	Upgrade
NAIC group < 3 (Safe)		
Zero dispersion	0.020	0.005
Low dispersion	0.030	0.032
High dispersion	0.040	0.022
NAIC group >3 (Risky)		
Zero dispersion	0.086	0.025
Low dispersion	0.068	0.075
High dispersion	0.082	0.097

Panel B: Rating Convergence	Zero dispersion	Low dispersion	High dispersion
After 4 quarters (%)	0.738	0.183	0.071
	(0.719)	(0.179)	(0.048)
After 8 quarters (%)	0.554	0.311	0.145
	(0.550)	(0.308)	(0.130)
After 12 quarters (%)	0.423	0.417	0.209
	(0.407)	(0.407)	(0.213)
After 16 quarters (%)	0.338	0.492	0.264
	(0.318)	(0.507)	(0.266)
Number of bonds	1,139	1,064	1,043
	(1,067)	(1,061)	(910)

Table A.5: **Probability-Based Dispersion and Future Rating Changes**

This table reports the relation between probability-based dispersion and future rating changes. Panel A reports the mean likelihood of one-quarter ahead rating changes in bond subsamples with different magnitudes of probability-based dispersion. Panel B tracks the likelihood of rating convergence up to 16 quarters for different dispersion groups, from 20 rounds of random sampling. *Probability-based dispersion* is the standard deviation of historical survival probabilities matched to alphanumeric ratings scaled by the square root of the NAIC score-equivalent survival probability. Historical survival probability curves are rolled each year without look-ahead bias. Dispersion is measured at the end of the prior quarter, and rating changes happen in the current quarter and beyond. Zero dispersion bonds are those for which all available ratings concur, and bonds with discordant ratings are placed into low and high groups by the median probability-based dispersion each quarter. The sample period is from Q4 of 2002 to Q4 of 2022.

Panel A: Rating Changes (Next Quarter)	Downgrade	Upgrade
NAIC group < 3 (Safe)		
Zero dispersion	0.020	0.005
Low dispersion	0.028	0.022
High dispersion	0.041	0.033
NAIC group >3 (Risky)		
Zero dispersion	0.086	0.025
Low dispersion	0.058	0.078
High dispersion	0.092	0.094

Panel B: Rating Convergence	Zero dispersion	Below-median dispersion	Above-median dispersion
After 4 quarters (%)	0.738	0.130	0.127
	(0.719)	(0.110)	(0.128)
After 8 quarters (%)	0.554	0.229	0.232
	(0.550)	(0.185)	(0.234)
After 12 quarters (%)	0.423	0.316	0.319
	(0.407)	(0.270)	(0.325)
After 16 quarters (%)	0.338	0.384	0.387
	(0.318)	(0.361)	(0.401)
Number of bonds	1,139	1,063	1,045
	(1,067)	(966)	(1,001)

Table A.6: **Controlling for Concurrent Rating Changes**

This table reports estimates of panel regression results of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, with interactions of rating dispersion and concurrent rating changes with NAIC group. *Rating dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score, or its equivalent measured with historical survival probabilities. *Concurrent downgrade* equals 1 if a bond is downgraded in the same quarter when rating dispersion is measured, and 0 otherwise. *Concurrent upgrade* is the counterpart dummy variable regarding upgrades. *NAIC_group* is the credit rating category defined by NAIC. Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Various fixed effects are included, and standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Dependent Variable:	Rating-based		Probability-based	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion	-0.090***	-0.026***	-3.089***	-1.377***
	(0.019)	(0.009)	(0.574)	(0.316)
Dispersion × NAIC_group	0.024***	0.012***	0.740***	0.341***
	(0.007)	(0.004)	(0.130)	(0.072)
Concurrent downgrade	-0.038***	-0.004	-0.041***	-0.004*
	(0.007)	(0.002)	(0.008)	(0.002)
Con. downgrade × NAIC_group	0.022***	0.004***	0.023***	0.005***
	(0.002)	(0.001)	(0.002)	(0.001)
Concurrent upgrade	0.012*	0.003	0.011	0.003
	(0.007)	(0.003)	(0.007)	(0.003)
Con. upgrade × NAIC_group	-0.009***	-0.002**	-0.009***	-0.002**
	(0.002)	(0.001)	(0.002)	(0.001)
Single rating dummy	-0.028**	-0.010	-0.024*	-0.010
	(0.013)	(0.009)	(0.013)	(0.008)
Yield spread	-0.356**	-0.020	-0.349**	-0.012
	(0.150)	(0.085)	(0.151)	(0.085)
Duration	0.006***	0.021***	0.006***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.033	-0.059**	0.034	-0.057**
	(0.047)	(0.029)	(0.048)	(0.029)
Bid-ask spread	-1.321***	-0.044	-1.331***	-0.043
	(0.262)	(0.067)	(0.263)	(0.067)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.034***	-0.006***	-0.034***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.359***	0.104*	0.389***	0.114**
	(0.111)	(0.054)	(0.113)	(0.054)
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,572	383,895	384,572	383,895
Adj. R^2	0.498	0.901	0.497	0.901

Table A.7: **Controlling for Probability of Downgrades/Upgrades**

This table reports estimates of panel regression results of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, with downgrade and upgrade probabilities. The probabilities are calculated at the beginning of each quarter by rating dispersion group (zero, low, and high) within each NAIC group. *Rating dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score, or its equivalent measured with historical survival probabilities. *NAIC_group* is the credit rating category defined by NAIC. Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Various fixed effects are included, and standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Dependent Variable:	Rating-based		Probability-based	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion	-0.117***	-0.030**	-2.851***	-1.574***
	(0.027)	(0.012)	(0.676)	(0.377)
Dispersion × NAIC_group	0.032***	0.012**	0.740***	0.367***
	(0.009)	(0.005)	(0.160)	(0.089)
Downgrade prob.	0.143	0.064	-0.653**	-0.062
	(0.166)	(0.080)	(0.263)	(0.088)
Downgrade prob. × NAIC_group	-0.065	-0.038	0.175**	0.012
	(0.045)	(0.023)	(0.067)	(0.029)
Upgrade prob.	0.464	0.098	0.218	0.149
	(0.340)	(0.126)	(0.364)	(0.125)
Upgrade prob.× NAIC_group	-0.129	-0.013	-0.095	-0.007
	(0.088)	(0.037)	(0.102)	(0.039)
Single rating dummy	-0.030**	-0.010	-0.029**	-0.010
	(0.013)	(0.008)	(0.013)	(0.008)
Yield spread	-0.217	0.015	-0.217	0.028
	(0.154)	(0.085)	(0.156)	(0.084)
Duration	0.006***	0.021***	0.006***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.027	-0.057*	0.028	-0.055*
	(0.047)	(0.029)	(0.047)	(0.029)
Bid-ask spread	-1.271***	-0.041	-1.275***	-0.040
	(0.268)	(0.068)	(0.268)	(0.068)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.034***	-0.006***	-0.034***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.352***	0.101*	0.374***	0.113**
	(0.113)	(0.055)	(0.114)	(0.055)
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	381,538	380,852	381,538	380,852
Adj. R^2	0.497	0.901	0.497	0.901

Table A.8: **Additional Fixed Effects by Rating Agency**

This table reports estimates of panel regression results of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, with rating agency or agency-by-quarter fixed effects. *Rating dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score, or its equivalent measured with historical survival probabilities. *NAIC_group* is the credit rating category defined by NAIC. Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Various fixed effects are included, and standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

	Rating-based				Probability-based			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rating dispersion	-0.093***	-0.093***	-0.032***	-0.026***	-2.694***	-2.665***	-1.648***	-1.319***
	(0.019)	(0.019)	(0.010)	(0.009)	(0.580)	(0.582)	(0.362)	(0.313)
Ambiguity × NAIC_group	0.029***	0.029***	0.016***	0.012***	0.685***	0.680***	0.411***	0.330***
	(0.007)	(0.007)	(0.005)	(0.004)	(0.131)	(0.132)	(0.082)	(0.071)
Single rating dummy	-0.037**	-0.034**	-0.018*	-0.012	-0.035**	-0.032**	-0.019*	-0.013
	(0.015)	(0.015)	(0.011)	(0.009)	(0.015)	(0.015)	(0.011)	(0.009)
Yield spread	-0.196	-0.202	0.080	0.022	-0.195	-0.201	0.093	0.030
	(0.149)	(0.146)	(0.077)	(0.078)	(0.151)	(0.147)	(0.077)	(0.078)
Duration	0.006***	0.006***	0.021***	0.021***	0.006***	0.006***	0.021***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.041	0.043	-0.054*	-0.050*	0.042	0.044	-0.052*	-0.049*
	(0.048)	(0.048)	(0.029)	(0.028)	(0.048)	(0.048)	(0.029)	(0.028)
Bid-ask spread	-1.247***	-1.222***	-0.017	-0.035	-1.257***	-1.234***	-0.016	-0.033
	(0.260)	(0.257)	(0.069)	(0.064)	(0.261)	(0.258)	(0.070)	(0.064)
ln(Trading volume)	-0.041***	-0.041***	-0.006***	-0.006***	-0.041***	-0.041***	-0.006***	-0.005***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
ln(Number of trades)	-0.034***	-0.034***	-0.007***	-0.006***	-0.034***	-0.033***	-0.007***	-0.006***
	(0.003)	(0.003)	(0.002)	(0.001)	(0.003)	(0.003)	(0.002)	(0.001)
Bond volatility	0.396***	0.403***	0.067	0.105*	0.423***	0.430***	0.080	0.114**
	(0.113)	(0.113)	(0.057)	(0.055)	(0.114)	(0.114)	(0.057)	(0.055)
Bond FE			Yes	Yes			Yes	Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
S&P FE	Yes		Yes		Yes		Yes	
Moody's FE	Yes		Yes		Yes		Yes	
Fitch FE	Yes		Yes		Yes		Yes	
S&P-Quarter FE		Yes		Yes		Yes		Yes
Moody's-Quarter FE		Yes		Yes		Yes		Yes
Fitch-Quarter FE		Yes		Yes		Yes		Yes
Observations	384,908	384,908	384,304	384,230	384,908	384,908	384,304	384,230
Adj. R^2	0.497	0.493	0.894	0.901	0.497	0.492	0.894	0.901

Table A.9: **Interaction of Rating Dispersion, Yield Spread, and NAIC Group**

This table reports estimates of panel regression results of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, with interactions of rating dispersion, yield spread, and NAIC group. *Rating dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score, or its equivalent measured with historical survival probabilities. *Yield spread* is a bond's yield-to-maturity in excess of a maturity-matched treasury yield. *NAIC_group* is the credit rating category defined by NAIC. Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Various fixed effects are included, and standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Dependent Variable:	Rating-based		Probability-based	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion	-0.097***	-0.027***	-3.171***	-1.343***
	(0.019)	(0.009)	(0.587)	(0.318)
Dispersion × NAIC_group	0.032***	0.015***	0.794***	0.352***
	(0.009)	(0.004)	(0.141)	(0.076)
Yield spread	-0.305	0.018	-0.460	-0.039
	(0.488)	(0.180)	(0.486)	(0.176)
Yield spread × NAIC_group	0.051	0.021	0.088	0.034
	(0.119)	(0.042)	(0.125)	(0.042)
Yield spread × Dispersion	-0.339	-0.202*	-1.371	-1.024
	(0.333)	(0.121)	(1.797)	(1.048)
Single rating dummy	-0.030**	-0.010	-0.025*	-0.011
	(0.013)	(0.009)	(0.013)	(0.008)
Duration	0.006***	0.021***	0.006***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.037	-0.055*	0.036	-0.054*
	(0.048)	(0.028)	(0.049)	(0.028)
Bid-ask spread	-1.294***	-0.038	-1.304***	-0.037
	(0.259)	(0.067)	(0.260)	(0.067)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.034***	-0.006***	-0.034***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.355***	0.100*	0.384***	0.109**
	(0.111)	(0.054)	(0.112)	(0.054)
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.496	0.900	0.495	0.901

Table A.10: **Alternative Rating Dispersion Measure**

This table reports estimates of panel regression results of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, with rating-by-quarter and industry-by-quarter fixed effects. *Rating-based dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score in columns (1) and (2), and is scaled by the square root of the average score in columns (3) and (4). *NAIC_group* is the credit rating category defined by NAIC. Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Panel A: Rating-based Dispersion				
Dependent Variable:	NAIC		Average	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion	-0.095***	-0.027***	-0.098***	-0.025***
	(0.019)	(0.009)	(0.019)	(0.009)
Dispersion × NAIC_group	0.026***	0.012***	0.028***	0.012***
	(0.007)	(0.004)	(0.007)	(0.004)
Single rating dummy	-0.030**	-0.010	-0.030**	-0.010
	(0.013)	(0.009)	(0.013)	(0.009)
Yield spread	-0.231	0.029	-0.232	0.028
	(0.151)	(0.083)	(0.151)	(0.083)
Duration	0.006***	0.021***	0.006***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.038	-0.055*	0.038	-0.055*
	(0.047)	(0.029)	(0.047)	(0.029)
Bid-ask spread	-1.302***	-0.039	-1.303***	-0.040
	(0.263)	(0.067)	(0.263)	(0.067)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.034***	-0.006***	-0.034***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.353***	0.099*	0.352***	0.099*
	(0.111)	(0.054)	(0.111)	(0.054)
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.496	0.900	0.496	0.900

Table A.10: **Alternative Rating Dispersion Measure - Continued**

	Panel B: Probability-based Dispersion							
	NAIC		Average		NAIC (ind)		Average (ind)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rating dispersion	-3.164***	-1.335***	-3.229***	-1.365***	-2.665***	-1.240***	-2.705***	-1.254***
	(0.583)	(0.318)	(0.587)	(0.320)	(0.497)	(0.274)	(0.496)	(0.274)
Dispersion × NAIC_group	0.769***	0.333***	0.787***	0.341***	0.654***	0.308***	0.665***	0.312***
	(0.132)	(0.073)	(0.133)	(0.073)	(0.112)	(0.064)	(0.112)	(0.065)
Single rating dummy	-0.026*	-0.011	-0.026*	-0.011	-0.026*	-0.011	-0.026*	-0.011
	(0.013)	(0.008)	(0.013)	(0.008)	(0.013)	(0.008)	(0.013)	(0.008)
Yield spread	-0.226	0.038	-0.226	0.038	-0.234	0.036	-0.233	0.036
	(0.152)	(0.083)	(0.152)	(0.083)	(0.152)	(0.083)	(0.152)	(0.083)
Duration	0.006***	0.021***	0.006***	0.021***	0.006***	0.021***	0.006***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.039	-0.053*	0.039	-0.053*	0.038	-0.054*	0.038	-0.054*
	(0.048)	(0.028)	(0.048)	(0.028)	(0.048)	(0.028)	(0.048)	(0.028)
Bid-ask spread	-1.313***	-0.038	-1.313***	-0.038	-1.315***	-0.038	-1.315***	-0.038
	(0.264)	(0.067)	(0.264)	(0.067)	(0.264)	(0.067)	(0.264)	(0.067)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.034***	-0.006***	-0.034***	-0.006***	-0.034***	-0.006***	-0.034***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.384***	0.109**	0.384***	0.109**	0.376***	0.107*	0.376***	0.107*
	(0.113)	(0.054)	(0.113)	(0.054)	(0.112)	(0.054)	(0.112)	(0.054)
Bond FE		Yes		Yes		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	384908	384230	384908	384230	384908	384230	384908	384230
Adj. R^2	0.495	0.901	0.495	0.901	0.495	0.901	0.495	0.901

Table A.11: **Granular Block-Diagonal Specification**

This table reports estimates of panel regression results of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, with a block-diagonal specification. *Rating dispersion N* equals a bond's *Rating dispersion* if the bond belongs to NAIC group N and zero otherwise, where $N = 1$ (safest),...,5 (most risky). Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Various fixed effects are included, and standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Dependent Variable:	Rating-based		Probability-based	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating Dispersion 1	-1.163***	-0.370**	-0.778***	-0.231***
	(0.326)	(0.145)	(0.217)	(0.082)
Rating Dispersion 2	-1.252***	0.055	-1.252***	-0.474***
	(0.287)	(0.133)	(0.221)	(0.114)
Rating Dispersion 3	0.060	0.168	-0.160	-0.130
	(0.338)	(0.261)	(0.362)	(0.218)
Rating Dispersion 4	0.798**	0.301	0.747**	0.304
	(0.340)	(0.259)	(0.307)	(0.190)
Rating Dispersion 5	1.173***	0.653**	0.445	0.635**
	(0.429)	(0.318)	(0.344)	(0.269)
Single rating dummy	-0.029**	-0.011	-0.026*	-0.011
	(0.013)	(0.009)	(0.013)	(0.008)
Yield spread	-0.229	0.030	-0.200	0.042
	(0.150)	(0.083)	(0.151)	(0.083)
Duration	0.006***	0.021***	0.006***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.039	-0.055*	0.042	-0.053*
	(0.047)	(0.029)	(0.047)	(0.028)
Bid-ask spread	-1.310***	-0.039	-1.306***	-0.038
	(0.263)	(0.067)	(0.264)	(0.067)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.034***	-0.006***	-0.034***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.348***	0.098*	0.371***	0.107**
	(0.111)	(0.054)	(0.112)	(0.054)
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.496	0.900	0.496	0.901

Table A.12: **Interaction of Yield Spread and Duration**

This table reports estimates of panel regression results of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, with interaction of yield spread and duration. *Rating dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score, or its equivalent measured with historical survival probabilities. *Yield spread* is a bond's yield-to-maturity in excess of a maturity-matched treasury yield. *Duration* is the bond's duration in years. Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Various fixed effects are included, and standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Dependent Variable:	Rating-based		Probability-based	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion	-0.097***	-0.026***	-3.179***	-1.348***
	(0.019)	(0.009)	(0.566)	(0.315)
Dispersion × NAIC_group	0.028***	0.012***	0.781***	0.336***
	(0.007)	(0.004)	(0.128)	(0.072)
Yield spread	0.844***	0.266***	0.851***	0.278***
	(0.214)	(0.090)	(0.215)	(0.090)
Yield spread × Duration	-0.287***	-0.066***	-0.287***	-0.067***
	(0.038)	(0.021)	(0.039)	(0.021)
Single rating dummy	-0.029**	-0.010	-0.025*	-0.011
	(0.013)	(0.009)	(0.013)	(0.008)
Duration	0.011***	0.022***	0.011***	0.022***
	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.005	-0.064**	0.006	-0.063**
	(0.047)	(0.028)	(0.047)	(0.028)
Bid-ask spread	-1.108***	-0.026	-1.118***	-0.024
	(0.263)	(0.066)	(0.264)	(0.066)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.035***	-0.006***	-0.035***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.431***	0.113**	0.462***	0.123**
	(0.110)	(0.053)	(0.111)	(0.053)
Controls	Yes	Yes	Yes	Yes
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.500	0.901	0.499	0.901

Table A.13: **Interaction of Single Rating and NAIC Group**

This table reports estimates of panel regression results of the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, with interaction of single rating dummy and NAIC group. *Rating dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score, or its equivalent measured with historical survival probabilities. *Single rating* is a dummy variable that equals one if the bond is rated by only one agency and zero otherwise. *NAIC_group* is the credit rating category defined by NAIC. Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Various fixed effects are included, and standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Dependent Variable:	Rating-based		Probability-based	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion	-0.097***	-0.029***	-3.188***	-1.361***
	(0.019)	(0.009)	(0.582)	(0.317)
Dispersion × NAIC_group	0.028***	0.013***	0.780***	0.344***
	(0.007)	(0.004)	(0.132)	(0.072)
Single rating dummy	-0.052**	-0.032*	-0.043*	-0.031*
	(0.024)	(0.018)	(0.024)	(0.018)
Single rating dummy × NAIC_group	0.010	0.009	0.008	0.009
	(0.006)	(0.007)	(0.006)	(0.007)
Yield spread	-0.231	0.030	-0.227	0.039
	(0.151)	(0.084)	(0.152)	(0.083)
Duration	0.006***	0.021***	0.006***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.039	-0.054*	0.040	-0.053*
	(0.047)	(0.028)	(0.048)	(0.028)
Bid-ask spread	-1.301***	-0.039	-1.312***	-0.038
	(0.263)	(0.067)	(0.264)	(0.067)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.034***	-0.006***	-0.034***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.356***	0.101*	0.386***	0.111**
	(0.111)	(0.054)	(0.112)	(0.054)
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.496	0.900	0.495	0.901

Table A.14: **Fitch Ratings**

This table reports estimates of panel regression results for the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, controlling for whether a bond has a Fitch rating. *Rating dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score, or its equivalent measured with historical survival probabilities. *Fitch* is a dummy variable indicative of whether a bond is rated by Fitch. *NAIC_group* is the credit rating category defined by NAIC. Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Various fixed effects are included, and standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Dependent Variable:	Rating-based		Probability-based	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion	-0.093***	-0.028***	-2.719***	-1.365***
	(0.020)	(0.009)	(0.583)	(0.317)
Dispersion × NAIC_group	0.028***	0.013***	0.685***	0.344***
	(0.007)	(0.004)	(0.132)	(0.073)
Fitch	-0.021**	0.008	-0.025**	0.009
	(0.010)	(0.006)	(0.010)	(0.006)
Fitch × NAIC_group	-0.000	-0.005	0.002	-0.004
	(0.004)	(0.003)	(0.004)	(0.003)
Single rating dummy	-0.040***	-0.010	-0.036***	-0.011
	(0.013)	(0.009)	(0.013)	(0.009)
Yield spread	-0.195	0.035	-0.194	0.043
	(0.150)	(0.083)	(0.151)	(0.083)
Duration	0.006***	0.021***	0.006***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)
Bond return	0.041	-0.054*	0.042	-0.053*
	(0.048)	(0.028)	(0.048)	(0.028)
Bid-ask spread	-1.244***	-0.041	-1.257***	-0.039
	(0.262)	(0.067)	(0.263)	(0.067)
ln(Trading volume)	-0.041***	-0.006***	-0.041***	-0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
ln(Number of trades)	-0.034***	-0.006***	-0.034***	-0.006***
	(0.003)	(0.002)	(0.003)	(0.002)
Bond volatility	0.396***	0.100*	0.420***	0.110**
	(0.114)	(0.054)	(0.115)	(0.054)
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.497	0.900	0.497	0.901

Table A.15: **Controlling for Concurrent Rating Changes - By Rating Agency**

This table reports estimates of panel regression results for the fraction of corporate bonds held by insurance companies on measures of rating dispersion and various control variables, with interactions of rating dispersion and concurrent rating changes by credit rating agency with NAIC group. *Rating dispersion* is the standard deviation of credit rating scores for a bond issue scaled by the square root of its NAIC score, or its equivalent measured with historical survival probabilities. *Agency downgrade* equals 1 if a bond is downgraded by a rating agency in the same quarter when rating dispersion is measured, and 0 otherwise. *Agency upgrade* is the counterpart dummy variable regarding upgrades. *NAIC_group* is the credit rating category defined by NAIC. Other variable definitions are as in Appendix A. Rating dispersion and other control variables are measured in the prior quarter. Various fixed effects are included, and standard errors, clustered by both issuer and quarter, appear in parentheses below the coefficient estimates. The sample period is from Q4 of 2002 to Q4 of 2022.

Dependent Variable:	Rating-based		Probability-based	
Insurers' Holdings	(1)	(2)	(3)	(4)
Rating dispersion	-0.090***	-0.026***	-3.062***	-1.367***
	(0.019)	(0.009)	(0.574)	(0.315)
Dispersion × NAIC_group	0.023***	0.012***	0.732***	0.337***
	(0.007)	(0.004)	(0.130)	(0.072)
S&P downgrade	-0.016**	0.002	-0.019**	0.002
	(0.007)	(0.003)	(0.008)	(0.003)
S&P downgrade × NAIC_group	0.012***	0.002	0.013***	0.002*
	(0.002)	(0.001)	(0.002)	(0.001)
Moody's downgrade	-0.038***	-0.008***	-0.041***	-0.008***
	(0.011)	(0.003)	(0.011)	(0.003)
Moody's downgrade × NAIC_group	0.021***	0.006***	0.022***	0.006***
	(0.003)	(0.001)	(0.003)	(0.001)
Fitch downgrade	-0.022***	-0.000	-0.021**	0.001
	(0.008)	(0.004)	(0.008)	(0.004)
Fitch downgrade × NAIC_group	0.012***	0.003*	0.011***	0.002
	(0.003)	(0.002)	(0.003)	(0.002)
S&P upgrade	0.025**	0.006	0.025**	0.007
	(0.010)	(0.005)	(0.010)	(0.005)
S&P upgrade × NAIC_group	-0.010***	-0.003	-0.010***	-0.003
	(0.003)	(0.002)	(0.003)	(0.002)
Moody's upgrade	-0.001	0.003	-0.003	0.004
	(0.013)	(0.004)	(0.013)	(0.004)
Moody's upgrade × NAIC_group	-0.005	-0.003*	-0.005	-0.003**
	(0.004)	(0.001)	(0.004)	(0.002)
Fitch upgrade	0.000	-0.003	-0.002	-0.003
	(0.010)	(0.004)	(0.010)	(0.004)
Fitch upgrade × NAIC_group	-0.008**	-0.001	-0.007*	-0.001
	(0.004)	(0.002)	(0.004)	(0.002)
Bond Controls	Yes	Yes	Yes	Yes
Bond FE		Yes		Yes
Rating-Quarter FE	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes
Observations	384,908	384,230	384,908	384,230
Adj. R^2	0.497	0.901	0.496	0.901

Table A.16: **NAIC Risk-Based Capital Requirements**

This table shows risk-based capital (RBC) charges for bonds set by the National Association of Insurance Companies (NAIC).

Moody's Rating	NAIC Designation Category	Base Capital Charges
Aaa	1	0.39%
Aa1	1	0.39%
Aa2	1	0.39%
Aa3	1	0.39%
A1	1	0.39%
A2	1	0.39%
A3	1	0.39%
Baa1	2	1.26%
Baa2	2	1.26%
Baa3	2	1.26%
Ba1	3	4.46%
Ba2	3	4.46%
Ba3	3	4.46%
B1	4	9.70%
B2	4	9.70%
B3	4	9.70%
Caa1	5	22.31%
Caa2	5	22.31%
Caa3	5	22.31%
Ca	6	30.00%