

Betting on Bond Ratings Disagreement

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Abstract

We examine investor responses to credit rating splits. Rating disagreements predict subsequent rating changes unreliably, clouding risk assessment. We develop a model in which rating dispersion drives bond trading via heterogeneous higher-order beliefs, forecasting opposite shifts in safe versus risky bonds, contrasting institutional investments, and leverage-dependent effects. Data corroborate the theory: wider dispersion induces insurers to trim safe-bond holdings and boost risky-bond exposure. A one-standard-deviation increase corresponds to 0.8% higher insurer holdings of lowest-rated bonds (13% of the mean). These effects persist, controlling for rating transitions, yields, and fixed effects, and strengthen for financially constrained insurers. Mutual funds move conversely.

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

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1 Introduction

Credit ratings are a central input into the pricing, regulation, and portfolio allocation of corporate bonds. Yet it is common for major rating agencies to disagree on the same issuer and security. Such split ratings can introduce an additional layer of information uncertainty. Investors observe multiple assessments of the same default risk, with limited ability to infer which assessment is more accurate or timely. The existing literature links rating splits to higher yields and risk premia, consistent with the view that disagreement signals risk and uncertainty associated with opacity and reduces demand. This paper asks a complementary question. How do key institutional investors reallocate bond positions when rating agencies disagree, and how does that reallocation vary across the credit quality spectrum?

We focus on the two largest institutional investor groups in U.S. corporate bonds, insurance companies and mutual funds.¹ The central empirical fact we document is a structured, sign-reversing reallocation pattern across investor type and credit risk. When ratings disagree, insurers *reduce* holdings of the safest bonds but *increase* exposure to the riskiest bonds. Mutual funds move in the opposite direction: they *increase* holdings of safe split-rated bonds and *decrease* holdings of risky split-rated bonds. The disagreement effect is economically meaningful and amplified among insurers with lower risk-bearing capacity (e.g., higher leverage or lower capital buffers). The pattern is also non-monotone in credit risk: for average-risk bonds, rating dispersion has little effect on portfolio allocations.

These findings are difficult to reconcile with a purely monotone risk and uncertainty

¹Insurance 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>). Kojien and Yogo (2023) note that as of 2017, insurers held 38% of U.S. corporate bonds, and mutual funds held 30%.

aversion interpretations in which disagreement simply raises perceived risk or uncertainty and therefore depresses demand for all investors and all rating categories. Likewise, unilateral mechanisms such as reach-for-yield or regulatory arbitrage can rationalize one side of the pattern (e.g., insurers buying risky bonds), but do not naturally explain why the same insurers simultaneously sell safe split-rated bonds *and* why mutual funds consistently take the opposite side in precisely those credit regions. Rather than interpreting the evidence as a puzzle that requires multi-faceted investor irrationality, we propose a parsimonious mechanism that generates a disciplined set of sign restrictions and maps directly into our empirical design.

A key institutional feature of the setting is that insurance companies face risk-based capital requirements tied to credit categories set by the National Association of Insurance Commissioners (NAIC)² When multiple ratings are available and disagree, NAIC designation follows deterministic rules (e.g., the lower of two ratings; the middle of three).³ This institutional structure matters for two reasons. First, it makes insurers a natural laboratory for studying how disagreement interacts with constrained risk-bearing capacity. Second, it allows us to compare bonds within the same broad regulatory category at the same time by using rating-by-quarter fixed effects, separating disagreement from shifts in average ratings and broad credit-cycle movements.

Regarding the theory, the model combines two ingredients. First, survival probabilities are bounded between zero and one and depend on a latent credit index. When agencies disagree, posterior uncertainty about the true survival likelihood increases. Because of boundedness, this increase in uncertainty can have asymmetric implications across the credit

²The NAIC, 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.

³Purposes & Procedures Manual of the NAIC Investment Analysis Office, December 2021.

spectrum, as illustrated in Figure 1 and Figure 4. This is modeled by setting (subjective) survival likelihood as a smooth, strictly increasing S-shaped function of credit rating. For very safe bonds, additional uncertainty shifts weight toward adverse outcomes and lowers the perceived value. For very risky bonds, additional uncertainty raises the perceived value by increasing lottery-like upside. Second, disagreement affects trading because investors form beliefs not only about fundamentals but also about *counterparty valuations* in a resale market. When insurers perceive mutual funds as relatively more optimistic (pessimistic) marginal counterparties, equilibrium demand predicts a reallocation in which insurers sell (buy) safe split-rated bonds and buy (sell) risky split-rated bonds, while mutual funds take the opposite side. The same framework implies stronger responses when insurers' risk-bearing capacity is tighter, consistent with the leverage/capital heterogeneity we document.

We test these predictions using quarterly holdings data from 2002–2022, linking security-level positions for insurers and mutual funds to bond characteristics and trading controls. We measure disagreement using dispersion in agency-implied default probabilities (with robustness using rating-score dispersion), and estimate panel specifications with rich fixed effects. The identifying variation compares bonds that share the same rating group in the same quarter but differ in the degree of disagreement across agencies. We also address the concern that disagreement is merely a short-lived precursor to rating changes. Ratings are sticky and split ratings often persist, and our main results remain after controlling for realized and expected rating transitions and for yield spreads. Taken together, the evidence supports an interpretation in which disagreement reshapes portfolios through the interaction of bounded default risk and heterogeneous valuation beliefs, rather than through conventional channels.

[Insert Figure 1 about here]

This paper contributes along three dimensions. First, it documents a new set of stylized facts about how rating disagreement reallocates corporate bond risk across the two largest institutional investors, with sign reversals across credit quality and amplification by insurer constraints. Second, it provides a tractable framework that links disagreement to portfolio demand via bounded survival probabilities and higher-order beliefs about counterparty valuation, generating sharp sign restrictions that match the data. Third, it highlights how regulatory capital and institutional heterogeneity govern who absorbs credit-information uncertainty in equilibrium.

2 Literature

Our paper is related to the literature exploring the relation between uncertainty and investors' investment decisions. Unlike the prior works that focus on ambiguity avoidance (e.g., Dimmock et al. (2016), Bianchi and Tallon (2019), Johnson et al. (2020)), our study focuses on heterogeneous beliefs of institutional investors in credit markets and provides evidence consistent with heterogeneous, higher-order beliefs of institutional investors in light of security-specific credit information quality.⁴ We highlight the contrasting reactions to information obscurity in the extreme risk categories. To the best of our knowledge, our paper is one of the first papers tackling this issue both theoretically and empirically.

Extant literature 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

⁴Extensive literature exists on asset pricing with heterogeneous beliefs. Miller (1977), Harrison and Kreps (1978), and Scheinkman and Xiong (2003) are the essential studies and closely related to our model. We specifically focus on the portfolio allocation aspects of the corporate bond market.

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.⁵

3 Theory and Hypothesis

This section develops our theoretical framework and hypotheses.

3.1 Information Updating With Credit Ratings

For bond l , the latent variable η_l represents the true (unobservable) creditworthiness shock, where $\eta_l \sim \mathcal{N}(\mu_0, \sigma_{\eta,l}^2)$. Bonds survive to horizon with probability mapped via an increasing function $\Phi: \mathbb{R} \rightarrow (0, 1)$ such that

$$\phi_l = \Phi(c_l + \eta_l), \quad \lim_{x \rightarrow -\infty} \Phi(x) = 0, \quad \lim_{x \rightarrow \infty} \Phi(x) = 1, \quad (1)$$

where c_l collects the observed characteristics of bond l relevant for credit risk. Popular choices of function Φ are sigmoid functions such as logit, probit, complementary log-log, or a piecewise linear, truncated functions ($\min\{1, \max\{0, x\}\}$). Assume that two rating agencies $k \in \{1, 2\}$ provide credit ratings $z_{k,l}$ about bond l 's future default probability. Each agency

⁵Dass 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.

k supplies a noisy, potentially biased signal. We model the signal process as follows.

$$z_{k,l} = \eta_l + b_{k,l} + \varepsilon_{k,l}, \quad b_{k,l} \sim \mathcal{N}(\mu_k^b, \tau_k^2), \quad \varepsilon_{k,l} \sim \mathcal{N}(0, \sigma_{k,l}^2), \quad (2)$$

with η_l , $b_{k,l}$, and $\varepsilon_{k,l}$ independent across k and l . Here μ_k^b captures the average bias of agency k with the cross-bond variability τ_k^2 , and $\sigma_{k,l}^2$, the idiosyncratic noise variance. Conditional on η_l , integrating out $b_{k,l}$, we have

$$z_{k,l} \mid \eta_l \sim \mathcal{N}(\eta_l + \mu_k^b, \tau_k^2 + \sigma_{k,l}^2).$$

Define rating dispersion (Δ_l) and average rating (\bar{z}_l) for bond l respectively as

$$\Delta_l \equiv \frac{1}{2}|z_{1,l} - z_{2,l}|, \quad \bar{z}_l \equiv \frac{1}{2}(z_{1,l} + z_{2,l}), \quad (3)$$

which implies the convenient normalization $z_{1,l} = \bar{z}_l + \Delta_l$, $z_{2,l} = \bar{z}_l - \Delta_l$. Based on this definition, our empirical analysis employs standardized standard deviations of credit ratings or assessed probabilities to proxy for Δ_l . Agency bias $b_{k,l}$ provides a channel for level shifts in posterior beliefs. Below, we show how agency bias can tilt posterior mean assessments even when agencies concur (i.e., $\Delta_l = 0$), suggesting that zero dispersion may have a distinct role due to agency-specific biases.

3.1.1 Posterior with Known Precision: Bias Level Effects

In this subsection, we treat the total signal variances $\tau_k^2 + \sigma_{k,l}^2$, $k = 1, 2$, as known constants for each bond l for expositional ease, and the mean bias μ_k^b as fixed. With conjugate normal

updating, the posterior mean and variance of η_l given $(z_{1,l}, z_{2,l})$ are

$$m_l = v_l \left(\sigma_{\eta,l}^{-2} \mu_0 + w_{1,l}(z_{1,l} - \mu_1^b) + w_{2,l}(z_{2,l} - \mu_2^b) \right), \quad (4)$$

$$v_l = \left(\sigma_{\eta,l}^{-2} + w_{1,l} + w_{2,l} \right)^{-1}, \quad w_{k,l} \equiv \left(\tau_k^2 + \sigma_{k,l}^2 \right)^{-1}. \quad (5)$$

At consensus on the bond l ($\Delta_l = 0$ so $z_{1,l} = z_{2,l} = \bar{z}_l$), the posterior mean, $m_l(0)$, is

$$m_l(0) = v_l \left(\sigma_{\eta,l}^{-2} \mu_0 + (w_{1,l} + w_{2,l}) \bar{z}_l - (w_{1,l} \mu_1^b + w_{2,l} \mu_2^b) \right). \quad (6)$$

Define the bond-specific bias-weighted term $\mathcal{B}_l \equiv \frac{w_{1,l} \mu_1^b + w_{2,l} \mu_2^b}{w_{1,l} + w_{2,l}}$. Then a bias-neutral benchmark is defined as the case with the same $(w_{1,l}, w_{2,l}, \bar{z}_l)$ yet $\mu_1^b = \mu_2^b = 0$, denoted as $m_l^{bm}(0)$.

Proposition 1. *Suppose $(\mu_1^b, \mu_2^b) \neq (0, 0)$. Then, for $\Delta_l = 0$, the posterior mean $m_l(0)$ differs from the bias-neutral benchmark $m_l^{bm}(0)$ by a shift proportional to \mathcal{B}_l ,*

$$m_l(0) = m_l^{bm}(0) - (w_{1,l} + w_{2,l}) v_l \mathcal{B}_l$$

The posterior variance v_l and the relative weight on the prior mean μ_0 are unaffected by the bias means μ_k^b .

Hence rating consensus does not necessarily imply convergence to an unbiased posterior about η_l or the survival probability $\phi_l = \Phi(c_l + \eta_l)$. To test this hypothesis and assess the significance of this channel, we incorporate a zero dispersion dummy variable. This approach also aids in controlling for potential effects arising from agency biases. Related, another obvious case of zero dispersion is the case with only one agency providing credit rating. In this light, our empirical analysis tests if single rating cases matter as well.

3.1.2 Posterior with Unknown Precision: Dispersion and Uncertainty

Given the unobservable nature of the true shock η_l , it is natural to let the precision of each rating agency be uncertain. For each bond l , introduce a latent precision state $\mathcal{A}_l \in \{1, 2\}$ indicating which agency is more accurate: $\mathcal{A}_l = 1$ means that agency 1 is more precise. Denote $\pi_a \equiv \Pr(\mathcal{A}_l = a)$, $a \in \{1, 2\}$, and for simplicity impose $\pi_1 = \pi$ and $\pi_2 = 1 - \pi$.

Conditional on $\mathcal{A}_l = a$, we assign high/low noise variances to the two agencies. In particular, for $k \in \{1, 2\}$ and $a \in \{1, 2\}$, write $\sigma_{k|a}^2 \equiv \text{Var}(\varepsilon_{k,l} \mid \mathcal{A}_l = a)$. In our two-state specification with $0 < \underline{\sigma}^2 < \bar{\sigma}^2$,

$$(\sigma_{1|1}^2, \sigma_{2|1}^2) = (\underline{\sigma}^2, \bar{\sigma}^2), \quad (\sigma_{1|2}^2, \sigma_{2|2}^2) = (\bar{\sigma}^2, \underline{\sigma}^2).$$

Given (2) and $b_{k,l} \sim \mathcal{N}(\mu_k^b, \tau_k^2)$, we have $z_{k,l} \mid (\eta_l, \mathcal{A}_l = a) \sim \mathcal{N}(\eta_l + \mu_k^b, \tau_k^2 + \sigma_{k|a}^2)$. For tractability, fix a bond l and drop the subscript, writing \mathcal{A} for \mathcal{A}_l and z_k for $z_{k,l}$. Conditional on $\mathcal{A} = a$ and $z = (z_1, z_2)$, the posterior for η is

$$\begin{aligned} \eta \mid z, \mathcal{A} = a &\sim \mathcal{N}(m^{(a)}(z), v^{(a)}), \\ v^{(a)} &= \left(\sigma_{\eta,l}^{-2} + (\sigma_{1|a}^2 + \tau_1^2)^{-1} + (\sigma_{2|a}^2 + \tau_2^2)^{-1} \right)^{-1}, \\ m^{(a)}(z) &= v^{(a)} \left(\sigma_{\eta,l}^{-2} \mu_0 + (\sigma_{1|a}^2 + \tau_1^2)^{-1} (z_1 - \mu_1^b) + (\sigma_{2|a}^2 + \tau_2^2)^{-1} (z_2 - \mu_2^b) \right). \end{aligned}$$

Let $\varphi_2(\cdot; \boldsymbol{\mu}, \Sigma)$ denote the bivariate normal density and define $\boldsymbol{\mu} = (\mu_0 + \mu_1^b, \mu_0 + \mu_2^b)^\top$, with Σ_a the bivariate covariance matrix of (z_1, z_2) under $\mathcal{A} = a$. By Bayes' rule,

$$\omega_a(z) = \frac{\pi_a \varphi_2(z; \boldsymbol{\mu}, \Sigma_a)}{\sum_{j=1}^2 \pi_j \varphi_2(z; \boldsymbol{\mu}, \Sigma_j)}, \quad a = 1, 2.$$

Combining the within-state posteriors with the state weights, the mixture posterior density of η is

$$f_{\eta|z}(\eta | z) = \sum_{a=1}^2 \omega_a(z) \varphi(\eta; m^{(a)}(z), v^{(a)}), \quad (7)$$

and the posterior variance satisfies

$$\text{Var}(\eta | z) = \sum_{a=1}^2 \omega_a(z) v^{(a)} + \sum_{a=1}^2 \omega_a(z) (m^{(a)}(z) - \bar{m}(z))^2, \quad (8)$$

where $\bar{m}(z) \equiv \sum_a \omega_a(z) m^{(a)}(z)$. The first term is the average within-state variance, each of v^a represents the residual uncertainty about η if investors knew which agency is more precise. The second is the weighted between-state variance, representing the information uncertainty associated with the disagreement between the two average assessments of the states. Then, from the case of $z_1 = \bar{z} + \Delta$ and $z_2 = \bar{z} - \Delta$ for fixed average rating \bar{z} and disagreement $\Delta > 0$, we can show that the conditional variance $\text{Var}(\eta | z)$ increases as disagreement (Δ) increases under certain conditions.

Proposition 2. *Suppose the two precision states are symmetric, such that the high and low noise variances simply swap across agencies: $(\sigma_{1|1}^2, \sigma_{2|1}^2) = (\underline{\sigma}^2, \bar{\sigma}^2)$ and $(\sigma_{1|2}^2, \sigma_{2|2}^2) = (\bar{\sigma}^2, \underline{\sigma}^2)$, with identical agency bias parameters $(\mu_1^b, \tau_1^2) = (\mu_2^b, \tau_2^2) = (\mu^b, \tau^2)$ and a uniform prior on the states ($\pi = 0.5$). Then, for a fixed average rating \bar{z} centered relative to the priors, the posterior variance $\text{Var}(\eta | z_1, z_2)$ strictly increases in rating disagreement Δ ,*

$$\frac{\partial}{\partial \Delta} \text{Var}(\eta | z_1, z_2) > 0 \quad \text{for } \Delta > 0.$$

3.1.3 Rating Disagreement and Entropy of Rating Outcomes

To translate the previous results into an empirical context, we assign the probabilities of rating change outcomes (downgrade d , no change 0 , and upgrade, u) based on latent cutoffs $\eta_{low} < \eta_{high}$ on η as follows.

$$p_d(\Delta) = \Pr(\eta \leq \eta_{low} \mid z(\Delta)), \quad p_0(\Delta) = \Pr(\eta_{low} < \eta < \eta_{high} \mid z(\Delta)), \quad p_u(\Delta) = \Pr(\eta \geq \eta_{high} \mid z(\Delta)),$$

where $p_d + p_0 + p_u = 1$, and the dependence on disagreement Δ is made explicit. Define the Shannon entropy in natural logarithmic base as

$$H(\Delta) = - \sum_{i \in \{d, 0, u\}} p_i(\Delta) \ln p_i(\Delta).$$

We capture the effect of disagreement as a local transfer of probability mass from the center to both tails, stated in the following assumption.

Assumption 1. *For some Δ_0 , as Δ increases through Δ_0 with the posterior mean of η held fixed,*

$$p'_0(\Delta_0) < 0, \quad p'_d(\Delta_0) \geq 0, \quad p'_u(\Delta_0) \geq 0,$$

with at least one of $p'_d(\Delta_0), p'_u(\Delta_0)$ strictly positive.

Under the Gaussian posterior, a local increase in $\text{Var}(\eta|z)$ at fixed mean pushes probability mass outward from the center interval $(\eta_{low}, \eta_{high})$ into both tails, so Assumption 1 holds for sufficiently small changes in Δ . This leads to the following proposition.

Proposition 3. *The distribution $P(\Delta_0) \equiv (p_d(\Delta_0), p_0(\Delta_0), p_u(\Delta_0))$ is center-dominant if $p_0(\Delta_0) \geq \max\{p_d(\Delta_0), p_u(\Delta_0)\}$. If Assumption 1 holds at Δ_0 and $P(\Delta_0)$ is center-*

dominant, then

$$\left. \frac{dH}{d\Delta} \right|_{\Delta_0} \geq 0,$$

with strict inequality if at least one of $p'_d(\Delta_0), p'_u(\Delta_0)$ is strictly positive and $p_0(\Delta_0) > \max\{p_d(\Delta_0), p_u(\Delta_0)\}$.

3.1.4 Directional Effects of Credit Rating Dispersion

The rise in posterior uncertainty induced by rating dispersion does not necessarily translate into a symmetric effect on perceived survival probabilities along the credit spectrum. To allow this feature, the latent creditworthiness shock η_l enters the true survival probability via a smooth, strictly increasing, S -shaped link function $\phi_l = \Phi(c_l + \eta_l)$. Thus, they are locally convex when survival probabilities are low (distressed/risky) and locally concave when probabilities are high (safe/investment grade), modeling slow transitions near the boundaries of 0 and 1. Fix a bond l and a vector of realized ratings $z_l = (z_{1,l}, z_{2,l})$. Conditional on z_l , investors form a posterior for the latent credit index $X_l \equiv c_l + \eta_l$. As established in Section 3, under conjugate priors, this posterior is (approximately) Gaussian.⁶

$$X_l | z_l \sim \mathcal{N}(m_l, s_l^2).$$

The perceived survival probability is the expectation of the transformed latent variable:

$$\tilde{\phi}_l(z_l) \equiv \mathbb{E}[\Phi(X_l) | z_l] = \mathbb{E}[\Phi(m_l + s_l Z)], \quad Z \sim \mathcal{N}(0, 1).$$

⁶With known precision, this is exactly Gaussian. However, with unknown precision, the posterior is a mixture of Gaussians, and we approximate it by a single normal with the same mean and variance for tractability.

Since rating disagreement (an increase in Δ_l) increases the posterior variance s_l^2 while leaving the mean unchanged in our symmetric, two-state case, the directional effect of dispersion on perceived survival is governed by the sensitivity of $\mathbb{E}[\Phi(X_l)]$ to changes in variance.

We can easily show the following result.⁷

$$\frac{\partial \tilde{\phi}_l(z_l)}{\partial s_l^2} = \frac{1}{2} \mathbb{E}[\Phi''(X_l) \mid z_l]. \quad (9)$$

Thus, the sign of the effect depends on whether the posterior mass of the latent index X_l falls primarily in the convex or concave region of the link function. For standard links, this curvature maps directly to credit quality.⁸ Then, from Proposition 2, rating dispersion Δ_l increases s_l^2 while leaving m_l locally unchanged. Hence the sign of $\partial \tilde{\phi}_l / \partial \Delta_l$ is governed by the sign of $\partial \tilde{\phi}_l / \partial s_l^2$, which is proportional to the expected curvature $\mathbb{E}[\Phi''(X_l) \mid z_l]$.

Proposition 4. *Assume Φ is S-shaped with a single inflection point x^* . Consider a bond l with posterior $X_l \sim \mathcal{N}(m_l, s_l^2)$.*

1. **Safe Bonds (Concave Region):** *If the bond is sufficiently safe such that the posterior mass lies predominantly above the inflection point ($m_l \gg x^*$), then $\mathbb{E}[\Phi''(X_l)] < 0$. Consequently, increased rating dispersion **reduces** the perceived survival probability:*

$$\frac{\partial \tilde{\phi}_l}{\partial s_l^2} < 0.$$

2. **Risky Bonds (Convex Region):** *If the bond is sufficiently risky such that the posterior mass lies predominantly below the inflection point ($m_l \ll x^*$), then $\mathbb{E}[\Phi''(X_l)] > 0$.*

⁷Proof is in an online appendix.

⁸For the logit link function $\Phi(x) = (1 + e^{-x})^{-1}$. $\Phi''(x) < 0$ for $x > 0$ (Safe), and $\Phi''(x) > 0$ for $x < 0$ (Risky). Similarly, for the probit link, $\Phi(x) = \Phi_{\text{std}}(x)$. $\Phi''(x) = -x\varphi_{\text{std}}(x)$, which implies $\Phi''(x) < 0$ for $x > 0$ (Safe) and $\Phi''(x) > 0$ for $x < 0$ (Risky).

Consequently, increased rating dispersion **raises** the perceived survival probability:

$$\frac{\partial \tilde{\phi}_l}{\partial s_l^2} > 0.$$

Proposition 4 formalizes the intuition that uncertainty is bounded. For very safe bonds ($\phi_l \approx 1$), survival probability is capped at 1. Greater uncertainty can only introduce downside uncertainty, pulling the average expectation down. Conversely, for very risky bonds ($\phi_l \approx 0$), survival probability is floored at 0. Greater uncertainty introduces lottery-like upside potential, pulling the average expectation up.⁹ Figure 1 illustrates this result. In particular, this asymmetry in probabilistic bounds affects portfolio decisions, and helps us identify the role of heterogeneous beliefs of investors on future buyers, which is described below.

3.2 Portfolio Choices

The two dominant investor classes in the corporate bond market – insurance companies and mutual funds – operate under distinct business models, face different regulatory constraints, and serve heterogeneous clienteles. In a stylized setting with one representative insurer and one representative mutual fund trading exclusively with each other, each investor must forecast the price at which the counterparty will transact to form expected returns. Credit signals arrive from two rating agencies whose assessments may diverge; when they do, both

⁹This result nests the intuition of a simple truncated linear model, $\Phi_{\text{trunc}}(x) = \min\{1, \max\{0, x\}\}$. While Φ_{trunc} is not differentiable, it represents the limit of smooth S -shaped functions as their steepness increases. In the truncated model, variance has no effect on the mean if the distribution is entirely within the linear range $(0, 1)$. However, if the distribution hits the upper bound (Safe), the truncation at 1 forces the mean downward as variance increases. If it hits the lower bound (Risky), the truncation at 0 forces the mean upward. Proposition 4 generalizes this boundary logic to smooth probabilities: the "hard" boundaries of 0 and 1 become the "soft" curvature of the convex and concave regions.

investors update not only their beliefs about bond risk but also their higher-order beliefs about the counterparty's valuation. The market clears in equilibrium from trading. Hence credit rating disagreement reshapes portfolios: whenever the insurer's expected sale price exceeds (or falls short of) the mutual fund's expected sale price, both parties rebalance their holdings in line with the evolving distribution of perceived counterpart valuations when credit rating ambiguity varies. The next subsection spells out our model and shows the results.

To explore the implications of rating dispersion on market clearing quantities, we model a simplified bond market. There exist bonds with different risk levels $l \in \{S, A, R\}$ (Safe, Average, Risky) and a risk-free asset with a gross return \mathcal{R}_f . We assume two classes of investors: Insurers (I) and Mutual Funds (MF). Both are equipped with Constant Absolute Risk Aversion (CARA) utility with risk aversion parameter ψ . To model heterogeneous trading behaviors, we assume a resale market structure where investor I considers selling to MF , and MF considers selling to I . In so doing, each investor updates their belief about the bond's fundamental survival, which is shared and publicly available. However, investors form their heterogeneous beliefs about the valuation of future buyers. This involves expectations about others' expectations, making higher-order beliefs crucial.

Let $V_l^{i \rightarrow j}$ denote the perceived liquidation value when investor i sells bond l to investor j , and we assume heterogeneous beliefs, or $V_l^{I \rightarrow MF} \neq V_l^{MF \rightarrow I}$. The subjective expected payoff for investor i , conditional on the signals $z_{1,l}$ and $z_{2,l}$, is:

$$E^i(V_l^j \mid z_{1,l}, z_{2,l}) = \tilde{\phi}_l(\Delta)V_l^{i \rightarrow j} + (1 - \tilde{\phi}_l(\Delta))\delta_l, \quad (10)$$

where δ_l is the recovery value, and $\tilde{\phi}_l(\Delta)$ is the posterior survival probability, as a function

of the rating dispersion Δ . Thus, $E^I(V_l^{MF} | \cdot)$ is the insurer's expectation of the payoff conditional on future sale to the mutual fund, and $E^{MF}(V_l^I | \cdot)$ refers to the mutual fund's expectation conditional on the sale to the insurer.

The bond payoff volatility, denoted as $\sigma_{i,l}^2$, is derived as

$$\sigma_{i,l}^2 = \tilde{\phi}_l(\Delta)(1 - \tilde{\phi}_l(\Delta))(V_l^{i \rightarrow j} - \delta_l)^2, \quad (11)$$

which depends on disagreement through Δ . The variance differs across investors because $V_l^{I \rightarrow MF} \neq V_l^{MF \rightarrow I}$, even if both evaluate the same survival probability $\tilde{\phi}_l(\Delta)$.

The optimal demand for investor $i \in \{I, MF\}$ for bond l , denoted θ_l^i , is given by the standard CARA demand function, it is computed as

$$\theta_l^i = \frac{E^i(V_l^j | z_{1,l}, z_{2,l}) - P_l \mathcal{R}_f}{\psi \sigma_{i,l}^2}. \quad (12)$$

Market clearing requires $\theta_l^I + \theta_l^{MF} = \Theta_l$, where Θ_l is the total supply of bond l . Solving for the equilibrium price P_l ,

$$P_l = \frac{\frac{E^I(V_l^{MF} | z_{1,l}, z_{2,l})}{\sigma_{I,l}^2} + \frac{E^{MF}(V_l^I | z_{1,l}, z_{2,l})}{\sigma_{MF,l}^2} - \psi \Theta_l}{\mathcal{R}_f (\sigma_{I,l}^{-2} + \sigma_{MF,l}^{-2})}. \quad (13)$$

Substituting the price back into the demand function (12) yields the equilibrium holdings:

$$\begin{aligned} \theta_l^I &= \Theta_l \frac{\sigma_{I,l}^{-2}}{\sigma_{I,l}^{-2} + \sigma_{MF,l}^{-2}} + \frac{E^I(V_l^{MF} | z_{1,l}, z_{2,l}) - E^{MF}(V_l^I | z_{1,l}, z_{2,l})}{\psi} \frac{\sigma_{I,l}^{-2} \sigma_{MF,l}^{-2}}{\sigma_{I,l}^{-2} + \sigma_{MF,l}^{-2}}, \\ \theta_l^{MF} &= \Theta_l - \theta_l^I. \end{aligned} \quad (14)$$

Portfolio holdings (14) highlights that the insurer's holding deviates from half the supply based strictly on the *valuation gap*: whether the insurer believes the mutual fund values the asset more than the mutual fund believes the insurer values it. To produce testable hypotheses, we assume that the two institutions have the following beliefs about each other.

Assumption 2. *Insurers are more optimistic about mutual funds' willingness to pay than vice versa for all bonds l . That is, $V_l^{I \rightarrow MF} > V_l^{MF \rightarrow I}$ holds.*

Rating disagreement affects investor demand only through its impact on the posterior survival probability. From Proposition 2, dispersion Δ_l raises posterior variance but leaves the posterior mean essentially unchanged in the symmetric two-state environment. Then with the result of Proposition 4, the following proposition shows the directional effects of dispersion on portfolio holdings

Proposition 5. *Let Φ be an S-shaped survival link function with inflection point x^* . For bond l , suppose rating dispersion Δ_l increases posterior variance s_l^2 while leaving the mean m_l locally unchanged, and Assumptions 1 and 2 hold. Then, $\frac{\partial \theta_l^I}{\partial \Delta_l} = \alpha_l \frac{\phi'(\Delta_l)}{(1-\phi(\Delta_l))^2}$, where $\alpha_l \equiv \frac{V_l^{I \rightarrow MF} - V_l^{MF \rightarrow I}}{\psi[(V_l^{I \rightarrow MF} - \delta_l)^2 + (V_l^{MF \rightarrow I} - \delta_l)^2]} > 0$, and the following results prevail.*

1. (**Safe bonds**) *If posterior mass lies predominantly above x^* (concave region), then increasing dispersion reduces insurer holdings and raises mutual fund holdings:*

$$\frac{\partial \theta_S^I}{\partial \Delta_S} < 0, \quad \frac{\partial \theta_S^{MF}}{\partial \Delta_S} > 0.$$

2. (**Risky bonds**) *If posterior mass lies predominantly below x^* (convex region), then increasing dispersion raises insurer holdings and reduces mutual fund holdings:*

$$\frac{\partial \theta_R^I}{\partial \Delta_R} > 0, \quad \frac{\partial \theta_R^{MF}}{\partial \Delta_R} < 0.$$

3. (**Average-risk bonds**) *If posterior mass lies near the inflection point (approximately linear region), dispersion has no first-order effect on holdings:*

$$\frac{\partial \theta_A^I}{\partial \Delta_A} \approx 0, \quad \frac{\partial \theta_A^{MF}}{\partial \Delta_A} \approx 0.$$

Proposition 5 outlines the crucial empirical test of our study.¹⁰ Finally, while it is reasonable to concentrate on the share of insurers (mutual funds) holdings to investigate corporate bond markets, our theory alludes that risk aversion (ψ) and the extent of heterogeneous beliefs ($V_l^{I \rightarrow MF} - V_l^{MF \rightarrow I}$) can be a source of within-group heterogeneity. For given credit region (safe/average/risky), the curvature term $\phi'_l(\Delta_l)/(1 - \phi_l(\Delta_l))^2$ is pinned down by the link function Φ and the posterior (m_l, s_l^2). Heterogeneity within the insurer group therefore operates primarily through the parameter α_l . We interpret high-leverage (or low-capital) insurers as those with more aggressive resale beliefs and lower effective risk aversion in the corporate bond segment. For such insurers, $V_l^{I \rightarrow MF} - V_l^{MF \rightarrow I}$ is larger and ψ is smaller, implying a larger value of α_l and therefore a larger magnitude of $\partial \theta_l^I / \partial \Delta_l$.

3.3 Testable Claims

The theoretical framework delivers three sets of empirical predictions.

Claim 1 (Informational content of dispersion): Propositions 2, 3, and 4 jointly imply that rating dispersion both increases the uncertainty about future credit states and tilts the balance between upgrades and downgrades in a credit-quality-dependent way. For safe bonds (posterior mass in the concave region of Φ), higher dispersion raises the probability of downgrades more than upgrades; for risky bonds (posterior mass in the convex region),

¹⁰If Assumption 2 does not hold in that the opposite direction (i.e., $V_l^{I \rightarrow MF} < V_l^{MF \rightarrow I}$) holds, the signs of the partial differentials will reverse.

higher dispersion raises the probability of upgrades more than downgrades. At the same time, as dispersion increases and posterior variance rises, the Shannon entropy of rating outcomes increases, reflecting greater uncertainty about future rating changes.

Claim 2 (Cross-sectional holdings by credit quality): Proposition 5 shows that the effect of dispersion on insurer holdings is proportional to the derivative of the posterior survival probability with respect to dispersion. Because this derivative is negative for safe bonds, approximately zero for average-risk bonds, and positive for risky bonds, dispersion induces systematically different portfolio responses across the credit spectrum. Holding other characteristics constant, higher dispersion should decrease insurers' relative holdings of safe bonds and increase their holdings of risky bonds, with negligible effects for bonds in the intermediate region. Mutual funds, as the primary counterparties, should adjust in the opposite direction.

Claim 3 (Heterogeneity by leverage and capital surplus): The magnitude of the dispersion effect on holdings is governed by the scaling parameter α_l , which depends on both the strength of heterogeneous beliefs about resale values and effective risk aversion. Insurers with high leverage or low capital surplus can be interpreted as having larger belief gaps about future resale prices and a lower effective risk-aversion parameter in the corporate bond segment. For given credit quality, these characteristics imply a larger α_l and hence a larger absolute response of holdings to dispersion. Thus, the portfolio rebalancing patterns predicted in Claim 2 should be most pronounced among high-leverage, low-capital-surplus insurers and attenuated among low-leverage, well-capitalized insurers.

The next section takes these three claims to the data by examining rating transition probabilities, entropy of rating changes, and cross-sectional bond holdings across credit-quality and insurer-balance-sheet dimensions.

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 Merger’s Fixed Income Securities Database.¹¹ We require sample bonds to be denominated in U.S. dollars; pay fixed or zero coupons; and be non-convertible, non-exchangeable, and non-puttable. 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 Lipper eMAXX).¹² 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 some 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

¹¹We 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/>

¹²In 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.

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 scale¹³—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 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.¹⁴ For reporting and analyses, we group NAIC 6 bonds together with NAIC 5, since the number of issues in NAIC group 6 is very small.

NAIC groups are designed for the RBC (risk-based capital) requirements, which are

¹³Our numerical rating scale follows Mergent’s Fixed Income Securities Database.

¹⁴As 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.

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.¹⁵ 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 risks. Consequently, with these added controls, our measure of rating dispersion can more 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,¹⁶ 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 mea-

¹⁵Before 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>)

¹⁶For 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.

sure 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.¹⁷ *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 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 to drive 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.

¹⁷Because 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.

We will also show that the main findings are robust to several alternative measures of credit rating dispersion.

4.1.4 Other Characteristics

We employ several bond-specific variables that may affect insurers' investment behavior, largely following Becker and Ivashina (2015).¹⁸ They document “reaching for yield” behavior in corporate bond investing 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.¹⁹ Because bonds with only one rating have zero dispersion 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 issue, 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 ($\ln(\textit{Trading volume})$), and the log of the number of investors reporting a change in holdings ($\ln(\textit{Number of trades})$). We control for potential investment

¹⁸As 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.

¹⁹Treasury yield data is from Liu and Wu (2021): <https://sites.google.com/view/jingcynthiawu/yield-data?pli=1>.

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

4.1.5 Descriptive Statistics

The descriptive statistics for 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 rare, with over 90% of bond ratings remaining unchanged. Downgrades are slightly more likely (3.6%) than upgrades (2.7%) each quarter. The mean yield spread and duration of sample bonds 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 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 sample 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 dispersion does not show a monotonic pattern across NAIC groups, but probability-based measure 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 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 than upgraded. The riskiest bonds are also more likely to experience negative credit shocks than favorable ones.²⁰

[Insert Table 1 About Here]

4.1.6 Rating Dispersion and Future Rating Changes

To answer our main research question, 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 underlying credit risk difference. For this alternative hypothesis to hold, first, rating adjustments must be directional *and* related to rating divergence, and second, the divergence must be short-lived. Our analyses of rating split persistence and rating change

²⁰In Table A.2 of the Appendix, we also report summary statistics of the data by the degree of credit rating dispersion.

direction show that neither case holds.

Figure 2 discusses the directionality of rating changes of bonds with zero vs. positive rating dispersion. The one-quarter ahead downgrade and upgrade probabilities are presented for bonds of differing credit risk grouped by the degree of rating dispersion.²¹

The main, and perhaps unexpected, takeaway from this figure is that bonds with current ratings or single rating 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. If the related concern is downgrade risk, the overall effect of rating dispersion on bond holdings regardless of risks could be *positive*, diametric to our theoretical prediction, which is a testable implication.

Among bonds with positive dispersion, safe bonds are more likely to experience downgrade than upgrade. In contrast, risky bonds are more likely to experience upgrade than downgrade. This appears consistent with Claim 1. We will provide more evidence on this asymmetric uncertainty below.

[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 line of reasoning suggests that rating divergence is transitory and convergence/corrections will happen 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

²¹Note that by construction, observations with zero and positive dispersion are exactly the same using either the rating-based or probability-based dispersion measure. This is also the case in Figure 3 below.

(i.e., 20 quarters).²² 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 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.²³ 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 high dispersion, with over 70% of them having their ratings failing to converge after four years.²⁴ Panel B reports results using probability-based dispersion, where the convergence rate is similar between low- and high-dispersion bonds, and more than 60% of both types

²²We exclude bonds that leave the sample before reaching the 16th quarter, but this requirement has little impact on our results.

²³Corresponding numbers are reported in Panel B of Table A.4 and A.5 of the Online Appendix.

²⁴Related, 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.

still have positive rating dispersion after four years.

[Insert Figure 3 About Here]

Taken together, the evidence provides little support for the story of rating splits as harbingers of imminent rating changes. Further, it highlights the persistent and ambiguous nature of credit assessment divergence. Rating dispersion, rather than being temporary, is more persistent than it would be if it were only caused by non-synchronous rating changes or random errors in prediction across rating agencies.

Theory shows that credit rating dispersion can stem from variations in rating agency bias and differing degrees of prediction accuracy, leading to heightened credit information uncertainty measured by the Shannon entropy, denoted as $H(\cdot)$. For a discrete random variable X with a probability mass function $p(x)$ on a finite alphabet \mathcal{X} ,

$$H(X) = - \sum_{x \in \mathcal{X}} p(x) \ln p(x),$$

with the convention $0 \ln 0 \equiv 0$. The base of the logarithm is e , so the units are *nats* (i.e., the natural unit of information). For a probability vector $P = (p_1, \dots, p_k)$ over k mutually exclusive outcomes,

$$0 \leq H(P) = - \sum_{i=1}^k p_i \ln p_i \leq \ln k,$$

with $H = 0$ for a point mass (no uncertainty) and $H = \ln k$ for a uniform distribution (maximal uncertainty). Table 2 presents the results for the safe and risky bonds for the three levels of rating dispersion (zero, low, and high).

[Insert Table 2 and Figure 4 About Here]

The outcome clearly suggests that rating dispersion stems from uncertain credit information, either concerning the underlying credit risk distribution faced by rating agencies or the disparities in their credit risk modeling. Shannon entropy increases as rating dispersion escalates, indicating a heightened level of credit rating uncertainty for riskier bonds. This supports the last part of **Claim 1**. The claim also states that rating dispersion increases downward (upward) predictability for safe (risky) bonds. While this claim may seem intuitive, it holds significant importance for our portfolio choice results. To validate this assumption, we conduct a test by examining whether changes in the probabilities of upgrades and downgrades are indeed asymmetric and bounded from below (above) for the risky (safe) bonds. Figure 4 supports this observation. In Panel A safe bonds are from NAIC 1 group and risky bonds are from NAIC 5 group. Safe high-dispersion bonds are .33% more likely to be downgraded and .31% less likely to be upgraded than those with low dispersion, suggesting an upper bound in survival probability. In risky bonds, high-dispersion bonds are 3.9% more likely to be upgraded than those with low dispersion, which is more than twice of the probability difference of being downgraded between the two groups (1.18%), indicating a lower uncertainty boundary. Alternatively, Panel B uses bonds from NAIC 1 and 2 (4 and 5) groups as safe (risky) bonds and reports the same patterns as Panel A.

4.2 Empirical Results

This section empirically tests the theory.

4.2.1 Empirical Specification

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

$$\begin{aligned}\theta_{i,t} = & \beta_1 * \textit{Rating dispersion}_{i,t-1} + \beta_2 * \textit{Rating dispersion}_{i,t-1} * \textit{NAIC_group}_{i,t-1} \\ & + \textit{Controls}_{i,t-1} + \textit{Fixed effects} + \epsilon_{i,t},\end{aligned}\tag{15}$$

where $\theta_{i,t}$ is the fraction of a bond outstanding collectively held by insurers at time t , and $\textit{Rating dispersion}_{i,t-1}$ 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 possible contamination by 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 trade execution before the investor observes the magnitude of credit rating dispersion. β_1 estimates the average predictive power of rating dispersion on one-quarter ahead insurers' holdings, 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*, $\ln(\textit{Trading volume})$, $\ln(\textit{Number of trades})$, *Bond return*, *Bond volatility*, *Upgrade*, and *Downgrade*. As discussed below, for some specifications, we also interact some of these control variables with *NAIC_group*.

The baseline specification includes high-dimensional fixed effects, especially, rating-by-quarter and industry-by-quarter fixed effects, where rating is based on *NAIC_score* and industry follows the 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' holdings 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 3. 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 following quarter's insurer bond holdings is negative, suggesting that insurance companies generally shy away from bonds with ratings disagreement. In contrast, the interaction term between *Rating dispersion* and *NAIC_group* loads significantly positive, implying that the effect of dispersion differs significantly across the NAIC groups. Recall in Section 3.2 we expound how heterogeneous beliefs about other

investors' future bond valuation affects portfolio holdings. The direction of the relation between rating dispersion and bond holdings indicate that insurers believe mutual funds to be more optimistic about future asset values, and mutual funds believe insurers to be less optimistic.

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 the 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.²⁵

The relations between rating dispersion and insurers' holdings may be influenced by some

²⁵The \$9 million is from $0.013 \times 700 \times (1 + 0.0039)$, where \$700 million is the unreported average amount outstanding at the beginning of the quarter when selling takes place, and 0.0039 is the RBC rate for NAIC group 1 bonds. Similarly, \$3.5 million is from $0.0066 \times 437 \times (1 + 0.2231)$, where \$437 million is the unreported average amount outstanding at the beginning of the quarter when buying takes place, and 0.2231 is the RBC rate for NAIC group 5 bonds.

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 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.²⁶ 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, $\ln(\textit{Trading volume})$ and $\ln(\textit{Number of trades})$, load negatively and are statistically significant at the 1% level in both specifications with or without bond fixed effects.²⁷ 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., 2022). 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

²⁶We 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.

²⁷Related, Paulson and Rosen (2016) provide evidence that life insurance firms tend to buy bonds when their liquidity is less than average.

reaching for yield among risky bonds.²⁸ To mitigate this concern, we add to Equation (15) the interaction term between yield spread and *NAIC_group*. Columns (3) and (4) report the results for specifications without and with bond fixed effects, respectively. The economic and statistical significance of the coefficients on both the rating dispersion measure and its interaction term with *NAIC_group* are almost unchanged. The coefficients on both yield spread and its interaction term with *NAIC_group* are statistically indistinguishable from zero, invalidating the alternate hypothesis.

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 indicator 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 additional 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 how 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 once issue-level heterogeneities are controlled for, insurers reduce (increase) holdings of downgraded (upgraded) issues and such effects do not vary significantly across NAIC groups.

Panel B of Table 3 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

²⁸Note, however, that Becker and Ivashina (2015) find that reaching for yield exists among investment-grade rather than speculative-grade bonds.

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 3 About Here]

It is evident that the portfolio effects of rating dispersion are hardly driven by insurers' reaching for yield or reacting to upcoming rating changes. To keep the empirical model parsimonious, for the rest of the paper, we report results based on the specifications of columns (1) and (2) of Table 3. That is, we use specifications that exclude *Upgrade*, *Downgrade*, and the interaction terms of *NAIC_group* with *Yield spread*, *Upgrade*, or *Downgrade*. In unreported analyses, 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 More Alternative Explanations We discuss additional tests that show that alternative stories are unlikely to drive our main findings. Consistent with **Proposition 1** in Section 3, Bongaerts et al. (2012) document that rating agencies differ in their power to predict future one-year default, and we can verify if particular rating agencies can drive our main findings on rating dispersion.²⁹ To this end, we expand our baseline specification

²⁹An alternative but related explanation is that, rating dispersion may be caused by one rating agency allowing ratings shopping and producing an 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

(Equation (15)) by including rating-agency fixed effects 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.³⁰ Table 4 reports the results, which are qualitatively similar to those of Table 3. This indicates that investors are unaffected by which agency assigns a particular rating.

[Insert Table 4 About Here]

Recall that zero-dispersion bonds are far more likely to be downgraded than upgraded, compared to bonds with divergent ratings (Figure 2), which might explain parts of our findings. For example, the positive relation between dispersion and risky bond holdings 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 heterogeneities 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*. Table 5 shows that, after controlling for the heterogeneity between zero- and positive-dispersion bonds, the primary findings still hold.³¹ On the other hand, results on the zero dispersion indicator are inconclusive. These results also test Proposition 1, suggesting

possibility.

³⁰In 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.

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

that agency-level bias does not affect our main results.

[Insert Table 5 About Here]

In addition, we investigate whether insurers simply anticipate rating changes behind dispersion by adding both concurrent rating-change indicators and historical upgrade/downgrade probabilities to the baseline specification. Across all variants—including concurrent upgrade/downgrade dummies, agency-specific versions, historical rating-change probabilities, and interactions with credit risk and yield spreads—the results remain qualitatively unchanged. The results are available in the Online Appendix.

4.2.3.2 Alternative Rating Dispersion Measures 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 3, 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 3. 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 alphanumeric rating from different 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.³²

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

³²We also find the results with unscaled dispersion measures to find robust results.

rating dispersion to vary across risk categories.

First, we group bonds into three categories: (1) investment-grade bonds (NAIC groups 1 and 2); (2) the middle risk category (NAIC 3); and (3) risky bonds (NAIC groups 4–6).³³ 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* of 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:

$$\begin{aligned} \theta_{i,t} = & \alpha_1 * \textit{Rating dispersion 1}_{i,t-1} + \alpha_2 * \textit{Rating dispersion 2}_{i,t-1} \\ & + \alpha_3 * \textit{Rating dispersion 3}_{i,t-1} + \textit{Controls}_{i,t-1} + \textit{Fixed effects} + \epsilon_{i,t}, \end{aligned} \quad (16)$$

where *Controls*_{*i,t-1*} include the same set of control variables as in Equation (15). Similar to the baseline analysis, we report results for two specifications: one including rating-by-quarter and industry-by-quarter fixed effects, and the other with incremental 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

³³We also report results in Table A.11 of the Online Appendix for a more granular version of Equation (16) using the five NAIC risk categories, where again we group NAIC 6 into NAIC 5.

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 6 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 are statistically different from each other at the 5% level.

The results are consistent with our theory, which posits that insurers will decrease holdings of safe bonds with high credit rating dispersion, and conversely, they will increase investment in risky bonds with high rating dispersion. In the middle ratings, both up- and down-sides are open, and rating dispersion in this region can result in inaction.

[Insert Table 6 About Here]

4.2.5 Rating Dispersion and Mutual Funds' Holdings

To show the contrasting portfolio rebalancing strategies as our theory posits, we digress from insurers and examine how disagreement in credit ratings affects mutual funds' bond holdings. Since mutual funds are, collectively, the second largest holder of U.S. corporate bonds after insurances, it is reasonable to assert that both institutions will seriously consider the other's future valuation in the event of a potential liquidation.

The effect of rating dispersion on mutual funds' collective holdings is shown in Table 7. The results, diametric to those in Table 3, state that mutual funds lean *toward* rating uncertainty, favoring bonds with rating disagreements in general. This is an important result that highlights the heterogeneous beliefs regarding each others' attitude toward rating uncertainty. The interaction term also supports this conjecture. There is an asymmetric attitude toward ambiguity in mutual funds, the preference for split-rated bonds decreasing as corporate credit quality deteriorates. Mutual funds decrease holdings of bonds with high yield spreads conditional on ratings, lean toward duration but at a much weaker degree compared to insurances, and past bond return does not load significantly. They prefer bonds with high liquidity, in terms of frequency of trading rather than total volume, and bond volatility does not affect mutual fund holdings once bond fixed effects are controlled for.

Panel B presents block-diagonal results, similar to Table 6 for insurers. Again, the differing attitudes toward rating dispersion depending on the riskiness of a bond are shown, that are totally different from those of insurance companies. This is not simply a model of trading where one sells to the other - in addition to the two subsets of investors, there remains around a third of the market not accounted for in our regressions. Moreover, positive and significant coefficients for duration in both insurers and mutual funds show that an automatic reverse relation between the two parties does not hold.

In line with prior findings in the literature, insurers are liquidity providers whereas mutual funds are demanders. Both types of investors demand duration, insurers show counter-cyclical behavior to past returns but mutual funds are insensitive. Yield spreads affect mutual funds' holding decisions but do not affect insurers. What is surprising is that while insurers lean away from rating dispersion in safe bonds but prefer risky bonds with such am-

biguity, mutual funds do exactly the opposite. Conventional wisdom that considers insurers to be risk-averse and uncertainty-averse would expect the opposite results – and even the coefficients on bond volatility confirm that this presumption may be totally wrong. It is the insurers who bet on rating uncertainty and return volatility in the riskiest bonds and mutual funds who do not.

[Insert Table 7 About Here]

Together with the results on insurance company funds, the findings on mutual funds provide strong supporting evidence for **Claim 2**. In the presence of heterogeneous higher-order beliefs about the future valuation of bonds, rating dispersion results in divergent portfolio rebalancing strategies among investors for bonds of different risk.

4.2.6 Leverage and Capital Surplus

Claim 3 posits that risk tolerance can enhance the impact of rating dispersion on portfolio holdings. To test this claim, we focus on insurance companies because we can compute each insurer’s capital ratio and leverage, which are our proxies for risk tolerance. Our prediction is that the fraction of a bond held by insurers is more sensitive to credit rating disagreement if it is held by those with high leverage or low intermediary capital. 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 the 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 held by low leverage funds, and *High Lev* is the proportion held by high leverage funds. Similarly for capital surplus, the variables *Low Cap* and *High Cap* are calculated accordingly.

First we run Equation (16) using *Low Lev* and *High Lev* as dependent variables, separately.³⁴ Table 8 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)). 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 fund holdings (column (2)), the coefficient 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

³⁴Unreported analyses show that using the interaction specification of Equation (15) yields consistent results.

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

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 8 and Table 9 About Here]

We repeat the same analysis, using *Low Cap* and *High Cap* as separate dependent variables, reported in Table 9. Low-capital funds produce a pattern similar to that of high-leverage funds, and vice versa. 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 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 need only to divest a smaller fraction of their holding of investment-grade bonds than low-capital funds.

5 Conclusion

Our analysis reveals a seemingly paradoxical pattern in institutional responses to credit rating dispersion in corporate bond markets. Using the magnitude of disagreement among multiple rating agencies as a proxy for information uncertainty, we document that insurance companies, the dominant players in bond markets, systematically increase their exposure to risky bonds when rating disagreement occurs. This betting on rating disagreement behavior stands in stark contrast to mutual funds which, despite their presumably higher risk tolerance, reduce their holdings of risky bonds under identical circumstances. Furthermore, these same insurance companies simultaneously decrease their positions in safe bonds when confronted with rating dispersion. We empirically demonstrate that anticipation of future

rating changes cannot explain these seemingly contradictory behaviors, pointing to a deeper underlying mechanism.

Our theory resolves this puzzle through two complementary channels. First, the bounded nature of survival probability assessments creates an inherent asymmetry in how uncertainty manifests across the credit quality spectrum—predominantly downward for safe bonds and upward for risky bonds. This asymmetry, reinforced by categorical risk classifications like NAIC groups, means that for safe bonds, rating dispersion signals potential deterioration, while for low-quality bonds, it emphasizes limited downside relative to upside potential. Second, heterogeneous beliefs about counterparty valuations drive opposing portfolio behaviors when insurers perceive mutual funds as more optimistic compared to how mutual funds perceive insurers. This relative optimism differential explains why insurers increase holdings of risky bonds while decreasing safe bond positions when rating disagreement occurs, with mutual funds exhibiting precisely the opposite behavior. Our theoretical mechanisms together provide a coherent explanation for the “betting on (or against) dispersion” behavior observed in institutional investment patterns.

The finding of an asymmetric reaction to credit rating disagreement 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. Insurers, despite regulatory controls to limit risk, tend to invest in risky bonds with high rating dispersion, especially those with low capital surplus and high leverage. This concentration of risk in vulnerable bonds can negatively impact social welfare.

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.

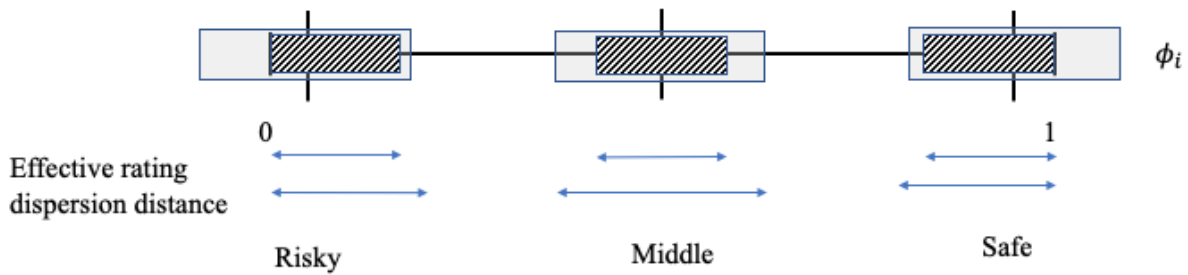


Figure 2: Rating Dispersion and Rating Changes

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.

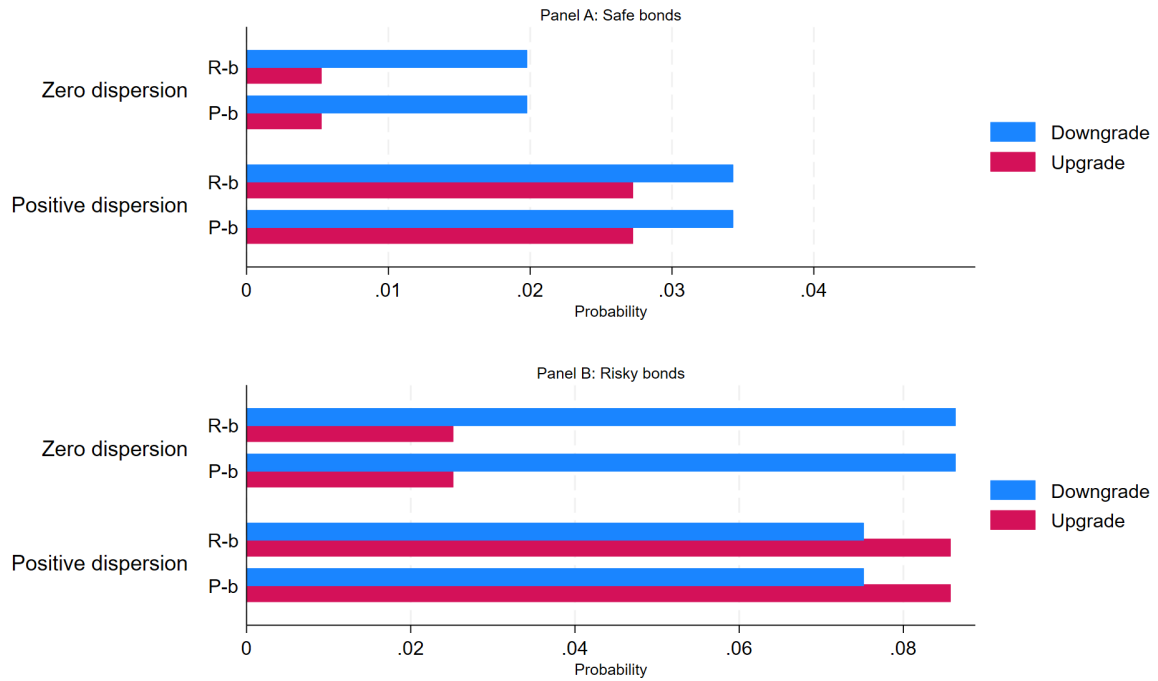


Figure 3: Rating Dispersion and Convergence

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.

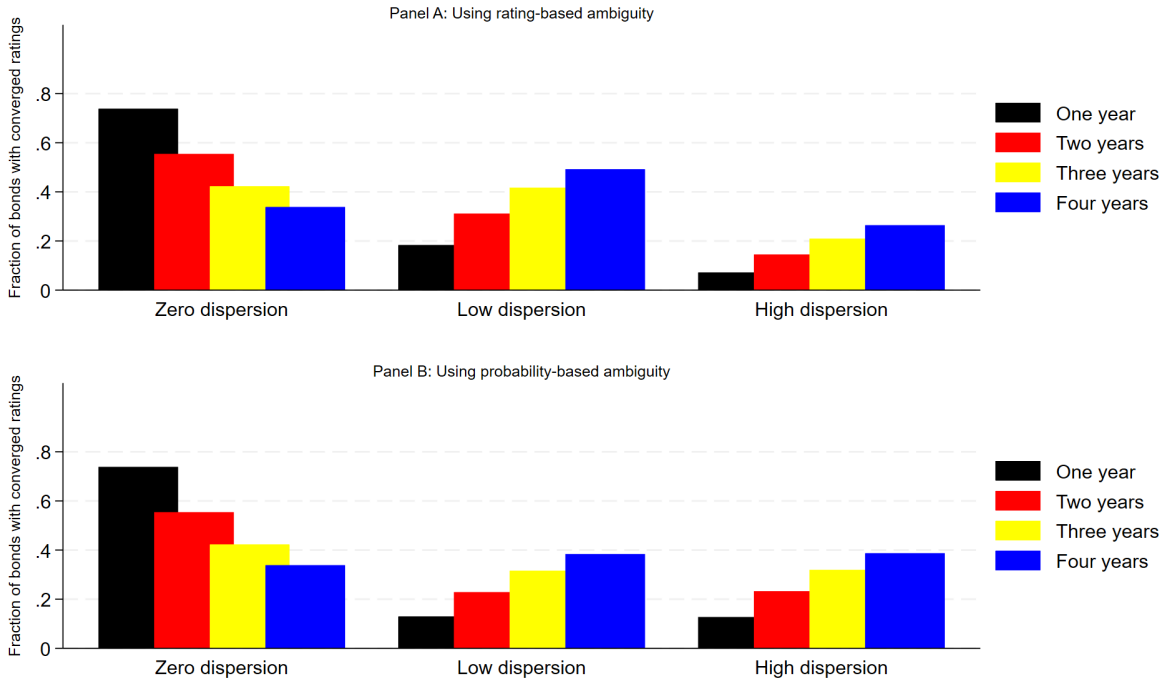


Figure 4: **Asymmetric Uncertainty Changes for Safe and Risky Bonds with Credit Rating Dispersion**

This figure displays differences in probability of rating upgrade and downgrade for safe and risky bonds with high minus low credit rating dispersions. High (low) rating dispersions are top (bottom) tercile among bonds with positive rating dispersions. Safe: Down (Up) refers to the case in which safe bonds with high rating dispersion are compared with safe bonds with low rating dispersion in terms of downgrade (upgrade) probabilities of future rating changes. Similarly, Risky: Down (Up) refers to the case in which risky bonds with high rating dispersion are compared with risky bonds with low rating dispersion in terms of downgrade (upgrade) probabilities of future rating changes. For Panel A, Safe bonds are those with NAIC 1 category, and the Risky bonds correspond to NAIC 5 group bonds. For Panel B, Safe bonds are those with NAIC 1 and 2 categories, and the Risky correspond to NAIC 4 to 5 group bonds.

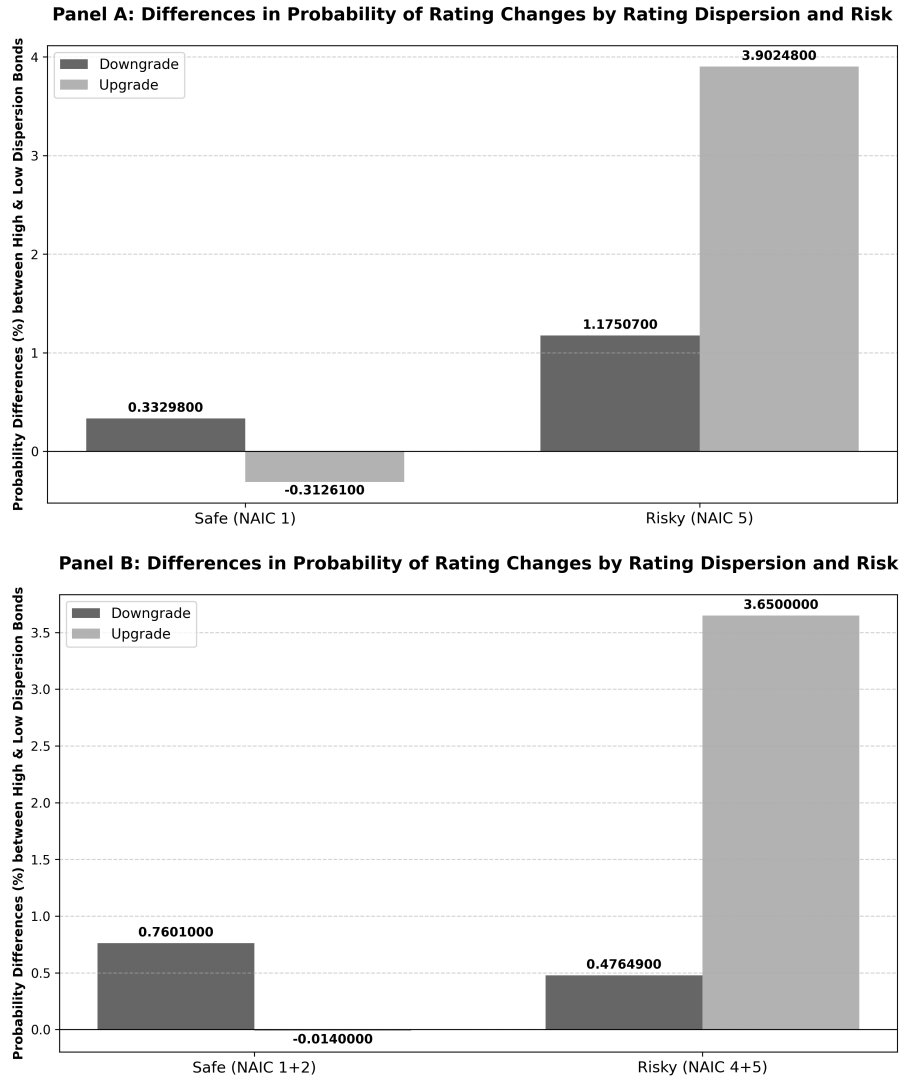


Table 1: **Descriptive Statistics**

This table presents descriptive statistics for variables of interest. *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 its counterpart measured from historical default probabilities. *Credit rating* are alphanumeric indicators of credit quality assigned by credit rating agencies converted into numerical scores (1 is the best rating, and 25 the worst). *NAIC_group* is the credit rating category defined by NAIC. Other variable definitions are as in Appendix A.

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 Dispersion	0.196	0.000	0.192	0.289	0.188	384,908
Probability-based Dispersion	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 Shannon Entropy for Safe and Risky Bonds**

Shannon entropy ($H(\cdot)$) values are computed for both safe and risky bonds across three levels of rating dispersion (Zero, Low, High). For a discrete random variable X with probability mass function $p(x)$ on a finite alphabet \mathcal{X} ,

$$H(X) = - \sum_{x \in \mathcal{X}} p(x) \ln p(x),$$

with the convention $0 \ln 0 \equiv 0$. The base of the logarithm is e , so the units are *nats*. For a probability vector $P = (p_1, \dots, p_k)$ over k mutually exclusive outcomes,

$$0 \leq H(P) = - \sum_{i=1}^k p_i \ln p_i \leq \ln k,$$

with $H = 0$ for a point mass (no uncertainty) and $H = \ln k$ for the uniform distribution (maximal uncertainty). In our context, higher entropy indicates greater uncertainty in rating-transition outcomes. Higher entropy indicates greater uncertainty in rating transitions. Risky bonds consistently exhibit higher entropy levels compared to safe bonds, suggesting that dispersion increases uncertainty more strongly in the risky bond segment.

Rating Dispersion	Safe Bonds	Risky Bonds
Zero Dispersion	0.090169011	0.283712552
Low Dispersion	0.189519742	0.353357500
High Dispersion	0.188484879	0.410936012

Table 3: 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.

<i>Dependent Variable:</i>	<i>Panel A: Rating-based Dispersion</i>					
<i>Insurers' Holdings</i>	(1)	(2)	(3)	(4)	(5)	(6)
Rating dispersion	-0.095*** (0.019)	-0.027*** (0.009)	-0.095*** (0.019)	-0.026*** (0.009)	-0.094*** (0.019)	-0.026*** (0.009)
Dispersion × NAIC_group	0.026*** (0.007)	0.012*** (0.004)	0.026*** (0.007)	0.012*** (0.004)	0.026*** (0.007)	0.012*** (0.004)
Single rating dummy	-0.030** (0.013)	-0.010 (0.009)	-0.030** (0.013)	-0.010 (0.009)	-0.029** (0.013)	-0.012 (0.009)
Yield spread	-0.231 (0.151)	0.029 (0.083)	-0.392 (0.476)	-0.030 (0.178)	-0.319 (0.481)	-0.010 (0.177)
Yield spread × NAIC_group			0.053 (0.119)	0.020 (0.043)	0.026 (0.121)	0.027 (0.044)
Downgrade					-0.020*** (0.007)	-0.009*** (0.002)
Downgrade × NAIC_group					0.009*** (0.002)	0.001 (0.001)
Upgrade					-0.008 (0.009)	0.009** (0.004)
Upgrade × NAIC_group					0.005* (0.003)	0.002 (0.001)
Duration	0.006*** (0.001)	0.021*** (0.001)	0.006*** (0.001)	0.021*** (0.001)	0.006*** (0.001)	0.021*** (0.001)
Bond return	0.038 (0.047)	-0.055* (0.029)	0.036 (0.048)	-0.056* (0.028)	0.037 (0.048)	-0.054* (0.028)
Bid-ask spread	-1.302*** (0.263)	-0.039 (0.067)	-1.296*** (0.259)	-0.039 (0.067)	-1.294*** (0.260)	-0.033 (0.067)
ln(Trading volume)	-0.041*** (0.002)	-0.006*** (0.001)	-0.041*** (0.002)	-0.006*** (0.001)	-0.041*** (0.002)	-0.006*** (0.001)
ln(Number of trades)	-0.034*** (0.003)	-0.006*** (0.002)	-0.034*** (0.003)	-0.006*** (0.002)	-0.034*** (0.003)	-0.006*** (0.002)
Bond volatility	0.353*** (0.111)	0.099* (0.054)	0.353*** (0.111)	0.099* (0.054)	0.349*** (0.111)	0.100* (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 3: Rating Dispersion and Insurers' Holdings - Continued

<i>Dependent Variable:</i>	<i>Panel B: Probability-based Dispersion</i>					
<i>Insurers' Holdings</i>	(1)	(2)	(3)	(4)	(5)	(6)
Rating dispersion	-3.164*** (0.583)	-1.335*** (0.318)	-3.147*** (0.584)	-1.332*** (0.318)	-3.141*** (0.587)	-1.308*** (0.315)
Dispersion \times NAIC_group	0.769*** (0.132)	0.333*** (0.073)	0.766*** (0.132)	0.332*** (0.072)	0.763*** (0.133)	0.324*** (0.072)
Single rating dummy	-0.026* (0.013)	-0.011 (0.008)	-0.025* (0.013)	-0.011 (0.008)	-0.025* (0.013)	-0.012 (0.008)
Yield spread	-0.226 (0.152)	0.038 (0.083)	-0.435 (0.481)	-0.019 (0.178)	-0.357 (0.486)	0.001 (0.177)
Yield spread \times NAIC_group			0.069 (0.121)	0.019 (0.043)	0.040 (0.123)	0.026 (0.044)
Downgrade					-0.021*** (0.007)	-0.009*** (0.002)
Downgrade \times NAIC_group					0.010*** (0.002)	0.002 (0.001)
Upgrade					-0.013 (0.009)	0.009** (0.004)
Upgrade \times NAIC_group					0.006** (0.003)	0.002 (0.001)
Duration	0.006*** (0.001)	0.021*** (0.001)	0.006*** (0.001)	0.021*** (0.001)	0.006*** (0.001)	0.021*** (0.001)
Bond return	0.039 (0.048)	-0.053* (0.028)	0.036 (0.049)	-0.055* (0.028)	0.037 (0.049)	-0.053* (0.028)
Bid-ask spread	-1.313*** (0.264)	-0.038 (0.067)	-1.305*** (0.260)	-0.037 (0.067)	-1.303*** (0.261)	-0.032 (0.067)
ln(Trading volume)	-0.041*** (0.002)	-0.006*** (0.001)	-0.041*** (0.002)	-0.006*** (0.001)	-0.041*** (0.002)	-0.006*** (0.001)
ln(Number of trades)	-0.034*** (0.003)	-0.006*** (0.002)	-0.034*** (0.003)	-0.006*** (0.002)	-0.034*** (0.003)	-0.006*** (0.002)
Bond volatility	0.384*** (0.113)	0.109** (0.054)	0.384*** (0.112)	0.109** (0.054)	0.379*** (0.112)	0.109** (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	384,908	384,230	384,908	384,230	384,380	383,710
Adj. R^2	0.495	0.901	0.495	0.901	0.496	0.901

Table 4: 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*** (0.019)	-0.093*** (0.019)	-0.032*** (0.010)	-0.026*** (0.009)	-2.694*** (0.580)	-2.665*** (0.582)	-1.648*** (0.362)	-1.319*** (0.313)
Dispersion \times NAIC_group	0.029*** (0.007)	0.029*** (0.007)	0.016*** (0.005)	0.012*** (0.004)	0.685*** (0.131)	0.680*** (0.132)	0.411*** (0.082)	0.330*** (0.071)
Single rating dummy	-0.037** (0.015)	-0.034** (0.015)	-0.018* (0.011)	-0.012 (0.009)	-0.035** (0.015)	-0.032** (0.015)	-0.019* (0.011)	-0.013 (0.009)
Yield spread	-0.196 (0.149)	-0.202 (0.146)	0.080 (0.077)	0.022 (0.078)	-0.195 (0.151)	-0.201 (0.147)	0.093 (0.077)	0.030 (0.078)
Duration	0.006*** (0.001)	0.006*** (0.001)	0.021*** (0.001)	0.021*** (0.001)	0.006*** (0.001)	0.006*** (0.001)	0.021*** (0.001)	0.021*** (0.001)
Bond return	0.041 (0.048)	0.043 (0.048)	-0.054* (0.029)	-0.050* (0.028)	0.042 (0.048)	0.044 (0.048)	-0.052* (0.029)	-0.049* (0.028)
Bid-ask spread	-1.247*** (0.260)	-1.222*** (0.257)	-0.017 (0.069)	-0.035 (0.064)	-1.257*** (0.261)	-1.234*** (0.258)	-0.016 (0.070)	-0.033 (0.064)
ln(Trading volume)	-0.041*** (0.002)	-0.041*** (0.002)	-0.006*** (0.001)	-0.006*** (0.001)	-0.041*** (0.002)	-0.041*** (0.002)	-0.006*** (0.001)	-0.005*** (0.001)
ln(Number of trades)	-0.034*** (0.003)	-0.034*** (0.003)	-0.007*** (0.002)	-0.006*** (0.001)	-0.034*** (0.003)	-0.033*** (0.003)	-0.007*** (0.002)	-0.006*** (0.001)
Bond volatility	0.396*** (0.113)	0.403*** (0.113)	0.067 (0.057)	0.105* (0.055)	0.423*** (0.114)	0.430*** (0.114)	0.080 (0.057)	0.114** (0.055)
Bond FE	Yes	Yes	Yes	Yes	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	Yes	Yes	Yes	Yes
Moody's FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fitch FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
S&P-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Moody's-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fitch-Quarter FE	Yes	Yes	Yes	Yes	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 5: **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.

<i>Dependent Variable:</i>	Rating-based		Probability-based	
<i>Insurers' Holdings</i>	(1)	(2)	(3)	(4)
Rating dispersion	-0.138*** (0.028)	-0.030** (0.013)	-2.354*** (0.624)	-1.535*** (0.353)
Dispersion × NAIC_group	0.042*** (0.009)	0.012** (0.005)	0.584*** (0.140)	0.349*** (0.079)
Zero dispersion	-0.024** (0.012)	-0.001 (0.005)	0.015* (0.009)	0.004 (0.004)
Zero dispersion × NAIC_group	0.009** (0.004)	-0.000 (0.002)	-0.004 (0.004)	-0.004** (0.002)
Yield spread	-0.239 (0.151)	0.029 (0.084)	-0.237 (0.151)	0.045 (0.083)
Duration	0.006*** (0.001)	0.021*** (0.001)	0.006*** (0.001)	0.021*** (0.001)
Bond return	0.038 (0.047)	-0.055* (0.029)	0.038 (0.047)	-0.053* (0.028)
Bid-ask spread	-1.293*** (0.263)	-0.039 (0.067)	-1.306*** (0.263)	-0.038 (0.067)
ln(Trading volume)	-0.041*** (0.002)	-0.006*** (0.001)	-0.041*** (0.002)	-0.006*** (0.001)
ln(Number of trades)	-0.034*** (0.003)	-0.006*** (0.002)	-0.033*** (0.003)	-0.006*** (0.002)
Bond volatility	0.356*** (0.111)	0.100* (0.054)	0.376*** (0.113)	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 6: **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.

<i>Dependent Variable:</i>	Rating-based		Probability-based	
	(1)	(2)	(3)	(4)
<i>Insurers' Holdings</i>				
Rating dispersion 1	-1.227*** (0.243)	-0.156 (0.108)	-1.065*** (0.167)	-0.388*** (0.086)
Rating dispersion 2	0.069 (0.338)	0.161 (0.259)	-0.157 (0.362)	-0.123 (0.219)
Rating dispersion 3	0.901*** (0.295)	0.397* (0.227)	0.706*** (0.267)	0.443** (0.187)
Single rating dummy	-0.029** (0.013)	-0.010 (0.009)	-0.026* (0.013)	-0.011 (0.008)
Yield spread	-0.226 (0.150)	0.028 (0.084)	-0.210 (0.150)	0.040 (0.083)
Duration	0.006*** (0.001)	0.021*** (0.001)	0.006*** (0.001)	0.021*** (0.001)
Bond return	0.039 (0.047)	-0.055* (0.028)	0.042 (0.047)	-0.053* (0.028)
Bid-ask spread	-1.310*** (0.263)	-0.040 (0.066)	-1.313*** (0.263)	-0.039 (0.066)
ln(Trading volume)	-0.041*** (0.002)	-0.006*** (0.001)	-0.041*** (0.002)	-0.006*** (0.001)
ln(Number of trades)	-0.034*** (0.003)	-0.006*** (0.002)	-0.034*** (0.003)	-0.006*** (0.002)
Bond volatility	0.345*** (0.110)	0.099* (0.054)	0.373*** (0.112)	0.106* (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 7: Mutual Funds' Holdings

This table reports estimates of panel regression results of the fraction of corporate bonds held by mutual fund companies on measures of rating dispersion and various control variables, with various 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 *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. 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.

<i>Panel A: Baseline Specification</i>				
<i>Dependent Variable:</i>	Rating-based		Probability-based	
<i>Mutual Funds' Holdings</i>	(1)	(2)	(3)	(4)
Rating dispersion	0.721*** (0.154)	0.440*** (0.139)	0.469*** (0.091)	0.266*** (0.071)
Dispersion × NAIC_group	-0.023*** (0.004)	-0.011*** (0.003)	-0.098*** (0.021)	-0.038** (0.016)
Single rating dummy	0.002 (0.005)	-0.006 (0.005)	0.004 (0.005)	-0.006 (0.005)
Yield spread	-0.122 (0.077)	-0.289*** (0.074)	-0.129* (0.077)	-0.295*** (0.074)
Duration	-0.000 (0.001)	0.003* (0.002)	-0.000 (0.001)	0.003** (0.002)
Bond return	0.042 (0.039)	0.020 (0.035)	0.041 (0.039)	0.019 (0.035)
Bid-ask spread	-0.498*** (0.157)	0.020 (0.125)	-0.512*** (0.157)	0.020 (0.125)
ln(Trading volume)	-0.002*** (0.001)	-0.002*** (0.000)	-0.002*** (0.001)	-0.002*** (0.000)
ln(Number of trades)	0.035*** (0.002)	0.012*** (0.001)	0.035*** (0.002)	0.012*** (0.001)
Bond volatility	-0.168*** (0.049)	-0.033 (0.041)	-0.185*** (0.050)	-0.038 (0.041)
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	0.734	0.496	0.734

Table 7: Mutual Funds' Holdings - Continued

<i>Panel B: Block-Diagonal Specificaion</i>				
<i>Dependent Variable:</i>	Rating-based		Probability-based	
<i>Mutual Funds' Holdings</i>	(1)	(2)	(3)	(4)
Rating dispersion 1	0.167* (0.088)	0.156** (0.073)	0.418*** (0.083)	0.241*** (0.067)
Rating dispersion 2	-0.363 (0.270)	-0.081 (0.145)	0.051 (0.253)	0.145 (0.156)
Rating dispersion 3	-1.409*** (0.225)	-0.448** (0.191)	-0.888*** (0.265)	-0.276 (0.193)
Single rating dummy	0.002 (0.005)	-0.006 (0.005)	0.004 (0.005)	-0.006 (0.005)
Yield spread	-0.124 (0.077)	-0.288*** (0.074)	-0.129* (0.076)	-0.295*** (0.074)
Duration	-0.000 (0.001)	0.003* (0.002)	-0.000 (0.001)	0.003** (0.002)
Bond return	0.042 (0.039)	0.020 (0.035)	0.041 (0.039)	0.019 (0.035)
Bid-ask spread	-0.495*** (0.156)	0.020 (0.125)	-0.511*** (0.157)	0.019 (0.125)
ln(Trading volume)	-0.002*** (0.001)	-0.002*** (0.000)	-0.002*** (0.001)	-0.002*** (0.000)
ln(Number of trades)	0.035*** (0.002)	0.012*** (0.001)	0.035*** (0.002)	0.012*** (0.001)
Bond volatility	-0.165*** (0.049)	-0.033 (0.042)	-0.182*** (0.050)	-0.037 (0.041)
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	0.734	0.496	0.734

Table 8: **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.

<i>Panel A: Rating-based Dispersion</i>				
<i>Dependent Variable:</i>	Low Lev		High Lev	
<i>Insurers' Holdings</i>	(1)	(2)	(3)	(4)
Rating dispersion 1	-0.096** (0.040)	-0.012 (0.039)	-0.816*** (0.183)	-0.081 (0.102)
Rating dispersion 2	0.344 (0.249)	0.082 (0.118)	-0.407 (0.325)	-0.021 (0.178)
Rating dispersion 3	0.178*** (0.041)	0.027 (0.064)	0.474** (0.222)	0.364** (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
<i>Panel B: Probability-based Dispersion</i>				
<i>Dependent Variable:</i>	Low Lev		High Lev	
<i>Insurers' Holdings</i>	(1)	(2)	(3)	(4)
Rating dispersion 1	-0.051 (0.044)	-0.000 (0.029)	-0.676*** (0.135)	-0.219*** (0.074)
Rating dispersion 2	0.209 (0.154)	-0.033 (0.041)	-0.470 (0.304)	-0.111 (0.183)
Rating dispersion 3	0.137*** (0.044)	0.024 (0.053)	0.386** (0.190)	0.366** (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 9: 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.

<i>Panel A: Rating-based Dispersion</i>				
<i>Dependent Variable:</i>	Low Cap		High Cap	
<i>Insurers' Holdings</i>	(1)	(2)	(3)	(4)
Rating dispersion 1	-0.803*** (0.176)	-0.076 (0.100)	-0.097** (0.042)	-0.017 (0.040)
Rating dispersion 2	-0.374 (0.323)	-0.033 (0.175)	0.341 (0.250)	0.087 (0.120)
Rating dispersion 3	0.452** (0.217)	0.400** (0.184)	0.183*** (0.043)	0.033 (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
<i>Panel B: Probability-based Dispersion</i>				
<i>Dependent Variable:</i>	Low Cap		High Cap	
<i>Insurers' Holdings</i>	(1)	(2)	(3)	(4)
Rating dispersion 1	-0.639*** (0.125)	-0.228*** (0.072)	-0.058 (0.044)	-0.002 (0.029)
Rating dispersion 2	-0.418 (0.299)	-0.104 (0.179)	0.205 (0.155)	-0.031 (0.041)
Rating dispersion 3	0.387** (0.187)	0.403*** (0.148)	0.143*** (0.046)	0.031 (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”**

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Proofs

Proof of Proposition 1

Proof. Fix a bond l and consider the case of consensus, $\Delta_l = 0$, so that $z_{1,l} = z_{2,l} = \bar{z}_l$. From (6), the posterior mean under possibly biased signals is

$$m_l(0) = v_l \left(\sigma_{\eta,l}^{-2} \mu_0 + (w_{1,l} + w_{2,l}) \bar{z}_l - (w_{1,l} \mu_1^b + w_{2,l} \mu_2^b) \right),$$

where $v_l = \left(\sigma_{\eta,l}^{-2} + w_{1,l} + w_{2,l} \right)^{-1}$ and $w_{k,l} \equiv (\tau_k^2 + \sigma_{k,l}^2)^{-1}$. Now define the *bias-neutral* benchmark as the posterior mean evaluated at the same $(w_{1,l}, w_{2,l}, \bar{z}_l)$ but with zero mean biases, $\mu_1^b = \mu_2^b = 0$. Denote this quantity by $m_l^{bm}(0)$. Plugging $\mu_1^b = \mu_2^b = 0$ into the same updating formula yields $m_l^{bm}(0) = v_l \left(\sigma_{\eta,l}^{-2} \mu_0 + (w_{1,l} + w_{2,l}) \bar{z}_l \right)$. Taking the difference of the two posterior means, we obtain

$$m_l(0) - m_l^{bm}(0) = -v_l (w_{1,l} \mu_1^b + w_{2,l} \mu_2^b).$$

By definition, $\mathcal{B}_l \equiv \frac{w_{1,l} \mu_1^b + w_{2,l} \mu_2^b}{w_{1,l} + w_{2,l}}$, so we can rewrite the difference as $m_l(0) - m_l^{bm}(0) = -(w_{1,l} + w_{2,l}) v_l \mathcal{B}_l$. Rearranging gives the asserted relationship,

$$m_l(0) = m_l^{bm}(0) - (w_{1,l} + w_{2,l}) v_l \mathcal{B}_l.$$

For the second claim, note from (5) that the posterior variance $v_l = \left(\sigma_{\eta,l}^{-2} + w_{1,l} + w_{2,l} \right)^{-1}$ depends only on the prior variance $\sigma_{\eta,l}^2$ and the signal precisions $w_{k,l}$, but not on the bias means μ_k^b . Thus v_l is unchanged when we move from the biased case to the bias-neutral benchmark. Moreover, the coefficient on the prior mean μ_0 in the posterior mean is $v_l \sigma_{\eta,l}^{-2}$, which again depends only on $\sigma_{\eta,l}^2$ and $(w_{1,l}, w_{2,l})$, not on (μ_1^b, μ_2^b) . Hence the relative weight on the prior mean μ_0 is also unaffected by the bias means. \square

Proof of Proposition 2

Proof. Let the signals be $z_1 = \bar{z} + \Delta$ and $z_2 = \bar{z} - \Delta$.

Step 1: Within-state variances. The posterior precision in state s is the sum of the prior precision and signal precisions. Let $\Lambda_H \equiv (\underline{\sigma}^2 + \tau^2)^{-1}$ and $\Lambda_L \equiv (\bar{\sigma}^2 + \tau^2)^{-1}$. Due to the symmetry of the variance structure, the total signal precision is identical in both states:

$$(v^{(1)})^{-1} = \sigma_{\eta}^{-2} + \Lambda_H + \Lambda_L = (v^{(2)})^{-1}.$$

Thus, $v^{(1)} = v^{(2)} \equiv v^*$. The first term in equation (??) simplifies to v^* , which is constant with respect to Δ .

Step 2: Conditional means. Define $K \equiv v^*(\sigma_{\eta}^{-2} \mu_0 - (\Lambda_H + \Lambda_L) \mu^b)$. The conditional means are:

$$\begin{aligned} m^{(1)} &= K + v^*(\Lambda_H(\bar{z} + \Delta) + \Lambda_L(\bar{z} - \Delta)) = K + v^*(\Lambda_H + \Lambda_L)\bar{z} + v^*(\Lambda_H - \Lambda_L)\Delta, \\ m^{(2)} &= K + v^*(\Lambda_L(\bar{z} + \Delta) + \Lambda_H(\bar{z} - \Delta)) = K + v^*(\Lambda_H + \Lambda_L)\bar{z} - v^*(\Lambda_H - \Lambda_L)\Delta. \end{aligned}$$

Letting $\kappa \equiv v^*(\Lambda_H - \Lambda_L)$, the distance between the state-contingent means is $m^{(1)} - m^{(2)} = 2\kappa\Delta$. Note that $\kappa > 0$ because the high-precision weight $\Lambda_H > \Lambda_L$.

Step 3: Weights and Total Variance. In addition to the assumptions of symmetric variances, assume further that the average rating is centered at the unconditional mean ($\bar{z} = \mu_0 + \mu^b$). In this case, by symmetry of the bivariate normal likelihoods, $\text{prob}(z|S=1) = \text{prob}(z|S=2)$ for all Δ , and with a uniform prior, we can obtain $\omega_1(z) = \omega_2(z) = 0.5$. Substituting these into the between-state variance term:

$$\begin{aligned} \sum_{s=1}^2 \omega_s(z) (m^{(s)}(z) - \bar{m}(z))^2 &= \frac{1}{2} \left(\frac{m^{(1)} - m^{(2)}}{2} \right)^2 + \frac{1}{2} \left(\frac{m^{(2)} - m^{(1)}}{2} \right)^2 \\ &= \frac{1}{4} (m^{(1)} - m^{(2)})^2 \\ &= \frac{1}{4} (2\kappa\Delta)^2 = \kappa^2 \Delta^2. \end{aligned}$$

The total posterior variance is $V(\Delta) = v^* + \kappa^2 \Delta^2$. Taking the derivative with respect to disagreement Δ :

$$\frac{\partial V(\Delta)}{\partial \Delta} = 2\kappa^2 \Delta.$$

Since $\kappa \neq 0$, for any positive disagreement $\Delta > 0$, the derivative is strictly positive. \square

Proof of Proposition 3

Proof. Write $\delta_i \equiv p'_i(\Delta_0)$ for $i \in \{d, 0, u\}$. Since $p_d + p_0 + p_u \equiv 1$, we have

$$\delta_d + \delta_0 + \delta_u = 0 \quad \Rightarrow \quad \delta_0 = -(\delta_d + \delta_u).$$

By definition,

$$H(\Delta) = - \sum_i p_i(\Delta) \ln p_i(\Delta),$$

so differentiating at Δ_0 yields

$$\begin{aligned} \left. \frac{dH}{d\Delta} \right|_{\Delta_0} &= - \sum_i \delta_i (1 + \ln p_i(\Delta_0)) \\ &= - \left[\delta_d (1 + \ln p_d) + \delta_0 (1 + \ln p_0) + \delta_u (1 + \ln p_u) \right], \end{aligned}$$

where, to lighten notation, we write p_i for $p_i(\Delta_0)$.

Use $\delta_0 = -(\delta_d + \delta_u)$ to eliminate δ_0 :

$$\begin{aligned} \left. \frac{dH}{d\Delta} \right|_{\Delta_0} &= - \left[\delta_d (1 + \ln p_d) - (\delta_d + \delta_u) (1 + \ln p_0) + \delta_u (1 + \ln p_u) \right] \\ &= - \left[\delta_d (\ln p_d - \ln p_0) + \delta_u (\ln p_u - \ln p_0) \right] \\ &= - \left[\delta_d \ln \frac{p_d}{p_0} + \delta_u \ln \frac{p_u}{p_0} \right]. \end{aligned}$$

By center dominance, $p_d \leq p_0$ and $p_u \leq p_0$, so

$$\ln \frac{p_d}{p_0} \leq 0, \quad \ln \frac{p_u}{p_0} \leq 0,$$

with a strict inequality ($<$) whenever $p_i < p_0$.

Under Assumption 1, we have $\delta_d \geq 0$, $\delta_u \geq 0$, and at least one is strictly positive. Therefore the bracket

$$\delta_d \ln \frac{p_d}{p_0} + \delta_u \ln \frac{p_u}{p_0}$$

is non-positive, and strictly negative if at least one tail both (i) gains mass ($\delta_i > 0$) and (ii) is strictly smaller than the center ($p_i < p_0$). Hence

$$\left. \frac{dH}{d\Delta} \right|_{\Delta_0} \geq 0,$$

with strict inequality in the latter case. □

Lemma for Proposition 4

The following lemma characterizes this sensitivity via the local curvature of Φ .

Lemma 6. *Let $f \in C^2(\mathbb{R})$ with bounded second derivative. For $v > 0$, define the expected value function*

$$g(v; m) \equiv \mathbb{E}[f(m + \sqrt{v} Z)], \quad Z \sim \mathcal{N}(0, 1).$$

Then g is differentiable with respect to v , and its derivative is proportional to the expected curvature of f :

$$\frac{\partial g}{\partial v}(v; m) = \frac{1}{2} \mathbb{E}[f''(m + \sqrt{v} Z)].$$

Proof. Let $p_v(x)$ denote the density of $\mathcal{N}(m, v)$. By the properties of the heat equation, the Gaussian density satisfies the identity $\frac{\partial p_v}{\partial v} = \frac{1}{2} \frac{\partial^2 p_v}{\partial x^2}$. Differentiating the expectation integral under the assumption of bounded f'' :

$$\frac{\partial g}{\partial v} = \int_{\mathbb{R}} f(x) \frac{\partial p_v(x)}{\partial v} dx = \frac{1}{2} \int_{\mathbb{R}} f(x) \frac{\partial^2 p_v(x)}{\partial x^2} dx.$$

Integrating by parts twice, and noting that boundary terms vanish because $p_v(x)$ decays faster than the polynomial growth of f and f' , we obtain:

$$\frac{\partial g}{\partial v} = \frac{1}{2} \int_{\mathbb{R}} f''(x) p_v(x) dx = \frac{1}{2} \mathbb{E}[f''(X)].$$

□

Proof of Proposition 4

Proof. Follows directly from Equation (9) and the definition of the inflection point (See the above Lemma). For the safe (risky) bonds, if X_l is concentrated in the domain where $\Phi'' < (>)0$, the expectation is negative (positive). □

Proof of Proposition 5

Proof. We proceed in three steps.

Step 1: Survival–probability sensitivity. Section 3.1.4 established that for $X_l \sim \mathcal{N}(m_l, s_l^2)$,

$$\frac{\partial \tilde{\phi}_l}{\partial s_l^2} = \frac{1}{2} E[\Phi''(X_l) | z_l]. \quad (17)$$

In the symmetric two–state precision structure, Proposition 2 implies that dispersion raises posterior variance while leaving the posterior mean fixed:

$$\frac{\partial s_l^2}{\partial \Delta_l} > 0, \quad \frac{\partial m_l}{\partial \Delta_l} = 0.$$

Thus

$$\text{sign}\left(\frac{\partial \tilde{\phi}_l}{\partial \Delta_l}\right) = \text{sign}\left(E[\Phi''(X_l) | z_l]\right).$$

Step 2: Closed–form equilibrium holdings under binary payoffs. From the payoff structure and (11), payoff variances for investor i are

$$\sigma_{i,l}^2 = \tilde{\phi}_l(\Delta_l)(1 - \tilde{\phi}_l(\Delta_l))(V_l^{i \rightarrow j} - \delta_l)^2.$$

Let $V_I \equiv V_l^{I \rightarrow MF}$, $V_M \equiv V_l^{MF \rightarrow I}$, and $\phi \equiv \tilde{\phi}_l(\Delta_l)$. The valuation gap is

$$\mu_I - \mu_M = \phi(V_I - V_M) \equiv \phi L, \quad L > 0.$$

Derivation of the closed–form insurer holdings. Recall from (14) that equilibrium insurer holdings can be written as

$$\theta_l^I = \Theta_l \frac{\sigma_{I,l}^{-2}}{\sigma_{I,l}^{-2} + \sigma_{MF,l}^{-2}} + \frac{\mu_{I,l} - \mu_{MF,l}}{\psi} \frac{\sigma_{I,l}^{-2} \sigma_{MF,l}^{-2}}{\sigma_{I,l}^{-2} + \sigma_{MF,l}^{-2}}, \quad (18)$$

where

$$\mu_{i,l} = E^i(V_l^{i \rightarrow j} | z_{1,l}, z_{2,l}), \quad \sigma_{i,l}^2 = \tilde{\phi}_l(\Delta_l)(1 - \tilde{\phi}_l(\Delta_l))(V_l^{i \rightarrow j} - \delta_l)^2.$$

For notational convenience, fix bond l and write

$$\phi \equiv \tilde{\phi}_l(\Delta_l), \quad V_I \equiv V_l^{I \rightarrow MF}, \quad V_M \equiv V_l^{MF \rightarrow I}, \quad \delta \equiv \delta_l.$$

Step 1: Valuation gap and variances. The expected payoffs are

$$\begin{aligned} \mu_I &= \phi V_I + (1 - \phi)\delta = \delta + \phi(V_I - \delta), \\ \mu_M &= \phi V_M + (1 - \phi)\delta = \delta + \phi(V_M - \delta), \end{aligned}$$

so their difference is

$$\mu_I - \mu_M = \phi(V_I - V_M) \equiv \phi L, \quad (19)$$

with $L \equiv V_I - V_M > 0$ by Assumption 2. From (11), the payoff variances are

$$\sigma_I^2 = \phi(1 - \phi)(V_I - \delta)^2, \quad \sigma_M^2 = \phi(1 - \phi)(V_M - \delta)^2.$$

Define the precisions

$$A \equiv \sigma_I^{-2} = \frac{1}{\phi(1-\phi)(V_I - \delta)^2}, \quad B \equiv \sigma_M^{-2} = \frac{1}{\phi(1-\phi)(V_M - \delta)^2}.$$

Step 2: Risk-sharing weight. The first term in (18) is

$$\Theta_l \frac{\sigma_{I,l}^{-2}}{\sigma_{I,l}^{-2} + \sigma_{M,l}^{-2}} = \Theta_l \frac{A}{A+B}.$$

Using the expressions for A and B , we can write

$$\frac{A}{A+B} = \frac{1/(V_I - \delta)^2}{1/(V_I - \delta)^2 + 1/(V_M - \delta)^2} \equiv \lambda_{I,l}.$$

Since $A+B$ is symmetric in A, B , using $\lambda_{I,l}$ or $1 - \lambda_{I,l}$ is purely a matter of which investor's precision we wish to attach to the label; we adopt

$$\lambda_{I,l} = \frac{1/(V_I - \delta)^2}{1/(V_I - \delta)^2 + 1/(V_M - \delta)^2}, \quad (20)$$

so the first term in (18) becomes

$$\Theta_l \lambda_{I,l}.$$

Step 3: Disagreement-driven component. The second term in (18) is

$$\frac{\mu_I - \mu_M}{\psi} \frac{AB}{A+B}.$$

First compute AB and $A+B$:

$$AB = \frac{1}{\phi(1-\phi)(V_I - \delta)^2} \cdot \frac{1}{\phi(1-\phi)(V_M - \delta)^2} = \frac{1}{\phi^2(1-\phi)^2(V_I - \delta)^2(V_M - \delta)^2},$$

$$A+B = \frac{1}{\phi(1-\phi)(V_I - \delta)^2} + \frac{1}{\phi(1-\phi)(V_M - \delta)^2} = \frac{(V_M - \delta)^2 + (V_I - \delta)^2}{\phi(1-\phi)(V_I - \delta)^2(V_M - \delta)^2}.$$

Therefore

$$\frac{AB}{A+B} = \frac{1}{\phi^2(1-\phi)^2(V_I - \delta)^2(V_M - \delta)^2} \cdot \frac{\phi(1-\phi)(V_I - \delta)^2(V_M - \delta)^2}{(V_I - \delta)^2 + (V_M - \delta)^2} = \frac{1}{\phi(1-\phi)k},$$

where

$$k \equiv (V_I - \delta)^2 + (V_M - \delta)^2.$$

Using (19), we obtain

$$\frac{\mu_I - \mu_M}{\psi} \frac{AB}{A+B} = \frac{\phi L}{\psi} \cdot \frac{1}{\phi(1-\phi)k} = \frac{L}{\psi k} \cdot \frac{1}{1-\phi}.$$

Defining

$$\alpha_l \equiv \frac{V_I - V_M}{\psi [(V_I - \delta)^2 + (V_M - \delta)^2]} = \frac{L}{\psi k} > 0, \quad (21)$$

the second term becomes

$$\alpha_l \frac{1}{1 - \phi}.$$

Step 4: Collecting terms. Putting Steps 2 and 3 together, (18) simplifies to

$$\theta_l^I(\Delta_l) = \Theta_l \lambda_{I,l} + \alpha_l \frac{1}{1 - \phi(\Delta_l)},$$

with $\lambda_{I,l}$ and α_l given by (20) and (21). This is equation (22) in the main text.

Thus, the equilibrium insurer holdings simplify to

$$\theta_l^I(\Delta_l) = \Theta_l \lambda_{I,l} + \alpha_l \frac{1}{1 - \phi(\Delta_l)}, \quad (22)$$

where

$$\lambda_{I,l} = \frac{1/(V_I - \delta_l)^2}{1/(V_I - \delta_l)^2 + 1/(V_M - \delta_l)^2}, \quad \alpha_l = \frac{V_I - V_M}{\psi[(V_I - \delta_l)^2 + (V_M - \delta_l)^2]} > 0.$$

The first term is constant in Δ_l ; the second captures how dispersion affects survival beliefs and thus risk-adjusted valuation. Differentiating (22) gives

$$\frac{\partial \theta_l^I}{\partial \Delta_l} = \alpha_l \frac{\phi'(\Delta_l)}{(1 - \phi(\Delta_l))^2}. \quad (23)$$

Since $\alpha_l > 0$ and $(1 - \phi(\Delta_l))^2 > 0$, the sign of $\partial \theta_l^I / \partial \Delta_l$ is the sign of $\phi'(\Delta_l)$.

Step 3: Curvature and investor responses. By (17),

$$\text{sign}(\phi'(\Delta_l)) = \text{sign}\left(E[\Phi''(X_l) \mid z_l]\right).$$

Safe bonds: If $m_l \gg x^*$ and X_l lies in the concave region where $\Phi''(x) < 0$, then $E[\Phi''(X_l) \mid z_l] < 0$, implying $\phi'(\Delta_l) < 0$. Substituting into (23) yields

$$\frac{\partial \theta_l^I}{\partial \Delta_l} < 0.$$

Mutual fund holdings satisfy $\theta_l^{MF} = \Theta_l - \theta_l^I$, so their comparative static has the opposite sign.

Risky bonds: If $m_l \ll x^*$ and X_l lies in the convex region where $\Phi''(x) > 0$, then $E[\Phi''(X_l) \mid z_l] > 0$, hence $\phi'(\Delta_l) > 0$. Thus

$$\frac{\partial \theta_l^I}{\partial \Delta_l} > 0.$$

Average-risk bonds: If m_l lies near x^* , the posterior is concentrated near the inflection point where $\Phi''(x) \approx 0$, so $\phi'(\Delta_l) \approx 0$ and therefore

$$\frac{\partial \theta_l^I}{\partial \Delta_l} \approx 0.$$

This completes the proof. □

Additional Tables

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.

<i>Panel A: Pairwise correlation</i>						
	(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

<i>Panel B: Lisewise correlation</i>						
	(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 (1,827)	1,597 (1,658)	1,573 (1,674)
Insurers' holdings	0.364 (0.340)	0.345 (0.311)	0.315 (0.272)
Credit rating	8 (8)	9 (9)	8 (7)
Survival probability	0.979 (0.993)	0.966 (0.990)	0.970 (0.995)
Single rating dummy	0.038 (0)	0.000 (0)	0.000 (0)
Offering amount (\$ Mil)	593 (450)	577 (400)	703 (500)
Time to maturity	10.019 (6.633)	9.898 (6.586)	10.479 (6.545)
Bond age	5.094 (3.619)	5.470 (4.011)	5.879 (4.329)
Duration	6.608 (5.483)	6.454 (5.327)	6.742 (5.356)
Upgrade	0.007 (0.000)	0.040 (0.000)	0.035 (0.000)
Downgrade	0.026 (0.000)	0.037 (0.000)	0.046 (0.000)
Yield spread	0.020 (0.015)	0.026 (0.019)	0.023 (0.014)
Bond return	0.001 (0.001)	0.001 (0.002)	0.002 (0.002)
Bid-ask spread	0.006 (0.004)	0.006 (0.004)	0.006 (0.004)
Bond volatility	0.026 (0.021)	0.029 (0.023)	0.029 (0.022)
ln(Trading volume)	4.471 (4.681)	4.537 (4.781)	4.488 (4.704)
ln(Number of trades)	2.488 (2.639)	2.512 (2.639)	2.423 (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 (1,827)	1,646 (1,719)	1,524 (1,463)
Insurers' holdings	0.364 (0.340)	0.373 (0.347)	0.287 (0.224)
Credit rating	8 (8)	6 (6)	11 (10)
Survival probability	0.980 (0.993)	0.995 (0.996)	0.944 (0.976)
Single rating dummy	0.038 (0)	0.000 (0)	0.000 (0)
Offering amount (\$ Mil)	593 (450)	738 (500)	539 (400)
Time to maturity	10.019 (6.633)	11.558 (7.378)	8.802 (6.126)
Bond age	5.094 (3.619)	5.892 (4.384)	5.447 (3.956)
Duration	6.608 (5.483)	7.513 (6.172)	5.674 (4.872)
Upgrade	0.007 (0.000)	0.024 (0.000)	0.052 (0.000)
Downgrade	0.026 (0.000)	0.029 (0.000)	0.054 (0.000)
Yield spread	0.020 (0.015)	0.014 (0.012)	0.034 (0.026)
Bond return	0.001 (0.001)	0.000 (0.001)	0.003 (0.003)
Bid-ask spread	0.006 (0.004)	0.005 (0.003)	0.007 (0.005)
Bond volatility	0.026 (0.021)	0.023 (0.020)	0.035 (0.026)
ln(Trading volume)	4.471 (4.681)	4.175 (4.441)	4.852 (5.082)
ln(Number of trades)	2.488 (2.639)	2.368 (2.565)	2.569 (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.

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

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

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

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

<i>Dependent Variable:</i> <i>Insurers' Holdings</i>	Rating-based		Probability-based	
	(1)	(2)	(3)	(4)
Rating dispersion	-0.097*** (0.019)	-0.027*** (0.009)	-3.171*** (0.587)	-1.343*** (0.318)
Dispersion × NAIC_group	0.032*** (0.009)	0.015*** (0.004)	0.794*** (0.141)	0.352*** (0.076)
Yield spread	-0.305 (0.488)	0.018 (0.180)	-0.460 (0.486)	-0.039 (0.176)
Yield spread × NAIC_group	0.051 (0.119)	0.021 (0.042)	0.088 (0.125)	0.034 (0.042)
Yield spread × Dispersion	-0.339 (0.333)	-0.202* (0.121)	-1.371 (1.797)	-1.024 (1.048)
Single rating dummy	-0.030** (0.013)	-0.010 (0.009)	-0.025* (0.013)	-0.011 (0.008)
Duration	0.006*** (0.001)	0.021*** (0.001)	0.006*** (0.001)	0.021*** (0.001)
Bond return	0.037 (0.048)	-0.055* (0.028)	0.036 (0.049)	-0.054* (0.028)
Bid-ask spread	-1.294*** (0.259)	-0.038 (0.067)	-1.304*** (0.260)	-0.037 (0.067)
ln(Trading volume)	-0.041*** (0.002)	-0.006*** (0.001)	-0.041*** (0.002)	-0.006*** (0.001)
ln(Number of trades)	-0.034*** (0.003)	-0.006*** (0.002)	-0.034*** (0.003)	-0.006*** (0.002)
Bond volatility	0.355*** (0.111)	0.100* (0.054)	0.384*** (0.112)	0.109** (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.9: **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.

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

<i>Panel B: Probability-based Dispersion</i>								
	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 \times 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	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.

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

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

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

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

<i>Dependent Variable:</i> <i>Insurers' Holdings</i>	Rating-based		Probability-based	
	(1)	(2)	(3)	(4)
Rating dispersion	-0.090*** (0.019)	-0.026*** (0.009)	-3.062*** (0.574)	-1.367*** (0.315)
Dispersion \times NAIC_group	0.023*** (0.007)	0.012*** (0.004)	0.732*** (0.130)	0.337*** (0.072)
S&P downgrade	-0.016** (0.007)	0.002 (0.003)	-0.019** (0.008)	0.002 (0.003)
S&P downgrade \times NAIC_group	0.012*** (0.002)	0.002 (0.001)	0.013*** (0.002)	0.002* (0.001)
Moody's downgrade	-0.038*** (0.011)	-0.008*** (0.003)	-0.041*** (0.011)	-0.008*** (0.003)
Moody's downgrade \times NAIC_group	0.021*** (0.003)	0.006*** (0.001)	0.022*** (0.003)	0.006*** (0.001)
Fitch downgrade	-0.022*** (0.008)	-0.000 (0.004)	-0.021** (0.008)	0.001 (0.004)
Fitch downgrade \times NAIC_group	0.012*** (0.003)	0.003* (0.002)	0.011*** (0.003)	0.002 (0.002)
S&P upgrade	0.025** (0.010)	0.006 (0.005)	0.025** (0.010)	0.007 (0.005)
S&P upgrade \times NAIC_group	-0.010*** (0.003)	-0.003 (0.002)	-0.010*** (0.003)	-0.003 (0.002)
Moody's upgrade	-0.001 (0.013)	0.003 (0.004)	-0.003 (0.013)	0.004 (0.004)
Moody's upgrade \times NAIC_group	-0.005 (0.004)	-0.003* (0.001)	-0.005 (0.004)	-0.003** (0.002)
Fitch upgrade	0.000 (0.010)	-0.003 (0.004)	-0.002 (0.010)	-0.003 (0.004)
Fitch upgrade \times NAIC_group	-0.008** (0.004)	-0.001 (0.002)	-0.007* (0.004)	-0.001 (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%