Internal Models, Make Believe Prices, and Bond Market Cornering*

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Abstract

We show that U.S. life insurers used internal models to over-report the value of a large fraction of corporate bonds during the financial crisis. Reported credit spreads of bonds valued using internal models were substantially lower by 220 bps, as compared to bonds that are otherwise similar but valued using external sources. Misreporting is higher for bonds that are likely to be impaired and negatively affect regulatory ratios, for insurers that have low regulatory capital, and for bonds that are held by few insurers. Using novel data on U.S. state regulators, we document that misreporting is negatively correlated with the degree of supervision at the state level, but only within bonds held by multiple insurers. In contrast, supervision has limited impact on misreporting when a bond has a single owner, as the lack of reference prices increases the search cost for regulators. Consistent with these incentives, we show that insurers "corner the market" by holding a large fraction of a bond's issue, as this allows them to bypass regulatory scrutiny and limit trading, factors that enable misreporting with internal models. Our findings have implications for the micro-structure of a segment of the corporate bond market and for properly assessing the fragility of financial institutions in bad times.

Keywords: Internal Models, Corporate Bonds, Capital Regulation, Bond Market Cornering, Life Insurers.

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1. Introduction

A wide class of financial assets, including corporate bonds, over-the-counter derivatives, and private equity, trade infrequently and have opaque prices. A common feature of such assets is that they inherently embed an *option* that provides holders discretion over reported values. When traded prices are unavailable, institutions have the flexibility to mark their asset positions using internal "models". This provides an option to report inflated asset values, which could be valuable when prices decline, balance sheets get constrained, and the marginal value of an extra unit of capital is high. Despite the large literature on agency frictions, it is not immediately obvious to what extent institutions can overcome costly internal and external scrutiny and exploit reporting discretion.[1] One way to maximize the option value of discretion is to tilt asset selection toward opaque assets, which are hard to value and thus minimize costs of scrutiny. At the same time, institutions can also "corner markets" and transform public assets into private assets, that have opaque prices, by acquiring large positions and not trading.[2]

We study these incentives for U.S. life insurers and their corporate bond investments. A vast majority of corporate bonds have just a handful of owners. Life insurers are also one of the largest holders of opaque securities, e.g. privately placed debt.[3] We examine to what extent the option to use reporting discretion matters for this behavior. We first tackle this question in an ex-post sense, i.e. conditional on selection of assets, to what extent and in which bonds is the option to use reporting discretion valuable? Second, we evaluate to what extent this shifts ex-ante behavior and distorts portfolio selection. We uncover strong evidence that U.S. life insurers used internal models to over-report the value of a large fraction of bonds during the financial crisis. Furthermore, we find shifts in ex-ante behavior. Insurers hold a large fraction of a bond's issue to bypass scrutiny and limit secondary market trading, factors that facilitate misreporting with internal models.

In general, it is difficult to empirically verify whether financial institutions indeed misreport the value of assets that trade less frequently because it is hard to find reliable pricing benchmarks. For example, assets that otherwise have comparable features also trade less frequently, by definition, and do not have observable prices. In addition, to observe any

[1] See, Jensen and Meckling (1976). Various stakeholders, both within the firm (corporate governance) and outside the firm (auditors, regulators) help to rein in these frictions (see, e.g. Shleifer and Vishny (1986) and Edmans, Gabaix, and Landier (2008)).

[2] Typically, the term "market cornering" is associated with investors misusing market power and acquiring large positions to manipulate markets and generate trading profits (Allen, Litov, and Mei (2006)).

[3] Over 60% of the bonds are held by up to 3 insurers and 65% of newly issued private debt each year is sold to life insurers.

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misreporting, we need the option to use reporting discretion to be in-the-money (net of any costs of scrutiny), at least at certain times, for certain institutions, or for certain assets. Finally, we require exogenous shifts in the ability to use reporting discretion to evaluate its impact on portfolio selection.

To study the ex-post behavior and the extent of misreporting, we exploit a unique regulatory set-up that provides heterogeneity in the incentives to use reporting discretion for the *same* bond at the *same* point in time but *across* insurers, depending on the cost at which insurers purchased a bond.[4] U.S. life insurers hold corporate bonds at book value (historical cost) for regulatory reporting. Assets are marked down when a bond is deemed "permanently impaired", which is likely to occur when fair value starts to fall below book value due to perceived permanent changes in credit risk of a bond.[5] A permanent impairment therefore implies a decline in the total value of assets and therefore the amount of regulatory capital. Thus, the incentive to report a higher fair value depends on the book value, which in turn depends on the cost at which the bond was originally purchased. Insurers that acquired the bond at a higher cost (higher book value), would like to report a price above this high threshold in order to avoid permanent impairment. In contrast, insurers who acquired the same bond when the market value of the bond was lower, have the incentive to report a lower price or a price that is likely to be closer to the true value. This incentive structure allows us to examine whether the reported prices of the *same* bond held by different insurers line up according to the variation in the bond's acquisition cost.

Our setting also allows us to make progress for a number of additional reasons. First, corporate bonds account for over 50% of insurers' assets. Thus, negative shocks to these assets matter in a large way. Second, we observe the *reported* fair values for all bond positions held by insurance companies. Corporate bonds trade in over-the-counter markets and often a continuously observable price does not exist because many bonds trade infrequently.[6] This implies that often corporate bonds are valued using models developed by the insurance companies holding these bonds. We observe not just the reported fair values, but also whether they are computed using internal models. This allows us to compare the evolution of prices of bonds valued using internal models and bonds valued using non-internal sources (e.g. bro-

[4]Regulation is not the only reason to misreport. Institutions may also over-report values for other reasons, e.g. GAAP reporting, performance driven compensation, or to avoid headline risk.

[5]See National Association of Insurance Commissioners' (NAIC) Statements of Statutory Accounting Principles (SSAP) number 26 and the discussion in Section 2.

[6]Corporate bonds have a wide spectrum of price discovery and liquidity, ranging from very liquid corporate bonds issued by large and publicly listed firms to very illiquid bonds, including privately placed debt issued by private corporations. See, for example, Collin-Dufresne, Goldstein, and Martin (2001) and Dick-Nielsen, Feldhutter, and Lando (2012) among others.

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kers) without relying on the unobserved true prices. Third, we observe the valuations during the financial crisis when balance sheets were constrained and the incentive to use reporting discretion was high. Moreover, we observe the actual extent of regulatory constraints at the firm level, which provides further cross-sectional variation in the incentives to use reporting discretion. Finally, we exploit the heterogeneity in regulatory strictness across state regulators in the U.S. to understand whether the extent of misreporting lines up with the costs of regulatory scrutiny.

Consistent with these ideas, using holdings data from 2004 to 2016, we first document significant dispersion in reported prices (and implied credit spreads) for the same bond and at the same point in time *across* insurers. Moreover, we show that this is not a general phenomena; it is concentrated in bonds that are valued using internal models and it increases sharply during the financial crisis when insurance balance sheets were constrained and the incentive to use reporting discretion was higher.[7]

Second, we show that the dispersion in reported prices, particularly during the crisis, is due to an increase in reporting discretion. Reported prices are higher (and credit spreads are lower) for bonds valued using internal models in 2008, as compared to bonds that are otherwise similar but for which external quotes are available. The economic magnitude of the difference is large and equals about 220 bps for the average bond, and increases substantially for high yield bonds, bonds with fewer owners, private placements, and issuers with only one bond. We show these findings are not driven by model uncertainty (Hansen and Sargent (2008)), disagreement about fundamentals (Lintner (1969)), or insurers simply reporting stale prices and extrapolating from past prices in the absence of traded prices.

Third, we compare the reported credit spreads of the *same* bond, but across insurers. Consistent with the regulatory incentives described above, we find a positive and statistically significant relationship between credit spread at acquisition and the credit spread reported by insurers. Thus, when insurers acquire a bond at a higher price, they are more likely to over-report prices, which helps to reduce the likelihood of permanent impairment. However, this is not true for all bonds. It *only* holds for bonds that are valued using internal models, but not for bonds valued using external sources where there is no reporting discretion. Moreover, placebo tests show that the positive relationship between between credit spread at acquisition and the credit spread reported by insurers only exists during the financial crisis and not in other years. Fourth, these effects are concentrated among insurers that

[7]These findings are consistent with alternative accounts of the health of the insurance sector during the financial crisis. See, for example, McDonald and Paulson (2014), Koijen and Yogo (2015), which in extreme cases resulted in bail outs under TARP.

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are relatively more constrained by regulatory capital, as measured by the ratio of available capital to required capital.

Our findings on misreporting imply that the option to use internal models may create incentives for insurers to hold concentrated bond positions and therefore distort portfolio selection ex-ante.[8] The ability to bypass regulatory scrutiny and the absence of transaction prices to justify the use of internal models, are two conditions that are necessary to misreport asset values. Insurers can enable both these conditions by being a dominant holder of a bond's total issuance. By exercising market power and cornering the market, insurers can reduce the number of available reference prices, which increases the search costs for regulators and makes it harder for them to verify the true value of a bond. In addition, holding concentrated position in a bond, decreases the overall number of market participants and the likelihood of trading and availability of reference prices.

We document a number of facts consistent with these ideas. First, using the fragmented regulatory structure in the U.S., where insurers are regulated at the state level, and novel data on the resources available with state regulators, we show that misreporting is negatively correlated with the degree of supervision in a state. The higher the extent of supervision, the lower is the extent of misreporting. We proxy for the extent of supervision in a number of ways, including the total number of financial analysts and examiners in a state, number of discretionary exams conducted, and the total budget per insurer. Crucially, the negative relationship exists only for bonds that have multiple owners, which means that state regulators have multiple reference prices within their jurisdiction. The relationship breaks down for bonds that have a single owner, as the lack of reference prices increases the search cost for state regulators, implying that insurers have a greater ability to bypass regulatory scrutiny when they hold positions with fewer owners.

Second, we show that misreporting is higher in bonds that are held by fewer number of insurers. Within bonds that are valued by internal models, those that have more concentrated holding structure have an even lower increase in reported credit spreads during the crisis, as compared to internal model bonds with a less concentrated holding structure. Third, we find that bonds that have a more concentrated holding structure, defined as bonds held by up to two insurers, trade less than bonds that have a less concentrated holding structure, consistent with the idea that insurers may have a greater control over the amount of trading and availability of reference prices, if it holds a substantial share of the bond's total issue.

[8]Indeed in the data, insurance bond holdings are highly concentrated. 60% of the bonds are held by up to three insurers and such bonds have a significantly lower propensity to trade in the secondary market.

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After demonstrating how cornering facilitates misreporting with internal models, we evaluate to what extent the option to use reporting discretion distorts ex-ante portfolio selection. To test this, we exploit a regulatory shift that made it easier for insurance companies to use internal models and therefore provided greater discretion over reported values. To proxy for cornering, we quantify the dominant share in each bond, i.e. the share of the total outstanding held by the largest holder of that bond.

We find that dominant share increased significantly for both existing positions and for new purchases after the regulatory shift for bonds with *small* issuance amounts. In the cross-section of insurers, the increase in dominant share is concentrated within insurers that use internal models and not within insurers that do not use internal models. Moreover, even within insurers that use internal models, these effects are larger for low RBC insurers, for whom the option to misreport is more valuable. Taken together, these results imply that the option to use reporting discretion likely distorts the ex-ante portfolio selection within small bonds. Intuitively, holding a large share in a bond, on one hand, allows more reporting discretion, but on the other hand, may have detrimental impact on portfolio diversification and capital requirements that are due to concentration limits. Holding a large share in bonds with *smaller* issuance size helps alleviate this trade-off problem. Our findings therefore have implications for the micro-structure of a segment of the corporate bond market.

Related Literature: Our paper contributes to broad strands of the literature on agency problems in financial institutions, heterogeneity in regulatory oversight, and micro-structure of corporate bond markets. First, our findings on reporting discretion relate to the literature on avoiding loss recognition and the misuse of models in regulatory reporting by financial institutions. Milbradt (2012) develops a theory of why constrained banks may have the incentives to suspend trading in opaque over-the-counter securities in order to avoid marking-to-market losses. Ellul, Jotikasthira, Lundblad, and Wang (2015) show that insurers facing historical cost accounting are more likely to participate in gains trading and not sell assets that have large unrecognized losses. Behn, Haselmann, and Vig (2014) show that model-based capital regulation allow banks to under-report probabilities of default and risk-weights. We add to this theme by establishing a direct channel of avoiding loss recognition and regulatory misreporting in the context of corporate bond investments of life insurers during the financial crisis.[9] Our findings point to the need to design systems that are able to better assess the fragility of financial institutions in bad times.

[9]Anecdotal evidence points towards the pervasiveness of this issue beyond insurers. See for example, "Private equity's mark-to-make-believe problem" by Matthew Klein, "The Big Short: Inside the Doomsday Machine" by Michael Lewis, and "The Greatest Trade Ever: The Behind-the-scenes Story of How John Paulson Defied Wall Street and Made Financial History" by Gregory Zuckerman.

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Second, our paper relates to the upcoming literature that documents heterogeneity in regulatory oversight across different regulators and its implications for regulated entities. Agarwal, Lucca, Seru, and Trebbi (2014) show that federal regulators are systematically tougher than state regulators and document considerable heterogeneity in the strictness of bank regulators across states. Kisin and Manela (2019) show that banks that pay higher fees face more lenient regulation. In the same vein, we document heterogeneity in oversight across state regulators and show how the lack of oversight manifests itself in the actions of insurance companies.

Our paper also helps to understand concentration in ownership patterns in the corporate bond market. Prominent explanations for concentrated holding structure go back to Bolton and Scharfstein (1996), who show that lower number of creditors increase coordination and bargaining power during renegotiation. Similarly, Bris and Welch (2005) show that dispersed creditors face more difficulty and higher cost when collecting claims than concentrated creditors. We provide an alternative account of why insurance companies might have a preference for concentrated holdings. As our results show, financial assets can have additional characteristics that are of interest to financial institutions beyond the standard risk-return characteristics. Thus, our findings also help to better understand the objective function and preferences of financial institutions, which are the key building blocks for the literature on intermediary asset pricing (He and Krishnamurthy (2013)) and characteristics based asset pricing (Koijen and Yogo (2018)).

The paper is organized as follows. Section 2 provides the institutional set-up. Section 3 describes the data sources and provides an overview of the regulatory structure of the U.S. insurance sector. Section 4 presents the main empirical findings on the use of internal models to misreport assets. Section 5 documents linkages between misreporting, regulatory scrutiny, and a bond's holding structure and documents our findings on bond market cornering. Section 6 concludes.

2. Institutional Details

A large portion of U.S. life insurers' assets are invested in corporate bonds, for example, about 46% of total assets in 2013.[10] Moreover, as credit risk (unlike interest rate risk) is largely mismatch risk because of lack of matched exposures on the liability side, shocks to credit risk are an important source of variation of capital for insurance companies. The ability

[10]See, McMenamin, Paulson, Plestis, and Rosen (2013).

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to use internal models allows insurance companies discretion over reported values. This could be valuable for a number of reasons, including smoothing fluctuations in regulatory or GAAP reporting, relaxing balance sheet constraints, avoiding headline risk, or smoothing performance driven compensation, features that are particularly valuable in bad times when the marginal value of an extra unit of capital is high.

We focus on the incentives arising from the regulatory framework for two reasons. First, prior literature has shown that U.S. life insurers operate subject to statutory regulation.[11] Moreover, the regulatory framework provides heterogeneity in the incentives to use reporting discretion for the same bond, at the same point in time, but across insurers, allowing us to pin-down the use of discretion cleanly. The regulatory framework also shifts over time, impacting the ability of insurers to use internal models. We describe the key features of the regulatory setting below.

The statutory (regulatory) reporting for corporate bond assets is largely at book value (historical cost), unless a bond is deemed permanently impaired in which case insurers have to recognize "other-than-temporary-impairment" (OTTI) and mark down the value of the bond to its market value.[12] Permanent impairment is likely to occur when a bond's fair value starts to fall below book value due to perceived permanent changes in credit risk of the bond (NAIC SSAP No. 26).[13] Thus, in general mark-to-market changes in the credit risk of a bond do not impact the regulatory value of total assets. However, when a bond is permanently impaired due to changes in credit risk, insurers are forced to recognize losses, which negatively affect the total value of regulatory assets.

A key metric for state regulators to determine capital adequacy and for rating agencies to determine credit ratings is the risk based capital ratio (RBC) of insurance companies, which is defined as the ratio of total available regulatory capital (assets minus liabilities) to total required capital:

$$\text{RBC Ratio} = \frac{\text{Assets - Liabilities}}{\text{Required Capital}}$$

[11] See Koijen and Yogo (2015-2019), Sen and Humphry (2016), and Ge (2017) for liability side, Becker and Ivashina (2014) and Ellul et. al. (2015-2016) for asset allocation, and Sen (2018) for risk management decisions.

[12] See NAIC Valuation Manual (2016) and Ellul, Jotikasthira, Lundblad, and Wang (2015) for a description of the statutory accounting framework for U.S. life insurance companies.

[13] NAIC Statements of Statutory Accounting Principles (SSAP) number 26 states that "An OTTI shall be considered to have occurred if it is probable that the reporting entity will be unable to collect all amounts due according to the contractual terms of a debt security in effect at the date of acquisition. A decline in fair value that is an OTTI *includes* situations when a reporting entity has made a decision to sell a security prior to its maturity at an amount below its carrying value."

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The National Association of Insurance Commissioners (NAIC) prescribes that insurers compute required capital at the bond level by multiplying the appropriate risk weights with the book value of a bond, where risk weights depend on the bond's credit rating. Corporate bonds are sorted into "NAIC risk categories" from 1 to 6 based on a bond's credit rating and each category is then assigned a risk weight. Category 1 (6) are the safest (riskiest) bonds and attract the lowest (highest) risk weights.[14]

Thus, permanent impairment introduces variability in RBC ratios because, first, there is a negative impact on regulatory capital (numerator of the ratio) as bond assets are marked down. Second, if accompanied with a rating downgrade, there is a simultaneous increase in required capital (denominator of the ratio). Both forces become stronger during a downturn, such as the 2008 financial crisis.

This gives *some* insures the incentive to use discretion and report higher fair values for certain bond positions and in certain times. The incentive to report a higher fair value depends on the book value at which a bond is being held, which in turn depends on the cost at which the bond was originally purchased.[15] Thus, we can use the variation in the initial cost of purchase, which determines the current book value of a bond, across insurers to get useful heterogeneity in the incentive to use reporting discretion for the same bond and at the same time, but across different insurers.

To keep track of potential cases of permanent impairment, regulators require insurance companies to report the fair value of each position, along with the book value. The reporting guidelines, suggest that wherever possible, insurers first report traded prices or prices taken from external sources, which include quotes from broker-dealers and pricing services (e.g. IDC, Reuters, Bloomberg). In the event that it is not possible to obtain prices from external sources, insurers are allowed to compute the fair value of securities "analytically" using "internal models".[16] As a large fraction of corporate bonds trade infrequently and in over-the-counter markets, often prices are not observed continuously. Thus, the fair values for a large fraction of bonds are obtained using models developed by insurers holding the bonds.

Prior to 2008, NAIC's Securities Valuation Office (SVO) acted as an aggregator of bond valuations, which the SVO sourced from public transactions, brokers-dealers, pricing services, and from insurers' analytical models. Along with providing bond valuations, the SVO also

[14] See NAIC Risk Based Capital Guidelines (2013).

[15] For further details see, NAIC's Report on U.S. Insurer Invested Asset Other-Than-Temporary Impairments as of Year-End 2015.

[16] NAIC SSAP no. 26 states that "Whenever possible, fair value should represent the price at which the security could be sold, based on market information. Fair value should only be determined analytically when the market-based value cannot be obtained."

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assigned credit ratings to bonds. In 2008, a NAIC task force amended the rules and allowed insurers to obtain valuations directly from public transactions, third-party sources, and internal models, bypassing the need to go to the SVO. While, SVO could still be used to source bond valuations, going to the SVO was no longer mandatory. Thus, the role of SVO, as a provider of bond valuations, declined and insurers' discretion over reported values increased after 2008.

The responsibility to determine the veracity of regulatory reporting also lies with state regulators, who employ a large number of financial examiners and analysts. Financial examinations investigate a company's accounting methods, verify and validate what is presented in the annual statements, and whether the company has complied with state regulations. For this purpose, financial examiners and analysts are trained in the use of specialized computer audit software.[17] However, monitoring is highly resource intensive due to the sheer number of bonds held by insurers, decentralized reporting at the state level, and the lack of active trading and price benchmarks in the corporate bond market. Crucially, as we will also discuss in depth in the next section, a key implication of the regulatory incentive structure is for insurers to exercise market power and hold a large share of the bond's issue, which further impedes price verification for some bonds. We exploit heterogeneity in regulatory strictness across states to understand to what extent the extent of misreporting lines up with strictness and whether insurers are able to bypass regulatory scrutiny for certain positions.

3. Data

3.1. Bond Holdings Data

Insurance companies report fixed income and equity holdings at the position level at an annual frequency to state regulators, which we collect from the NAIC's Schedule D database. We restrict attention to corporate bonds positions. For each position, we observe the bond's CUSIP, the par value held, the NAIC credit rating categories, coupon paid, callable or not, asset backed or not, the purchase and maturity dates, price paid at acquisition, the book value at the time of acquisition, and the book value at which the bond is being held currently. NAIC rating categories are grouped as NAIC 1 to NAIC 6, where NAIC 1 are AAA, AA, and A, NAIC 2 are BBB, NAIC 3 are BB, NAIC 4 are B, NAIC 5 are CCC and NAIC 6 are CC or below rated bonds.[18] The sample spans from 2004 to 2016.

Although bonds are held at book value, insurers also have to report the "market value"

[17] See, Insurance Department Resources Report.
[18] See, NAIC Risk Based Capital Guidelines (2013)

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of each position to the state regulators. The unique aspect of the data is that we observe an insurer's own valuation of a bond, in cases where traded prices or quotes from external pricing services are apparently unavailable. Moreover, we also observe how insurance companies obtained the fair value of each position. Figure 1 reports a breakdown of total number of bonds and total par value by the valuation method. 45% of the corporate bond positions as a share of total par value and 38% as a share of total number of bonds are valued using internal models. The remaining positions are valued using inputs from external sources, which include NAIC's security valuation office, pricing services, and broker-dealers.[19] Henceforth, we refer to prices sourced from all external sources as "non-internal models".

As permanent impairment occurs due to a decline in the *credit risk* of a bond and not due to changes in interest rates, we compute the implied credit spreads for each position from reported prices. We proceed as follows. First, we compute the reported price by dividing the total reported market value of the position by the total par value of the position and then multiplying the ratio by 100, so that the computed prices correspond to a par value of $100. Second, using the computed price, bond's remaining maturity, coupon rate, and assuming a semi-annual payment schedule, we compute the implied yield-to-maturity (YTM) of the corporate bond position. In doing so, we exclude positions where par value, market value, maturity date, or coupon rate are not populated. Finally, to compute the credit spread, we subtract from the implied YTM of the corporate bond, the YTM of a comparable maturity treasury, where the YTM of treasuries are from Datastream.[20]

To understand the differences between bonds valued using internal models and bonds valued using external sources, we compare the key bond characteristics in Table 1. Our sample contains a total of 19,259 bonds from 9,615 issuers in 2008, approximately 40% of which are bonds valued by internal models. These bonds are similar in many dimensions. For example, the average (and median) rating for both internal model valued and non-internal model valued bonds is 2, which corresponds to a rating of BBB. The average remaining maturity is around 6 years for both types of bonds. Consistent with this, we find that both types of bonds have similar reported price and credit spreads during the non-crisis period and the acquisition costs are also roughly similar.

The holdings data are reported at the state subsidiary level which is the unit of operation

[19]The main pricing services used are IDC, Reuters, and Bloomberg.

[20]We match the maturity of bond with the maturity of treasury to the closest month. Datastream provides the treasury YTM for the following maturities: 1 month, 3 months, 6 months, 1 year, 2 years, 3 years, 5 years, 7 years, 10 years, 20 years, and 30 years. We linearly interpolate for remaining maturities starting from 1 month to 360 months (30 years).

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for U.S. life insurers.[21] We first aggregate the bond positions at the insurance group level by using NAIC operating company code to group code mappings. Our final sample comprises of holdings data of 350 insurance groups in the U.S.. We next study the differences in ownership patterns across the two types of bonds. To do so, we aggregate the data at the bond level and compute the cross-sectional (across insurance group) average of dollar holding amount and the duration for which each bond is held by insurers. We find that the average dollar holding amount for internal model valued bonds is higher at $12 million as compared to the average dollar holding amount for non-internal model valued bonds, which is at $7 million. Also, the average duration for which a bond is held is higher for internal model valued bonds (4.3 years) than non-internal model valued bonds (3.0 years). We return to these differences in the ownership patterns in the next section, where we describe the main empirical results.

3.2. U.S. State Regulatory Data

U.S. insurers are subject to regulation and supervision in their state of domicile and do not have a centralized federal regulator. We collect novel data on state regulators from the NAIC's annual "Insurance Department Resources Report". The reports are available from 2005 and contain information on the activities and resources of state insurance departments. Each report is organized in five sections: (i) staffing; (ii) budget and funding; (iii) examination and oversight; (iv) insurance producers; and (v) consumer services and anti-fraud. The statistics provided for each jurisdiction include the number of departmental staff, annual budgets, revenues collected, premium volume, number of insurers, and the number of consumer complaints filed.

Each state regulator conducts a number of "financial exams" to verify insurers' accounting methods, modeling procedures, and financial statement presentations. The focus of these exams is to ascertain whether insurers have complied with reporting guidelines and state regulations and any reporting discrepancies result in disciplinary "actions" such as delinquency orders, suspensions, and revocation of licenses. The financial exams are of two type: regular and discretionary. Regular exams are conducted at a predefined schedule and the frequency is governed by underlying state regulations. However, discretionary exams are conducted on an ad hoc basis depending on whether state regulators feel a need to conduct additional financial exams.

Table 2 documents summary statistics of these regulatory characteristics. For each char-

[21] For example, an insurer's subsidiary in Connecticut reports holdings separately from the same insurer's subsidiary in California.

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acteristic, we compute a time-series average from 2005 to 2008 as we want an ex-ante measure of supervision to examine its relationship with misreporting. We present summary statistics of the time-series averages for the 43 U.S. states in our sample. There is substantial heterogeneity in the total number of financial analyst and examiners (hereafter examiners) and the total budget available with a state regulator to supervise the insurers domiciled in its state. On average, we have about 0.27 financial examiners allocated to a insurer. There is considerable variation across states in staffing, with some states employing only 0.07 financial examiners to supervise insurers. On the other hand, other states employ as many as 0.56 financial examiners per insurer (90th percentile). We see similar heterogeneity in total budget per insurer. While the average state regulator has about $0.2 million per insurer, the standard deviation is about equal in magnitude. As the regular exams are governed by regulatory requirements, we find considerably less variation in the frequency across states (standard deviation is around 33% of the mean). On the other hand, the frequency of discretionary exams varies considerably across states (standard deviation is around 150% of the mean), suggesting heterogeneity in the degree of supervision across states.

4. Internal Models and Reporting Incentives

4.1. The Impact of Internal Models on Reporting

We start by documenting stylized facts on the valuation patterns of corporate bonds across insurers. For each bond at every valuation date, we compute the cross-sectional (across insurers) standard deviation and range of implied credit spreads and reported prices. Figure 2 shows a time series plot from 2004 to 2016 for the dispersion in credit spreads and Figure A.1 shows the same for prices. Two key facts stand out. There is significant dispersion in reported prices and implied credit spreads for the same bond at the same point in time across insurers.[22] Moreover, this phenomenon is largely concentrated within bonds that are valued using internal models. Second, the dispersion increases substantially during the financial crisis. For example, the average cross-sectional standard deviation for bonds valued using internal models during the crisis is $5 for a par value of $100 and the average difference between the highest and the lowest reported price is $11. Credit spreads show similar trends. The average cross-sectional standard deviation of spreads is 160 bps and the average range is 330 bps during the crisis for internal model bonds.

[22]In line with this, Cici, Gibson, and Merrick (2011) show dispersion in month-end valuations of identical corporate bonds held by different mutual funds. They show cross-fund pricing dispersion is higher for lower credit quality bonds, longer maturity bonds, and smaller-size issues. Price dispersion for individual bonds also increases during periods when bond market return volatility is high.

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We interpret the dispersion in reported prices as evidence supporting a systematic increase in the use of reporting discretion during the financial crisis. However, the dispersion in internal valuations can also result from disagreement about fundamentals (Lintner (1969)) and model uncertainty (Hansen and Sargent (2008)), both of which can be more pronounced in a crisis. In addition, it can be driven by model error. Our empirical set-up allows us to address these alternative explanations in a number of ways.

We first show the evolution of reported fair values and implied credit spreads over time. Bonds valued by internal models not just have a higher reported dispersion in credit spreads, but also have a lower increase in credit spreads during the crisis. Figure 3 illustrates this. In general, the average reported credit spreads of bonds valued using internal models and non-internal models are similar throughout time. However, during the crisis, when bond prices crashed, we see a sharp difference in reported credit spreads for the two types of bonds. While bonds valued using non-internal models exhibit a sharp increase in credit spreads, bonds valued using internal models have a significantly lower increase in credit spreads. We witness the same trend in fair values Figure A.2. Before the crisis, both types of bonds are valued slightly above par at around \$104 and after the crisis at around \$110.[23] There is a sharp decline in prices of bonds valued using non-internal models and a lower decline for bonds valued using internal models. The difference between average fair values and spreads is as high as \$8 and 220 bps respectively during the crisis.

We next examine the reported credit spreads of bonds valued by internal models and non-internal model by various NAIC rating categories. Figure 4 plots the average credit spreads during the financial crisis. The credit spreads are consistently lower for internal model valued bonds for NAIC rating categories 2 to 6, but not for NAIC category 1 (AAA, AA, A) for which the reported spreads are slightly higher for internal model bonds. Moreover, the difference between the reported credit spreads of internal model and non-internal model valued bonds is much higher for non-investment grade bonds, which could be due to a higher likelihood of permanent impairment in low rated bonds.

To illustrate more formally that the differential change in implied credit spreads of internal model and non-internal model bonds during the crisis is not due to differences in bond characteristics, we estimate the following regression specification:

$$\overline{CS}_{it} = \gamma(IM_i \times Crisis_t) + \beta X_{it} + \alpha_i + \alpha_t + \epsilon_{it}, \tag{1}$$

where $\overline{CS}_{it}$ is the average of the reported credit spreads for bond i at time t across all

[23] This rise is largely explained by the decrease in interest rates during this time.

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insurers, IM_i is a dummy variable for bond i that takes a value of 1 if it is valued by internal models by at least one insurer in 2008, $Crisis_t$ is a dummy variable that takes a value of 1 if the year is 2008, X_{it} are bond level controls, and α_i and α_t are bond and time fixed effects. Bond level controls include credit rating and maturity. The regression conditions on bonds that existed in 2008 and the sample starts in 2004 and ends in 2016. The main coefficient of interest is γ, which measures the increase in credit spreads in 2008 for internal model bonds compared to all other years, relative to the same change for non-internal model bonds.

Table 3 documents the main findings. In our baseline specification, where we control for credit rating and maturity, we estimate a negative and statistically significant coefficient, γ, (at the 1% level (column I)), which implies that the credit spreads for internal model bonds increase less than the non-internal model bonds. The economic magnitude of the difference is large and equal to 220 bps, as also seen in Figure 3. In column II, we add bond fixed effects and time fixed effects. Bond fixed effects allow us to control for time invariant bond characteristics, e.g. seniority, callable, coupon rate, covenants etc, that impact changes in credit spreads. As column II shows, the estimate does not change meaningfully.

In column III, we add issuer cross time fixed effects.[24] The coefficient of this specification is identified by comparing internal and non-internal bonds but issued by the same issuer and at the same point in time. This helps in two ways. First, it controls for time varying issuer characteristics, e.g., impact of the crisis on credit quality of the issuer which may not be fully captured by credit ratings. Second, it allows us to control for disagreement about fundamentals and model uncertainty that are at the issuer level. The estimate is significant and the difference in change of spreads between internal model and non-internal model is 40 bps. We think of this as a lower bound of the effect we estimate. As we will discuss in Section 4.3, there could be limits to the use of discretion. When there are other bonds issued by the same issuer and priced by external sources or traded in the market, an insurance company may have limited power to use discretion. Moreover, as the likelihood of permanent impairment in higher in high yield bonds, we find higher misreporting in high yield bonds relative to investment grade bonds (Table A.1).

One concern could be that some insurers simply report stale prices, i.e. 2007 prices, in the absence of traded prices. If some insurers report stale prices and other report true prices, then on average we may uncover a lower decline (increase) in prices (spreads) for internal model bonds. To test to what extent stale prices drive our results, we plot a distribution of the difference in reported spreads between 2008 and 2007. For each insurer, we compute

[24] We identify the issuer by the first six digits of a CUSIP, which are unique to the issuing company.

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the difference in reported spreads of all their bonds and then compute average values for a bond. If insurers report stale prices, then we expect to see a large mass at zero. Figure A.3 shows that the distribution is not concentrated at zero. On similar lines, another concern could be that insurers extrapolate using past changes in spreads. We plot a distribution of the difference in change in reported spreads between 2008 vs. 2007 and 2007 vs. 2006. If insurers extrapolate using past growth rates, then we expect to see a large mass at zero. Figure A.4 shows that the distribution is not concentrated at zero.

4.2. The Role of Regulatory Incentives

A concern about comparing internal model and non-internal model bonds could be that somehow internal model bonds are different and this difference is correlated with the crisis, which would explain a lower increase in relative credit spreads. This is alleviated if we can compare the same bond but across different insurers. In this section, we document our findings from an identification strategy that addresses this concern.

The regulatory framework provides heterogeneity in the incentives to use discretion for the same bond at the same time, but across insurers. Life insurers report corporate bonds at book value. The regulatory guidelines require insurers to mark down the book value when a bond's market value starts to fall below its book value, resulting in permanent impairment. Permanent impairment reduces the amount of regulatory capital. Thus, the incentive to report a higher fair value depends on the book value at which a bond is being held, which in turn depends on the cost at which the bond was purchased. An insurer that acquired the bond at a higher cost, which translates to a higher book value, has the incentive to report a price above this high threshold to avoid permanent impairment. In contrast, insurers who acquired the same bond likely at a different point in time when the market value of the bond was lower, has the incentive to report a price closer to the true value.

We illustrate the regulatory incentives with a hypothetical example. Suppose there are two insurers who hold a bond and both value the bond using internal models. Insurer A acquired the bond at a price of \$70 and insurer B acquired the same bond at a price of \$80. The book value for insurer A is \$70 and for insurer B is \$80.[25] In 2007, let us assume the bond was trading at \$90 but falls to \$60 during the crisis. Then, the regulatory framework provides heterogeneous reporting incentives because insurer A would like to report a price no less than \$70 to avoid impairment, while insurer B would like to report a price no less than \$80. This implies a positive relationship between acquisition cost (acquisition credit

[25] We ignore amortization over the life of the bond.

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spread) and reported price (reported credit spread) for bonds valued using internal models.

Illustration 1 depicts the idea graphically. There is a bunching of reported prices above \$70 for insurers that acquired the bond at \$70 and similarly above \$80 for insurers that acquired the bond at \$80. Thus, the relationship between reported fair value and acquisition cost is expected to be positive for bonds valued using internal models. However, if a bond is valued using external sources, then there is no flexibility and we should find no relationship between acquisition cost and reported price.

To test the relationship between acquisition cost (acquisition credit spread) and reported price (reported credit spread) formally, we estimate the following regression specification:

$$CS_{ij} = \gamma IM_{ij} + \delta CS_{ij}^{Acq} + \lambda(CS_{ij}^{Acq} \times IM_{ij}) + \alpha_i + \alpha_j + \epsilon_{ij}, \tag{2}$$

where CS_{ij} denotes the implied credit spread of bond i held by insurer j, CS_{ij}^{Acq} denotes the credit spread of bond i at the time of acquisition by insurer j, IM_{ij} is a dummy variable for bond i that takes a value of 1 if insurer j valued the bond using an internal model, and α_i and α_j are bond and insurer fixed effects. A bond can be valued by both internal model or by external sources by different insurers. Thus, IM_{ij} is not constant at the bond level and does not get absorbed by bond fixed effects. We discuss this in more detail later. The sample includes all bonds held in 2008.

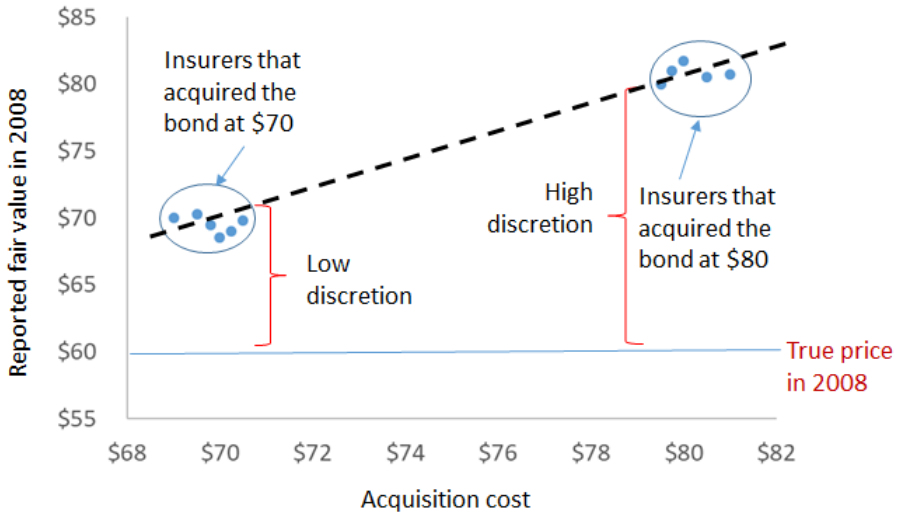


Illustration 1: Identification Strategy

Coefficient of interest are δ and λ which measure the relationship between reported credit spread of a bond in 2008 and its credit spread at acquisition, when the bond is not valued by

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an internal model and when the bond is valued by an internal model respectively. As we add bond fixed effects, δ identifies the relationship between reported credit spreads and credit spread at acquisition, by comparing the credit spread of the *same* bond, but across insurers. Insurer fixed effects control for insurer characteristics that do not vary from bond to bond, e.g. RBC ratio, leverage, risk aversion, etc. Moreover, this helps control for a component of model error that does not vary at the bond level, e.g. modeling of the macro-economic variables.

Table 4 documents the main findings. In column I, we restrict the sample to all bonds that are valued using internal models. There is a positive and statistically significant (at the 1% level) relationship between reported credit spreads and the credit spreads at acquisition.[26] The magnitude is large: a 100 bps difference in credit spreads at acquisition results in a 30 bps higher reported credit spreads. In contrast, there is no relationship between reported credit spreads and the credit spread at acquisition for bonds that are valued using non-internal models (column II). In column III, we test for the difference in the two coefficients formally. We estimate a positive and statistically significant coefficient λ (at the 1% level) and an insignificant δ, which imply that when insurers acquire a bond at a higher credit spread, they are more willing to report a credit spread that is high, relative to insurers that acquired the bond at a lower credit spread, as this helps to reduce the likelihood of permanent impairment. Moreover, this only holds for bonds valued by internal models.

One concern could be that the positive correlation between reported spreads and acquisition spreads could also arise because of model uncertainty (Hansen and Sargent (2008)) or disagreement about fundamentals (Lintner (1969)). More optimistic insurers would place a higher value on a bond both at acquisition and at all subsequent points. Similarly, uncertainty about model parameters could lead to higher valuations both at acquisition and at all subsequent points. To alleviate this concern, we conduct placebo tests by re-estimating equation (2) in alternate years for internal model bonds. Table A.2 shows that the positive relationship only exists in 2008 and 2009, when balance sheets were constrained, but not in other years, implying that model error or disagreement about fundamentals is less likely to drive our results.

The incentives to use reporting discretion varies depending on the extent of regulatory constraints. Thus, to illustrate the mechanism more precisely, we test to what extent the relationship between reported credit spreads and the acquisition credit spreads varies in the

[26] As the estimation happens within the same bond by comparing across two different insurers, only bonds that are held by more than one insurer identify the coefficient and bonds held by just one insurer get dropped from the sample.

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cross-section of insurers and lines up with regulatory constraints. To test this, we exploit the heterogeneity in RBC ratio across insures in 2007 and split our sample in three groups: low, medium, and high RBC ratio. The "low" ("high") group are insurers in the bottom tertile of RBC ratio and thus have the highest (lowest) incentive to avoid permanent impairment. Table 5 reports the findings from estimating equation (2) on the three sub-samples. We find that the positive relationship between reported credit spreads and the credit spread at acquisition is mainly concentrated and highest in magnitude for the "low" group, i.e. among insurers that are most constrained by regulatory capital.

5. Cornering the Market: Implications for Bonds Market Concentration

The extent to which an insurance company can misreport bond valuations depends on two underlying conditions. First, the ability of insurers to surpass regulatory scrutiny. An insurer would like to hold bonds where there are fewer reference points available to the regulator, which would make it difficult for the regulator to pin down the true value of a bond. Second, the lack of trading in a bond significantly increases the likelihood that internal models are used for valuations. Thus, an insurer will be unwilling to trade itself and crucially also avoid positions where the propensity that other insurers might trade is high.

We argue that both these conditions creates incentives to hold more concentrated positions and distorts ex-ante portfolio selection in corporate bonds. Bonds owned by fewer insurers implies that regulators have lesser number of discrete price points to compare. In addition, an insurer has greater control on the amount of trading that can take place in the bond if it owns a large market share in a bond. Indeed, in the data, the holding patterns are highly concentrated. Figure 5 shows a distribution of the number of insurers holding a particular bond. Over 46% of bonds are held by just one insurer and over 60% of the bonds are held by up to three insurers only.

We empirically illustrate these incentives and the impact on portfolio selection in two broad steps. First, we motivate the preference for concentrated positions by showing that concentrated ownership structure helps to bypass regulatory scrutiny, that misreporting is higher in concentrated positions, and that bonds owned by fewer insurers trade less. After establishing these preferences, we examine the impact on insurers' portfolio compositions. We show that concentration positions increased after a regulatory shift that made it easier to use internal models for reporting bond valuations.

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5.1. *Regulatory Supervision and Price Opaqueness*

5.1.1. *Bypassing Regulatory Supervision*

Regulatory Supervision and Misreporting

We first investigate the extent to which regulatory strictness impacts reporting behavior. Insurance companies are regulated and supervised at their state of domicile and not at the federal level. We show that the cross-sectional dispersion in reported fair values and credit spreads is mainly concentrated within a state and not across states, i.e. insurers report different bond valuations for the same bond to the same state regulator. To quantify the proportion of within state dispersion, we compute the cross-sectional (across insurers) standard deviation of the reported fair values and credit spreads for internal model bonds within a state, i.e. for each state, we only consider reported bond prices from insurers that are domiciled in a state and ignore bond prices from insurers that are domiciled outside. The overall U.S. level dispersion is computed by combining all U.S. states as described in Section 4.1. Table A.5 shows that the bulk of misreporting is concentrated within states. The average within state standard deviation (1.1%) is 70% of the overall standard deviation (1.55%) in credit spreads of internal model bonds. In contrast, bulk of the variation for non-internal model bonds are due to across state variation.

We next document significant heterogeneity in misreporting across states. We measure the extent of misreporting within a state by the change in credit spreads for internal model bonds in 2008 compared to all other years, relative to the same change for non-internal model bonds after controlling of various bond characteristics. To do so, we re-estimate the specification in equation (1) with bond and year fixed effects (see Table 3, column II) and compute the main coefficient of interest γ_k for each state k separately.[27] For ease of interpretation we define misreporting for state k as:

$$Misreporting_k = -(\gamma_k). \tag{3}$$

Thus, higher values of $Misreporting_k$ indicate higher misreporting. Figure 6 documents the heterogeneity across states, where we group states by the estimated coefficient $Misreporting_k$. Misreporting is economically large (over 100 basis points) in a substantial fraction of states (51%). At the same time, 18% of states have negligible and 31% states have lower degrees of misreporting.

[27] The regression conditions on the bonds that existed in a state in 2008. A bond is classified as internal model within a state if at least one insurer domiciled in that state valued the bond using an internal model.

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To understand how various measures of regulatory supervision impact misreporting we estimate:

$$Missreporting_k = \alpha + \gamma(Supervision_k) + \beta X_k + \epsilon_k,$$

where $Missreporting_k$ denotes the extent of misreporting in state k as described in Equation (3), $Supervision_k$ denotes the degree and quality of supervision in state k, which we proxy by number of financial analysts and examiners, number of discretionary exams, and budget per domestic insurer in a state as described in Section 3.2, X_k are controls, which include mean RBC ratio and mean log assets of all insurers domiciled in each state. We split our analysis at two levels: (i) bonds valued by internal models and owned by multiple insurers within a state which implies that a regulator has multiple reference prices for comparing reported values; (ii) bonds valued by internal models and owned by a single insurer within a state which implies that regulators have no reference price for comparison.

Table 6 documents the key findings. First, there exists a negative relationship between misreporting and the degree of supervision across all three measures for the bonds with reference prices (columns I, II, and III). Thus, the extent to which an insurance company can misreport bond valuations depends on the extent of regulatory supervision. However, this negative relationship only exists for bonds that have multiple owners within a state and therefore multiple reference prices. The relationship breaks down for bonds that have single owners and therefore no reference price. We find no relationship between misreporting and the degree of regulatory supervision in such cases (columns IV, V, VI), implying that insurers have a greater ability to bypass regulatory scrutiny when they hold more concentrated positions.

Quantifying Misreporting in Concentrated Positions

We next show that indeed misreporting is higher in bonds that are held by lower number of insurers. We estimate the specification in equation (1) to capture the differential effect for bonds with more concentrated holding as follows:

$$\begin{aligned}\overline{CS}_{it} = \lambda(CO_i \times IM_i \times Crisis_t) + \gamma(IM_i \times Crisis_t) + \delta(CO_i \times Crisis_t) + \\ + \beta X_{it} + \alpha_i + \alpha_t + \epsilon_{it},\end{aligned} \tag{4}$$

where CO_i is a dummy variable for bond i that takes a value of 1 if a bond is held by up to two insurers in 2008, which is the median number of insurers holding a bond. The rest of the specification is same as in equation (1). The main coefficient of interest is λ, which measures whether there is a differential increase in the credit spreads in 2008 for internal model bonds that have more concentrated holding structure as compared to internal model

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bonds that have less concentrated holding structure.

Table 7 documents the findings. λ is negative and significant (at the 5% level). This implies that within bonds that are valued by internal models, those that have more concentrated holding structure have a lower increase in reported credit spreads, as compared to internal model bonds with less concentrated holding structure. In other words, non-internal model bonds have the maximum increase in reported spreads during the crisis, followed by internal model bonds with less concentration, and finally followed by internal model bonds with high concentration. The difference in credit spreads between more and less concentrated holding bonds is close to 60 bps on average, which is one-third of the average difference between internal and non-internal model credit spreads during the crisis. Thus, there is more misreporting in the bonds that have lesser number of reference credit spreads.

5.1.2. Creating Price Opaqueness

NAIC guidelines specify that insurers should only use internal models to value an asset when the prices are not available from an external source. In this section we analyze how concentrated ownership structure correlates with trading and availability of reference prices in the secondary market. To identify bond transactions, we merge our sample of bonds with the TRACE database. Figure 7 documents the main findings on transactions patterns. Bonds that have a more concentrated holding structure, defined as bonds that are held by up to two insurers, trade less than bonds that have a less concentrated holding structure, defined as bonds that are held by more than two insurers. Bonds that have more concentrated holding structures had on average 7 transactions in TRACE per month, in comparison to 64 transactions for bonds that have less concentrated holding structures. We formally test whether the difference is statistically significant after accounting for differences in bond and issuer specific characteristics. Table A.4 documents the findings and confirms that bonds that have a more concentrated holding structure are likely to trade less by 50 percentage points, which implies that they have lower price discovery.

5.2. Implications for Portfolio Selection

Our results imply that insurers that have the ability to use internal models, ex-ante, may prefer to hold the entire (or a large enough share) of a bond's total issue. By exercising market power and "cornering the market", insurers can create two conditions that facilitate misreporting. First, it reduces the availability of reference prices (and increases the search cost of regulators). Second, it reduces the total number of participants in the secondary market, which helps to decrease transactions and quotes from broker-dealers. However, at

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the same time, holding a large share in a bond could be detrimental as it implies lower diversification and more capital requirements arising due to concentration limits.[28] Holding higher amounts in bonds with *small issuance size* helps solve this trade-off problem.[29]

It is natural to expect a higher dominant share within small bonds. For example, bonds that have a smaller issuance size may suffer from lower liquidity or higher information asymmetry, if small issuance size is correlated with firm size. If insurers prefer illiquid bonds because they are typically buy and hold investors and have long-dated liabilities, then we expect a higher dominant share in bonds with smaller issuance size. Moreover, portfolio constraints that impose minimum dollar investment thresholds, because of search and monitoring costs, also imply a higher dominant share in small bonds.

To alleviate this natural identification concern, we use variation along two dimensions: across insurers and over time. We split insurers into two groups: insurers that used internal models in 2008 (IM insurers) and insurers that did not use internal models at all in 2008 (non-IM insurers). To the extent that reporting discretion matters, and both IM and non-IM insurers are equally patient and have similar minimum investment thresholds, we expect that market cornering would arise more from insurers that used internal models.

Moreover, we exploit a shift in the regulation that made it easier for insurers to use internal models after 2008, providing us time series variation in the use of reporting discretion. This allows us to study the shift in dominant share over time and across IM and non-IM insurers instead of focusing on the difference in levels. Prior to 2008, NAIC's SVO (Securities Valuation Office) acted as the main provider of bond valuations to insurers, which the SVO sourced from public transactions, brokers-dealers, and from insurers' analytical models. In 2008, a NAIC task force amended the rules and allowed insurers to obtain valuations directly from public transactions, third-party sources, and internal models. While, SVO could still be used to source bond valuations, going to the SVO was no longer mandatory for insurers. Thus, the role of SVO as a provider of bond valuations declined and insurers' discretion over reported values increased after 2008. Moreover, the large decline in insurers' regulatory positions and the uncertainty about the future recovery of bond spreads during the financial crisis, also created significant incentives for an increased use of internal models.

To test the idea that insurers that use internal models wants to become the dominant

[28]NAIC deals with concentration risk by applying an asset concentration factor. The purpose of the concentration factor is to reflect the additional risk of high concentrations in single exposures (represented by an individual issuer of a security or a holder of a mortgage, etc.)

[29]This also helps to satisfy the budget constraint more easily, compared to holding a large proportion in a bond which has a large issuance amount.

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holder in bonds with small issuance sizes, we proceed as follows. As we are interested in quantifying the holdings of the insurer that is the dominant holder of a bond, for each bond, we compute the dominant share, i.e. the amount held by the largest IM and non-IM insurer:

$$\text{Dominant Share}_{ijt} = \max_{j} \left(\frac{\text{Amount Held}_{ijt}}{\text{Issuance Size}_{i}} \right)$$

where Amount Held_{ijt} is the par value held by insurer j at time t and for bond i and Issuance Size_{i} is the outstanding amount for bond i.

Figure 8 plots the evolution of dominant share in two subset of bonds: small and large, where small bonds are bonds that are in the bottom quartile of issuance size and large bonds bonds are bonds that are in the top quartile of issuance size. For each bond, we first compute the dominant share as described above and then compute the average for IM and non-IM insurers. Panel (a) documents a large shift in dominant share for IM insures in small bonds, but not for non-IM insurers. Panel (b) shows the results for large bonds, which shows that these effects are only concentrated within small bonds.[30]

To test this formally, we estimate the following triple differences specification, which compares the difference in dominant share between IM and non-IM insurers, after the shift in the regulation in 2008 to before, for small bonds relative to large bonds. We estimate:

$$\begin{aligned} \text{Dominant Share}_{ijt} = \gamma(IMInsurer_j \times SmallBond_i \times Post_t) + \delta(IMInsurer_j \\ \times SmallBond_i) + \alpha_{it} + \alpha_{jt} + \epsilon_{ijt}. \end{aligned} \tag{5}$$

where α_{it} are bond cross year fixed effects, which controls for any time varying change in bond characteristics driving our results, and α_{jt} are insurer type (IM or non-IM) cross year fixed effects, which controls for any time varying change in insurer characteristics that affect IM or non-IM insurers differently. The coefficient of interest is γ, which measures the shift in dominant share after 2008 for IM insurers relative to non-IM insurers for small bonds.

Table 8 shows that dominant share increased within small bonds for IM insurers relative to non-IM insurers after 2008 vis-a-vis the same change for large bonds. Column II introduces bond cross year fixed effects, thus we compare the shift in dominant share for bonds held by both IM and non-IM insurers, which alleviates concerns that our results might be driven by bonds that are held only by IM or only by non-IM insurers, where the shift in dominant shares occur due to reasons other that the shift in reporting discretion.

[30] This exercise is conducted on all insurers in the sample. For robustness, we conduct the same exercise on a subset of insurers that have similar size, as measured by total assets. Our findings are similar.

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We next ask to what extent our results are driven by new purchases. We re-estimate equation (5), but condition it only on the new bonds that were added in insurers' portfolio in any given year. Column III shows that dominant share of IM insurers increased after the regulatory change and the magnitude of the increase is similar to the increase in the overall portfolio.

Our results in Section 4 show that insurers that have low RBC ratios find the option to misreport more valuable than insurers that have high RBC ratios (and therefore lower regulatory costs). Thus, to further tighten our identification and alleviate the concern that IM insurers could be inherently different from non-IM insurers, we test whether low RBC ratio insurers have a greater shift in dominant share relative to high RBC ratio insurers. To test this hypothesis, we examine the shift in dominant share within IM insurers, but comparing low RBC insurers (first tertile) relative to high RBC insurers (third tertile). More specifically, we re-estimate equation (5), where we replace the dummy variable for IM insurers with a dummy variable for low RBC ratio insurers. Table 9 shows that there is a significant difference in the shift in dominant share after 2008 between low RBC and high RBC insurers within insurers that used internal models. Moreover, the magnitude of the difference is larger among new purchases. Taken together, these results imply that the option to use internal models likely distorts the ex-ante portfolio selection within small bonds.

6. Conclusion

Using corporate bonds as a setting, in this paper, we show that insurance companies misreport the prices of bonds for which traded prices do not exist and that are priced using internally developed models, to improve their regulatory capital positions during the financial crisis. We show that misreporting is heterogeneous across U.S. states and correlates with the degree of regulatory supervision in the state.

Our results imply that ex-ante insurers have a preference for concentrated bond positions. To avoid regulatory scrutiny, insurers misreport more in positions that are held by fewer number of insurers, as a concentrated ownership implies lower number of reference points and a higher search cost for regulators. We empirically demonstrate that the ability of regulators to check the veracity of reporting increases when a bond is held by multiple insurers within a state. Concentrated positions also help insurers to limit trading in the secondary market, which further facilitates the use of internal models and misreporting. Using a shift in the regulation that made it easier to use internal models, we show an increase in concentration in bonds with smaller issuance size.

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Our findings have implications for the micro-structure of a segment of the corporate bond market and could be helpful to design regulatory initiatives that are aimed to increase transparency and price discovery in financial markets such as MiFID and TRACE. Moreover, this channel may also hold for other financial institutions and other asset classes that share similar characteristics. For example, pension funds and endowments hold a large portfolios of private equity and real estate assets, which also suffer from a high degree of price opacity. Understanding the way financial institutions employ reporting discretion across asset classes will be helpful in properly assessing the fragility of financial institutions in bad times.

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References

[1] Agarwal, S., D. Lucca, A. Seru, and F. Trebbi, 2014. *Inconsistent Regulators: Evidence from Banking. The Quarterly Journal of Economics, Volume 129, Issue 2, May 2014, Pages 889–938.*

[2] Allen, F., L. Litov, and J. Mei, 2006. *Large Investors, Price Manipulation, and Limits to Arbitrage: An Anatomy of Market Corners. Review of Finance, 10: 643–69.*

[3] Allen, F. and A.M. Santomero, 1997. *The theory of financial intermediation. Journal of Banking & Finance, 21(11-12), pp.1461-1485.*

[4] Becker, B., and V. Ivashina, 2015. *Reaching for Yield in the Bond Market. The Journal of Finance, 70(5), 1863-1902.*

[5] Behn, M., R. F. H. Haselmann, and V. Vig, 2014. *The Limits of Model-Based Regulation. Working Paper.*

[6] Bolton, P., and D. S. Scharfstein, 1996. *Optimal Debt Structure and the Number of Creditors. The Journal of Political Economy 104(1), 1-25.*

[7] Bris, A., and I. Welch, 2005. *The Optimal Concentration of Creditors. The Journal of Finance, 60(5), 2193-2212.*

[8] Cici, G., S. Gibson, and J. J. Merrick, 2011. *Missing the marks? Dispersion in corporate bond valuations across mutual funds. Journal of Financial Economics, 101(1), 206-226.*

[9] Collin-Dufresne, P., R. S. Goldstein, and J. S. Martin, 2001. *The Determinants of Credit Spread Changes. Journal of Finance, 56(6), 2177-2207.*

[10] Dick-Nielsen, J., P. Feldhütter, and D. Lando, 2012. *Corporate bond liquidity before and after the onset of the subprime crisis. Journal of Financial Economics, 103, 471-492.*

[11] Edmans, A., X. Gabaix, and A. Landier, 1976. *A Multiplicative Model of Optimal CEO Incentives in Market Equilibrium. Review of Financial Studies.*

[12] Ellul, A., C. Jotikasthira, C. T. Lundblad, and Y. Wang, 2015. *Is Historical Cost a Panacea? Market Stress, Incentive Distortions and Gains Trading. Journal of Finance 70 (6), 2489-2538.*

[13] Elton, E.J., Gruber, M.J., Agrawal, D. and Mann, C., 2001. *Explaining the rate spread on corporate bonds. The Journal of Finance, 56(1), pp.247-277.*

Electronic copy available at: https://ssrn.com/abstract=3534313

[14] Ge. S., 2016. *How Do Hurricanes Affect Life Insurance Premiums? The Effect of Financial Constraints on Pricing. Working Paper, Ohio State University.*

[15] Gründl, H. and Gal, J., 2017. *The evolution of insurer portfolio investment strategies for long-term investing. OECD Journal: Financial Market Trends, 2016(2), pp.1-55.*

[16] Hansen, L.P. and Sargent, T.J., 2008. *Robustness. Princeton university press.*

[17] He, Z. and Krishnamurthy, A., 2013. *Intermediary asset pricing. American Economic Review, 103(2), 732-70.*

[18] Huang, J.Z. and Huang, M., 2012. *How much of the corporate-treasury yield spread is due to credit risk?. The Review of Asset Pricing Studies, 2(2), pp.153-202.*

[19] Jensen, M., and W. Meckling, 1976. *Theory of the Firm: Managerial Behavior, Agency Costs, and Capital Structure. Journal of Financial Economics 3:305–60.*

[20] Koijen, R. S. J. and M. Yogo, 2015a. *The Cost of Financial Frictions for Life Insurers. American Economic Review 105 (1), 445-475.*

[21] Koijen, R. S. J. and M. Yogo, 2015b. *Risks of Life Insurers: Recent Trends and Transmission Mechanisms, The Economics, Regulation, and Systemic Risk of Insurance Markets. Oxford University Press, chapter 4.*

[22] Koijen, R. S. J. and M. Yogo, 2016. *Shadow Insurance. Econometrica 84 (3), 1265-1287.*

[23] Koijen, R. S. J. and M. Yogo, 2017. *The Fragility of Market Risk Insurance. Princeton University Working Paper.*

[24] Koijen, R.S. and Yogo, M., 2018. *A demand system approach to asset pricing. Journal of Political Economy (forthcoming).*

[25] Lintner, John, 1969. *The aggregation of investor's diverse judgements and preferences in competitive capital markets, Journal of Financial and Quantitative Analysis 4, 347-400.*

[26] McDonald, R. and Paulson, A., 2015. *AIG in Hindsight. Journal of Economic Perspectives, 29(2), pp.81-106.*

[27] McMenamin, R., Paulson, A., Plestis, T. and Rosen, R., 2013. *What do US life insurers invest in?. Chicago Fed Letter, (309), p.1.*

[28] Milbradt, K., 2012. *Level 3 Assets: Booking Profits and Concealing Losses. Review of Financial Studies, 25(1), 55-95.*

Electronic copy available at: https://ssrn.com/abstract=3534313

[29] National Association of Insurance Commissioners, 2012. *Valuation Manual 20-21.*

[30] National Association of Insurance Commissioners, 2012. *Annual Statement Instructions.*

[31] National Association of Insurance Commissioners, 2013. *Risk Based Capital Guidelines.*

[32] National Association of Insurance Commissioners, 2018. *Statement of Statutory Accounting Principles: Accounting Practices and Procedures Manual.*

[33] Shleifer, A., and R. W. Vishny, 1986. *Large Shareholders and Corporate Control. Journal of Political Economy. Vol 94 (3).*

[34] Sen, I., 2018. *Regulatory Limits to Risk Management. Harvard Business School Working Paper.*

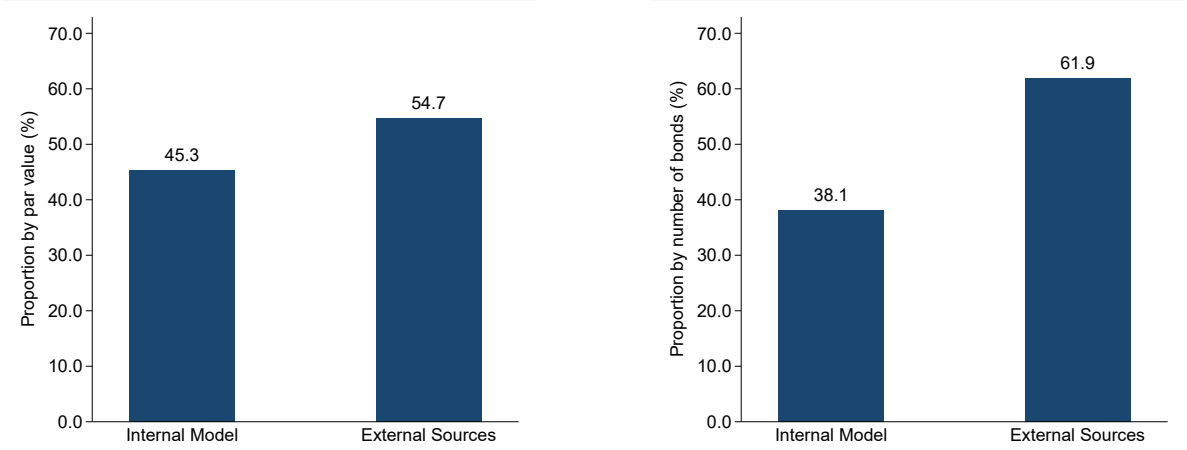
[35] Sen, I. and D. Humphry 2016. *Capital Regulation and Product Market Outcomes. Bank of England Working Paper.*

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I. Figures

Figure 1: How do Insurance Companies Value Corporate Bonds?

The figure shows the breakdown of the corporate bond holdings data by valuation method in 2008. Figure (a) plots the share of total par value held and figure (b) plots the share of total number of bonds. External sources include NAIC's security valuation office, pricing services (e.g. Bloomberg and IDC), and brokers.



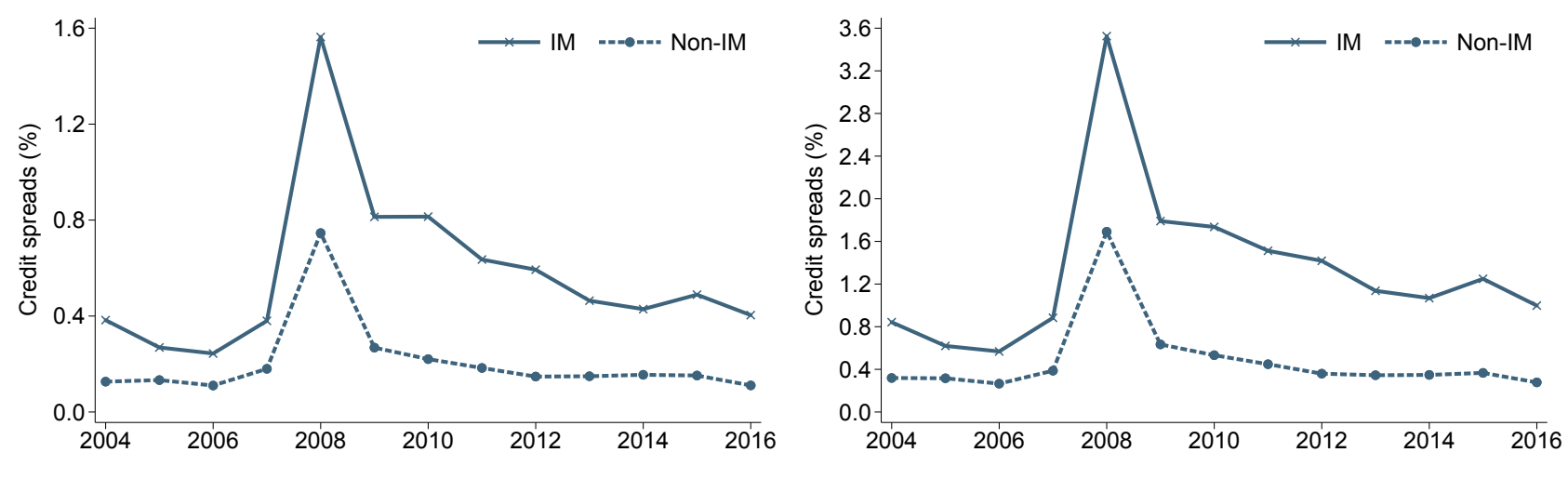
(a) By Total Par Value

(b) By Total Number of Bonds

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Figure 2: Cross Insurer Dispersion in Reported Credit Spreads

This figure shows the average cross-sectional standard deviation and range of reported credit spreads. We compute cross-sectional standard deviation (sd) and range for each bond at each point in time across insurers and then compute the average standard deviation and average range for internal model (IM) and non-internal model (non-IM) valued bonds separately. A bond is classified as internal model if at least one insurer valued it using an internal model in 2008. The sample includes bonds held in 2008. Figure (a) and figure (b) plot the average standard deviation and range of reported implied credit spreads.



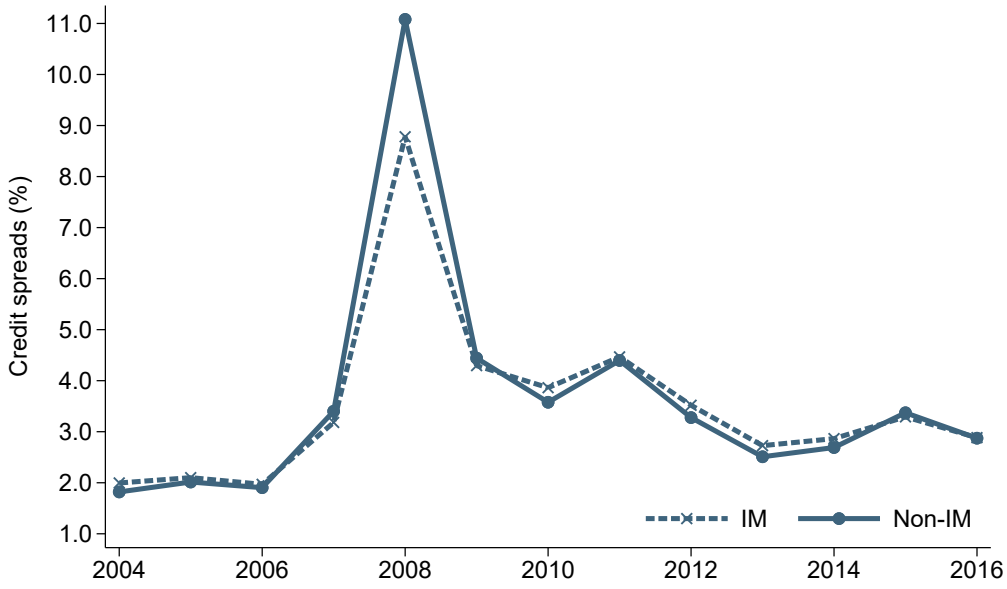
(a) Standard Deviation

(b) Range

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Figure 3: Evolution of Reported Credit Spreads

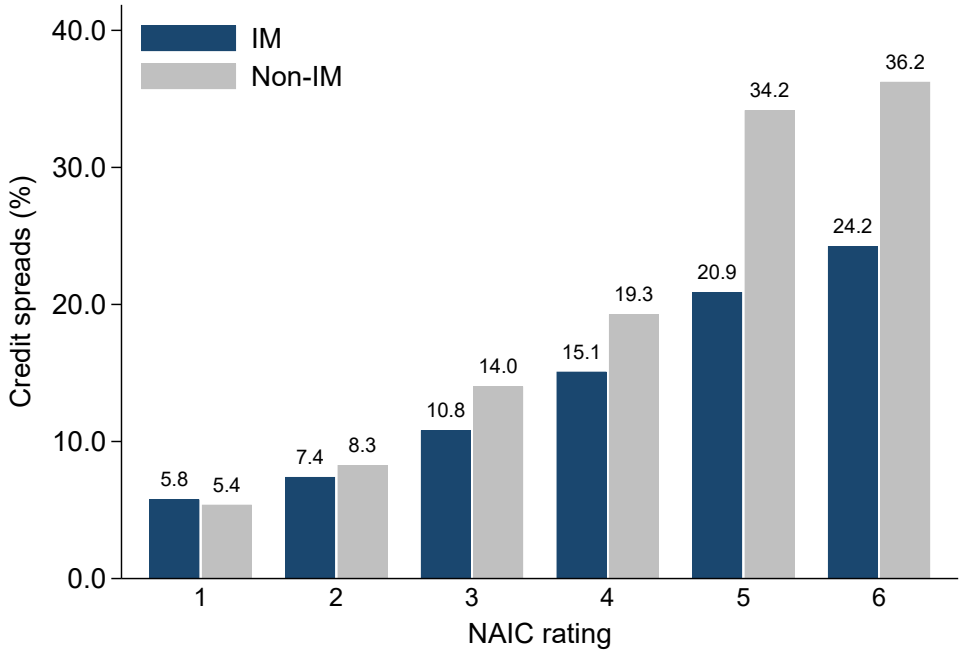
The figure shows how credit spreads have changed during the financial crisis for bonds that were valued using internal models as compared to bonds that were not valued by internal models. We compute the cross-sectional average of reported credit spreads for each bond at each point in time across insurers and then compute the mean for internal model (IM) and non-internal model (non-IM) valued bonds. A bond is classified as internal model if at least one insurer valued it using an internal model in 2008. The sample includes bonds held in 2008.



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Figure 4: Reported Credit Spreads by NAIC Rating Categories During the Financial Crisis

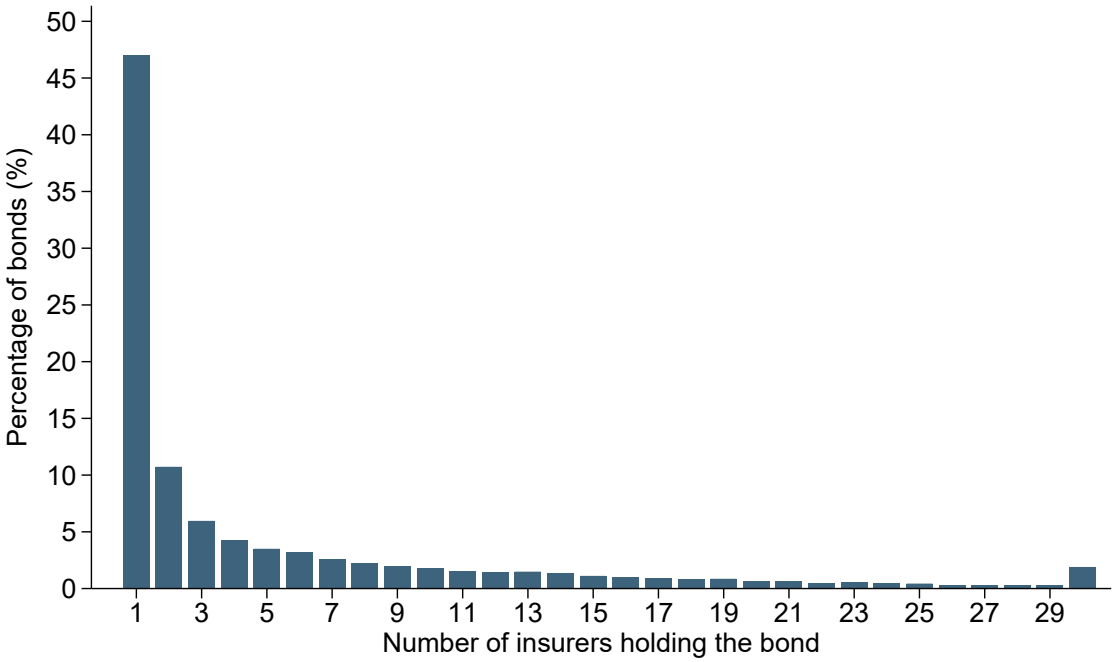
The figure shows the average credit spreads in 2008 for internal model (IM) and non-internal model (non-IM) valued bonds split by NAIC ratings. A bond is classified as internal model if at least one insurer valued it using an internal model in 2008. The sample includes bonds held in 2008. NAIC rating categories are grouped category 1 to 6, where NAIC 1 are AAA, AA, and A, NAIC 2 are BBB, NAIC 3 are BB, NAIC 4 are B, NAIC 5 are CCC and NAIC 6 are CC or below rated bonds.



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Figure 5: Concentration in Holding Structure of Corporate Bonds

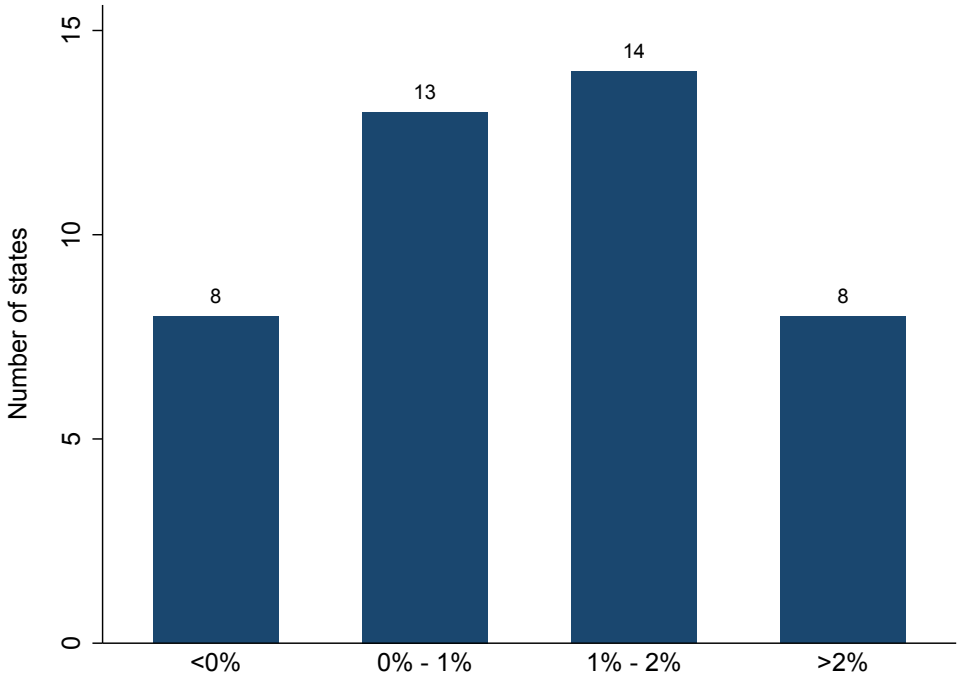
The figure shows the distribution of total number of insurance companies holding a particular corporate bond. The sample includes corporate bonds held by insurance companies in 2008.



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Figure 6: Cross-sectional Heterogeneity in Misreporting Across States

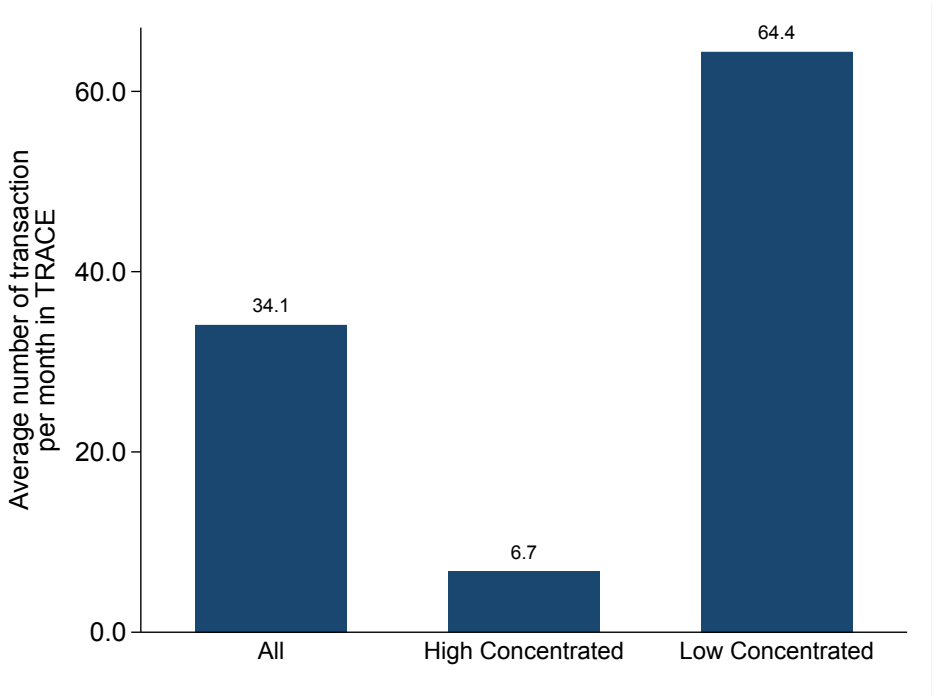
The figure shows the difference between the credit spreads of the bonds valued using external sources and the bonds valued using internal models for different US states. To quantify the difference, we re-estimate the specification in equation (1) with bond and year fixed effects and compute the main coefficient of interest γ_j for each state j separately. The red triangles represent states where γ_j is statistically significant at the 5% level and blue circles are states where the coefficient is insignificant.



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Figure 7: Number of Transactions in TRACE

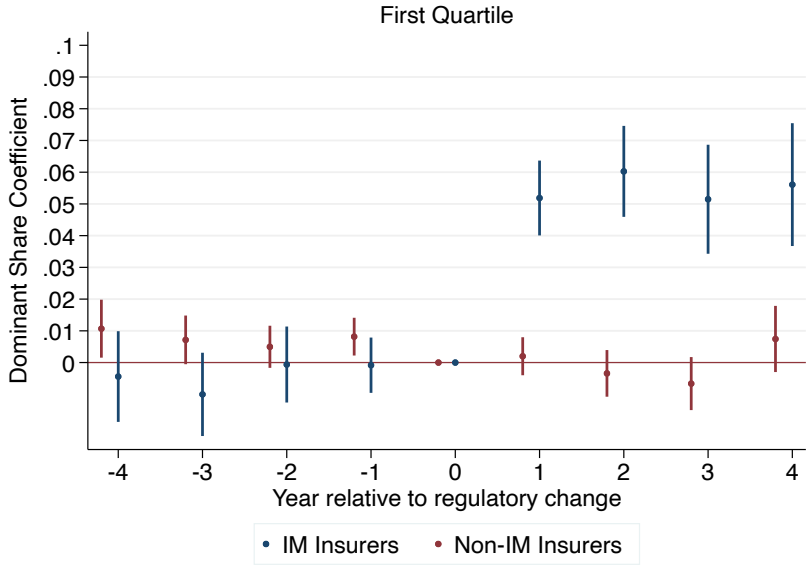
The figure shows the number of TRACE transactions during the crisis for bonds that had a highly concentrated holding structure, i.e bonds that were held by up to two insures, as compared to bonds that had less concentrated holding structure, i.e bonds that were held by more than two insures.



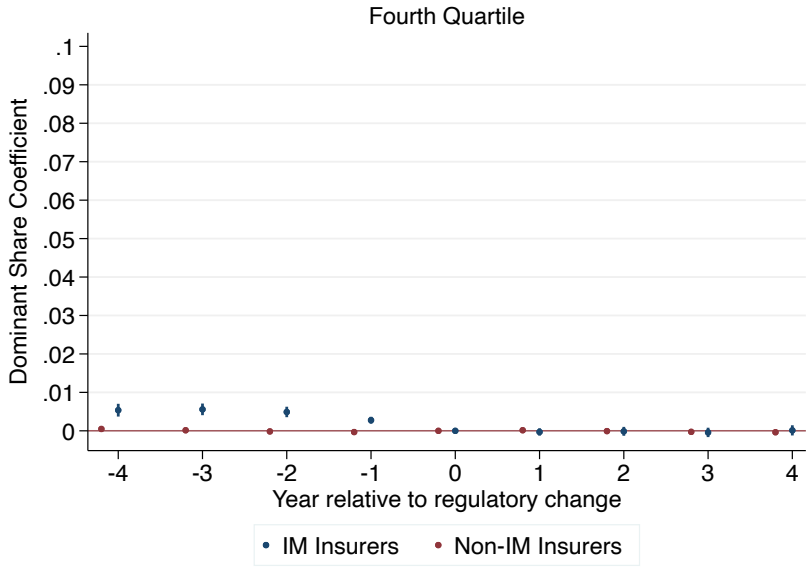
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Figure 8: Shift in Dominant Share

The figure shows the shift in dominant share for insurers that used internal models in 2008 and insurers that did not use internal models in 2008. Figure (a) plots the average dominant share for bonds with small issuance size (below first quartile) and figure (b) average dominant share for bonds with large issuance size (above fourth quartile).



(a) Small Bonds



(b) Large Bonds

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II. Tables

Table 1: Summary Statistics: Bond Holdings

Table shows the descriptive statistics for internal model and non-internal model valued bonds for year 2008. A bond is classified as internal model if at least one insurance company valued the bond by using an internal model in 2008. Panel (a) shows the descriptive statistics for internal model valued bonds and panel (b) shows the descriptive statistics for non-internal model valued bonds.

	Mean	StDev	P10	P25	Median	P75	P90
Panel a: Internal model							
Number of bonds	7340						
Number of issuers	3830						
NAIC rating	2.09	1.18	1.00	1.00	2.00	2.00	4.00
Remaining maturity	7.74	5.90	2.17	3.75	6.00	9.58	16.08
Callable share (%)	26						
Credit spread (2008)(%)	8.78	8.58	3.55	4.85	6.41	9.37	15.00
Reported price (2008)	90.34	18.12	67.81	84.74	95.01	101.07	106.22
Credit spread (excl 2008)(%)	3.57	3.92	1.33	1.82	2.56	3.83	6.12
Reported price (excl 2008)	104.24	11.93	95.78	100.71	105.02	110.08	115.11
Credit spread (acquisition)(%)	3.08	3.24	0.95	1.47	2.23	3.64	5.64
Reported price (acquisition)	98.23	12.00	95.54	99.44	100.00	100.00	103.51
Holding Size (million)	12.03	22.76	1.00	3.17	7.33	13.50	24.00
Duration held (years)	4.31	3.77	0.53	1.44	3.46	5.79	9.59
Panel b: Non-internal model							
Number of bonds	11919						
Number of issuers	5785						
NAIC rating	2.13	1.32	1.00	1.00	2.00	3.00	4.00
Remaining maturity	8.95	7.39	2.25	3.83	6.17	11.00	21.58
Callable share (%)	17						
Credit spread (2008)(%)	11.08	11.73	3.31	4.53	6.93	13.02	22.94
Reported price (2008)	84.19	22.42	51.35	70.59	89.47	100.40	106.13
Credit spread (excl 2008)(%)	3.64	4.05	1.16	1.67	2.54	4.22	6.75
Reported price (excl 2008)	103.56	12.83	92.35	98.44	103.61	109.88	117.15
Credit spread (acquisition)(%)	3.58	3.95	1.04	1.68	2.58	4.26	6.94
Reported price (acquisition)	98.28	11.91	91.60	97.68	99.99	100.74	106.48
Holding Size (million)	7.06	10.57	0.28	1.53	4.82	9.01	14.38
Duration held (years)	3.04	2.99	0.38	0.88	2.05	4.42	6.75

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Table 2: U.S. State Regulator's Characteristics

Table shows the descriptive statistics for the resources available with and the measures of supervision taken by state insurance regulators from 2005 to 2008.

	Mean	StDev	P10	P25	Median	P75	P90
Domiciled insurers	170	154	45	66	110	208	382
Examiners per insurer	0.27	0.19	0.07	0.13	0.22	0.34	0.56
Budget per insurer ($ million)	0.20	0.19	0.05	0.08	0.15	0.32	0.38
Discretionary exams per insurer	0.02	0.03	0.00	0.00	0.00	0.02	0.05
Regular exams per insurer	0.23	0.08	0.13	0.17	0.22	0.29	0.32
Observations	43						

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Table 3: Internal Models and Misreporting During the Financial Crisis

The table shows the evolution of credit spreads of bonds valued by internal models in comparison to bonds valued by non-internal models during the financial crisis. We estimate:

$$\overline{CS}_{it} = \gamma(IM_i \times Crisis_t) + \beta X_{it} + \alpha_i + \alpha_t + \epsilon_{it},$$

where $\overline{CS}_{it}$ is the average of the reported credit spreads for bond i at time t across all insurers, IM_i is a dummy variable for bond i that takes a value of 1 if it is valued by internal models by at least one insurer in 2008, $Crisis_t$ is a dummy variable that takes a value of 1 if the year is 2008, X_{it} are bond level controls, and α_i and α_t are bond and time fixed effects. Bond level controls include credit rating and maturity. The regression conditions on bonds that existed in 2008 and the sample starts in 2004 and ends in 2016. The main coefficient of interest is γ, which measures the increase in credit spreads in 2008 for internal model bonds compared to all other years, relative to the same change for non-internal model bonds. For column I, a constant is estimated but not reported. Table shows standard errors in parentheses. Standard errors are clustered at bond level. Significance: * 10%; ** 5%; *** 1%.

	I	II	III
$IM_i \times Crisis_t$	-0.022***	-0.022***	-0.004***
	(0.001)	(0.001)	(0.001)
$Crisis_t$	0.073***		
	(0.001)		
IM_i	0.000		
	(0.000)		
R^2	0.439	0.661	0.923
Observations	124163	122974	89043
Controls	Yes	Yes	Yes
Bond Fixed Effects	No	Yes	Yes
Year Fixed Effects	No	Yes	NA
Year × Issuer Fixed Effects	No	No	Yes

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Table 4: The Role of Regulatory Incentives

The table shows the relationship between reported credit spreads during crisis and at acquisition. We estimate:

$$CS_{ij} = \gamma IM_{ij} + \delta CS_{ij}^{Acq} + \lambda(CS_{ij}^{Acq} \times IM_{ij}) + \alpha_i + \alpha_j + \epsilon_{ij},$$

where CS_{ij} denotes the reported credit spread of bond i held by insurer j, CS_{ij}^{Acq} denotes the implied credit spread of bond i at the time of acquisition by insurer j, IM_{ij} is a dummy variable for bond i that takes a value of 1 if insurer j valued the bond using an internal model, and α_i and α_j are bond and insurer fixed effects. The sample includes all bonds held in 2008. We first estimate the model separately for IM bonds (Column I) and non-IM bonds (Column II) and subsequently estimate the model on full sample (Column III). Coefficient of interest are δ and λ which measure the relationship between reported credit spread of a bond in 2008 and its credit spread at acquisition, when the bond is not valued by an internal model and when the bond is valued by an internal model respectively. Table shows standard errors in parentheses. Standard errors are clustered at insurer level. Significance: * 10%; ** 5%; *** 1%.

	IM	Non-IM	All
	I	II	III
CS_{ij}^{Acq}	0.305***	0.005	0.013
	(0.056)	(0.010)	(0.010)
IM_{ij}			-0.003
			(0.002)
$CS_{ij}^{Acq} \times IM_{ij}$			0.121***
			(0.042)
R^2	0.752	0.969	0.953
Observations	8257	83165	94424
Bond Fixed Effects	Yes	Yes	Yes
Insurer Fixed Effects	Yes	Yes	Yes

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Table 5: Regulatory Incentives - Cross-sectional Split by Regulatory Constraints

The table shows the relationship between implied credit spreads during crisis and at acquisition for insurers with low, medium, and high RBC Ratio in 2007. We estimate:

$$CS_{ij} = \gamma IM_{ij} + \delta CS_{ij}^{Acq} + \lambda(CS_{ij}^{Acq} \times IM_{ij}) + \alpha_i + \alpha_j + \epsilon_{ij},$$

where CS_{ij} denotes the implied credit spread of bond i held by insurer j, CS_{ij}^{Acq} denotes the implied credit spread of bond i at the time of acquisition by insurer j, IM_{ij} is a dummy variable for bond i that takes a value of 1 if insurer j valued the bond using an internal model, and α_i and α_j are bond and insurer fixed effects. The sample includes all bonds held in 2008. Coefficient of interest are δ and λ which measure the relationship between reported credit spread of a bond in 2008 and its credit spread at acquisition, when the bond is not valued by an internal model and when the bond is valued by an internal model respectively. Table shows standard errors in parentheses. Standard errors are clustered at insurer level. Significance: * 10%; ** 5%; *** 1%.

	Low RBC	Medium RBC	High RBC
	I	II	III
CS_{ij}^{Acq}	0.006	0.001	0.058
	(0.016)	(0.011)	(0.035)
IM_{ij}	-0.012**	0.001	-0.004
	(0.005)	(0.002)	(0.003)
$CS_{ij}^{Acq} \times IM_{ij}$	0.354**	0.036	0.079*
	(0.165)	(0.029)	(0.046)
R^2	0.972	0.961	0.958
Observations	15323	54697	15791
Bond Fixed Effects	Yes	Yes	Yes
Insurer Fixed Effects	Yes	Yes	Yes

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Table 6: Regulatory Supervision and Misreporting

The table shows the relationship between misreporting and regulator's level of strictness in 2008 across U.S. states. We estimate:

$$Misreporting_k = \alpha + \gamma(Supervision_k) + \beta X_k + \epsilon_j$$

where $Misreporting$ denotes the level of misreporting by insurers in state k and *Supervision* denotes the level of supervision by regulator in state k. Supervision is measured using three different proxies: 1) Number of financial analysts and examiners state has per domestic insurer; 2) Number of discretionary exams state conducts per domestic insurer; and 3) Regulators budget per domestic insurer. X_k represents the controls. Controls include mean RBC ratio and mean log assets of the insurers in each state. $Misreporting$ and *Supervision* are standardised by dividing them with their standard deviation. All Significance: * 10%; ** 5%; *** 1%.

	With Reference Prices			No Reference Prices		
	I	II	III	IV	V	VI
Examiners per insurer	-0.266***			-0.015		
	(0.096)			(0.138)		
Discretionary exams per insurer		-0.151*			0.036	
		(0.086)			(0.094)	
Budget per insurer			-0.179*			-0.059
			(0.091)			(0.088)
R^2	0.219	0.184	0.192	0.0553	0.0564	0.0585
Observations	43	43	43	43	43	43
Controls	Yes	Yes	Yes	Yes	Yes	Yes

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Table 7: Concentrated Positions and Misreporting

The table shows how changes in reported credit spreads during the financial crisis depend on the valuation method and holding structure of the bonds. We estimate:

$$\overline{CS}_{it} = \gamma(IM_i \times Crisis_t) + \delta(CO_i \times Crisis_t) + \lambda(CO_i \times IM_i \times Crisis_t) + \beta X_{it} + \alpha_i + \alpha_t + \epsilon_{it},$$

where $\overline{CS}_{it}$ is the average of the reported credit spreads for bond i at time t across all insurers, IM_i is a dummy variable for bond i that takes a value of 1 if it is valued by internal models by at least one insurer in 2008, $Crisis_t$ is a dummy variable that takes a value of 1 if the year is 2008, CO_i is the dummy for bond i that takes the value of one if the bond was held by less than or equal to two insurers in 2008 (median number of insurers holding a bond in 2008 was two), X_{it} are bond level controls, and α_i and α_t are bond and time fixed effects. Bond level controls include credit rating and maturity. The regression conditions on bonds that existed in 2008 and the sample starts in 2004 and ends in 2016. The main coefficient of interest is λ, which measures whether there is a differential increase in the credit spreads in 2008 for internal model bonds that had concentrated ownership. Table shows standard errors in parentheses. Standard errors are clustered at bond level. Significance: * 10%; ** 5%; *** 1%.

	I	II
$CO_i \times IM_i \times Crisis_t$	-0.006**	-0.004
	(0.002)	(0.002)
$IM_i \times Crisis_t$	-0.019***	-0.003**
	(0.001)	(0.001)
$CO_i \times Crisis_t$	0.003	0.001
	(0.002)	(0.002)
R^2	0.661	0.923
Observations	122974	89043
Controls	Yes	Yes
Bond Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	NA
Year × Issuer Fixed Effects	No	Yes

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Table 8: Market Cornering for Small Bonds

The table shows the shift in dominant share for insures that used internal models relative to those that did not after 2008. Small bonds are bonds with small issuance size (below first quartile) and large bonds are bonds with large issuance size (above fourth quartile). *IM Insurer*$_j$ is a dummy variable for insurers that used internal models in 2008, *Small Bond*$_i$ is a dummy variable for small bonds, and $Post_t$ is a dummy variable that takes a value of 1 after 2008. The first two columns estimates the model on all bonds and the last column estimates the model on new purchases only. We estimate:

$$Dominant\ Share_{ijt} = \gamma(IM\ Insurer_j \times Small\ Bond_i \times Post_t) + \delta(IM\ Insurer_j \times Small\ Bond_i) + \alpha_{it} + \alpha_{jt} + \epsilon_{ijt}$$

	All		New
	I	II	III
Small Bond × Post	-0.013***		
	(0.003)		
IM Insurer × Small Bond	0.082***	0.078***	0.071***
	(0.004)	(0.005)	(0.005)
IM Insurer × Small Bond × Post	0.034***	0.047***	0.041***
	(0.005)	(0.007)	(0.012)
R-squared	0.955	0.769	0.767
Observations	107332	75994	18046
Insurer Type × Year Fixed Effects	Yes	Yes	Yes
Bond Fixed Effects	Yes	NA	Yes
Bond × Year Fixed Effects	No	Yes	NA
Bond Level Controls	Yes	NA	NA

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Table 9: Market Cornering for Small Bonds - Cross-sectional Comparison

The table shows the shift in dominant share for insures that had low RBC ratio relative to those that had high RBC ratio in 2007. Small bonds are bonds with small issuance size (below first quartile) and large bonds are bonds with large issuance size (above fourth quartile). $Low\ RBC_j$ is a dummy variable for insurers that had RBC ratio in first tertile in 2007, $Small\ Bond_i$ is a dummy variable for small bonds, and $Post_t$ is a dummy variable that takes a value of 1 after 2008. The first two columns estimates the model on all bonds and the last column estimates the model on new purchases only. The sample only includes the bonds that were held by insures that used internal models in 2008. We estimate:

$$Dominant\ Share_{ijt} = \gamma(Low\ RBC_j \times Small\ Bond_i \times Post_t) + \delta(Low\ RBC_j \times Small\ Bond_i) + \alpha_{it} + \alpha_{jt} + \epsilon_{ijt}$$

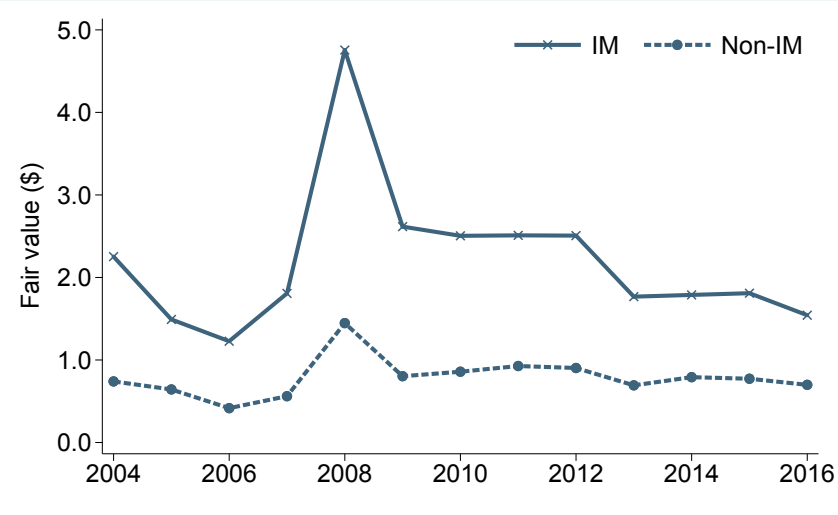
	All		New
	I	II	III
Small Bond × Post	-0.003		
	(0.002)		
Low RBC Insurer × Small Bond	-0.000	-0.000	0.003
	(0.003)	(0.003)	(0.003)
Low RBC Insurer × Small Bond × Post	0.009***	0.010**	0.018*
	(0.003)	(0.004)	(0.011)
R-squared	0.962	0.715	0.720
Observations	80586	57768	12776
Insurer Type × Year Fixed Effects	Yes	Yes	Yes
Bond Fixed Effects	Yes	NA	Yes
Bond × Year Fixed Effects	No	Yes	NA
Bond Level Controls	Yes	NA	NA

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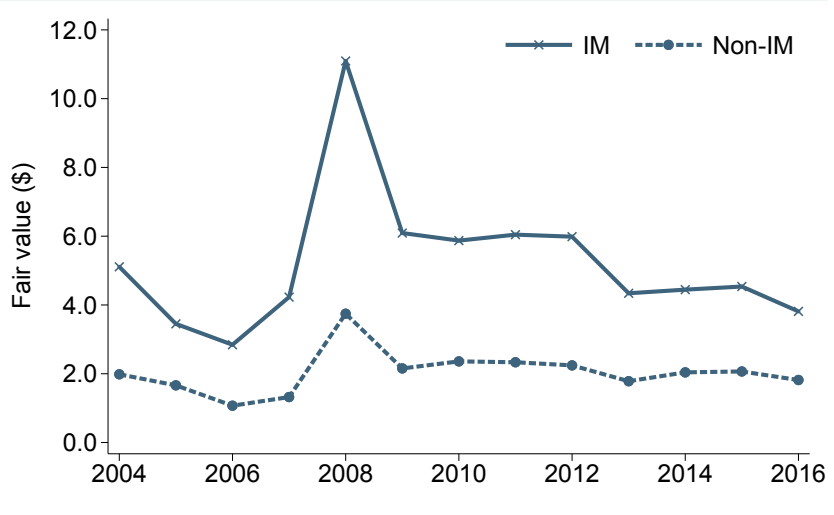
A. Additional Figures and Tables

Figure A.1: Cross Insurer Dispersion in Reported Fair Values

This figure shows the average cross-sectional standard deviation and range of reported fair values. We compute cross-sectional standard deviation (sd) and range for each bond at each point in time across insurers and then compute the average standard deviation and average range for internal model (IM) and non-internal model (non-IM) valued bonds separately. A bond is classified as internal model if at least one insurer valued it using an internal model in 2008. The sample includes bonds held in 2008. Figure (a) and figure (b) plot the average standard deviation and range of reported fair values.



(a) Standard Deviation

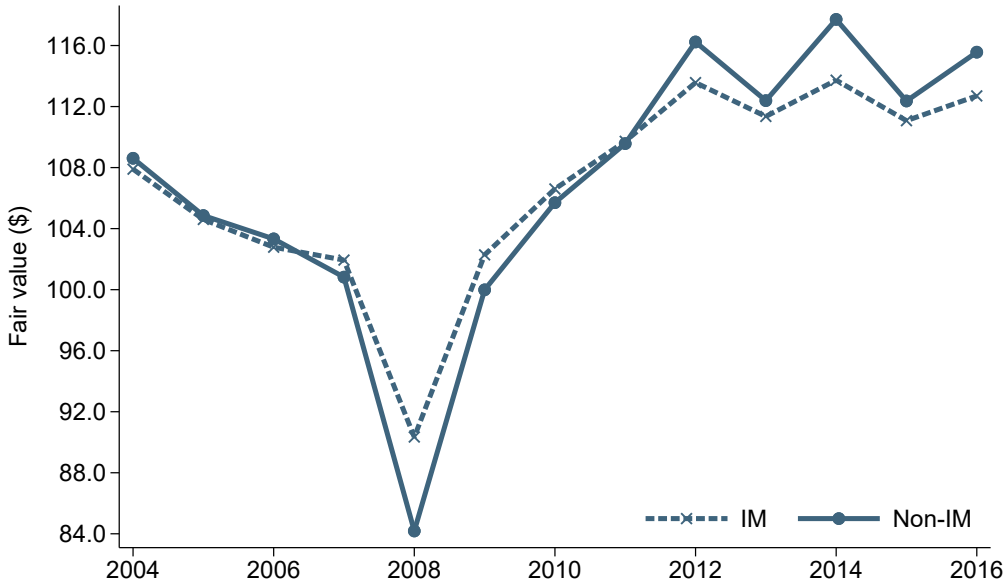


(b) Range

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Figure A.2: Evolution of Reported Fair Values

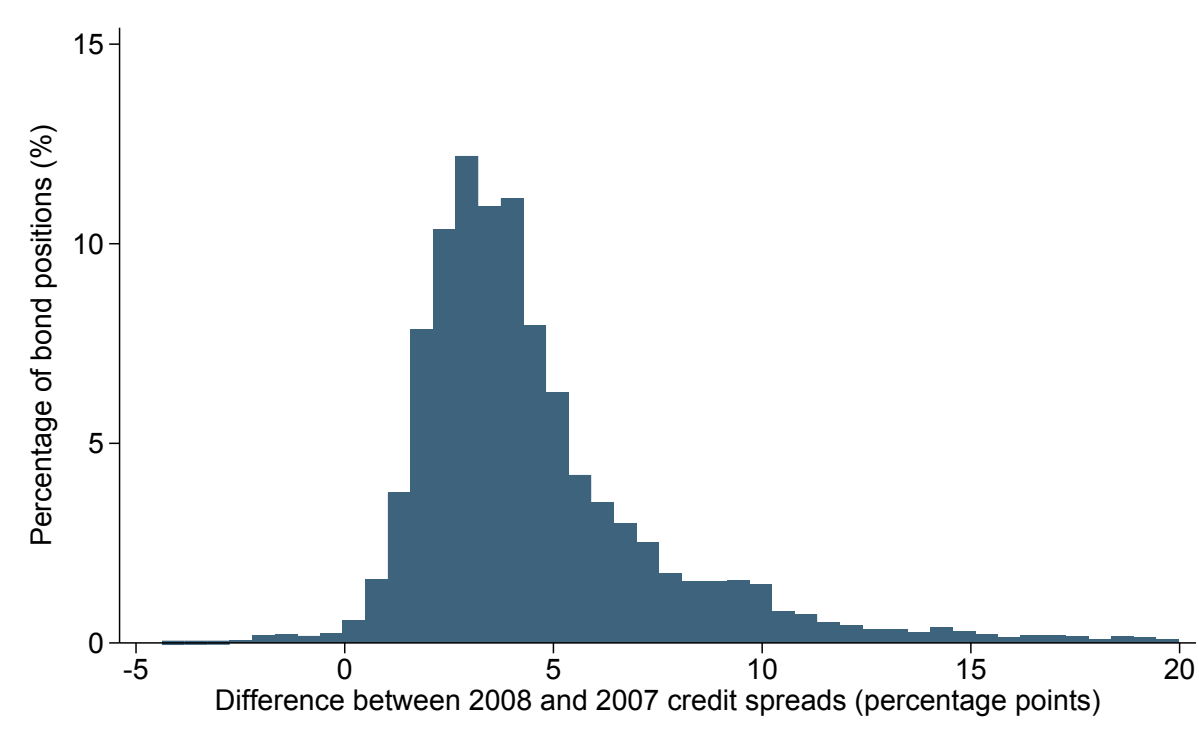
The figure shows how fair value have changed during the financial crisis for bonds that were valued using internal models as compared to bonds that were not valued by internal models. We compute the cross-sectional average of reported fair values for each bond at each point in time across insurers and then compute the mean for internal model (IM) and non-internal model (non-IM) valued bonds. A bond is classified as internal model if at least one insurer valued it using an internal model in 2008. The sample includes bonds held in 2008.



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Figure A.3: Stale Prices

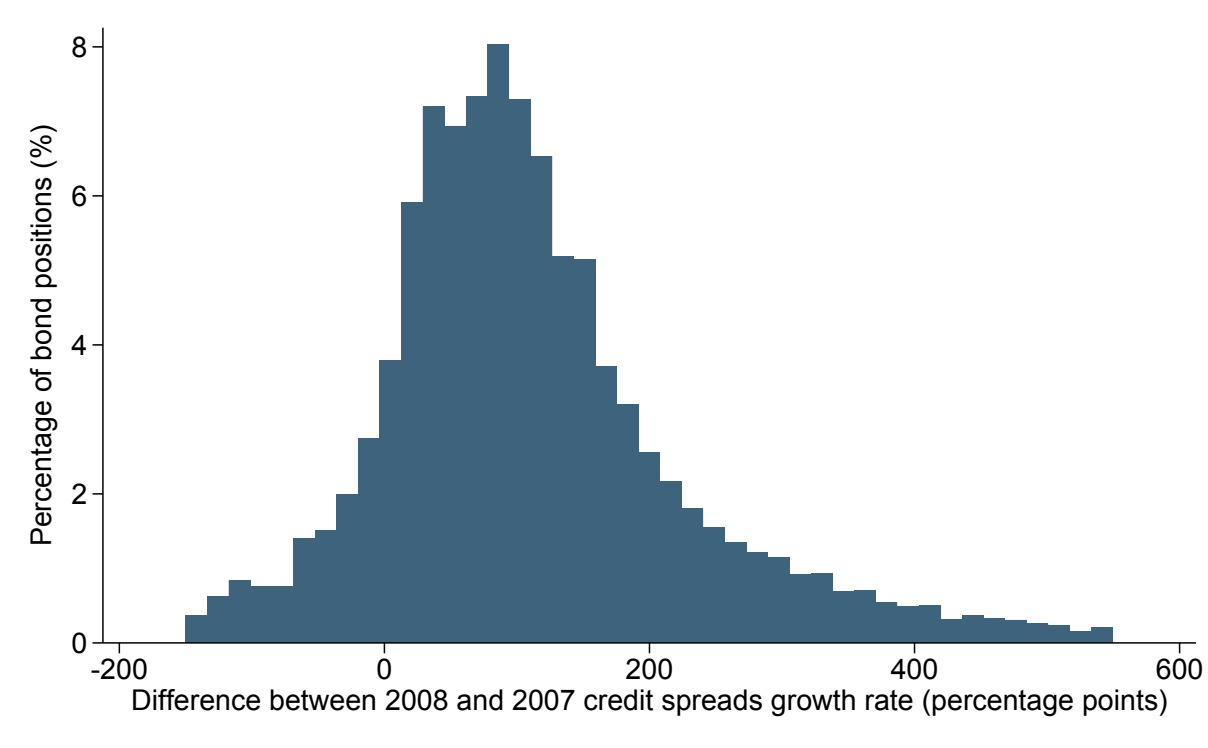
The figure shows the distribution of the difference between 2008 and 2007 credit spreads. The figure conditions on the bonds that were valued using internal models in 2008. The distribution would be concentrated at 0 if insurers were using stale prices from 2007 to report the prices for 2008.



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Figure A.4: Extrapolation

The figure shows the distribution of the difference between the growth rate of credit spreads from 2008 to 2007 and growth rate of credit spreads from 2007 to 2006. The figure conditions on the bonds that were valued using internal models in 2008. The distribution would be concentrated at 0 if insurers were extrapolating previous year's trend.



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Table A.1: Misreporting During the Crisis (By Rating)

The table shows the evolution of credit spreads of bonds valued by internal models in comparison to bonds valued by non-internal models during the financial crisis separately for investment grade (column 1) and high yield bonds (column 2). We estimate:

$$\overline{CS}_{it} = \gamma(IM_i \times Crisis_t) + \beta X_{it} + \alpha_i + \alpha_t + \epsilon_{it},$$

where $\overline{CS}_{it}$ is the average of the reported credit spreads for bond i at time t across all insurers, IM_i is a dummy variable for bond i that takes a value of 1 if it is valued by internal models by at least one insurer in 2008, $Crisis_t$ is a dummy variable that takes a value of 1 if the year is 2008, X_{it} are bond level controls, and α_i and α_t are bond and time fixed effects. Bond level controls include credit rating and maturity. The regression conditions on bonds that existed in 2008 and the sample starts in 2004 and ends in 2016. The main coefficient of interest is γ, which measures the increase in credit spreads in 2008 for internal model bonds compared to all other years, relative to the same change for non-internal model bonds. For column I, a constant is estimated but not reported. Table shows standard errors in parentheses. Standard errors are clustered at bond level. Significance: * 10%; ** 5%; *** 1%.

	IG	HY
	I	II
$IM_i \times Crisis_t$	-0.004***	-0.064***
	(0.001)	(0.004)
R-squared	0.643	0.666
Observations	97783	24117
Control	Yes	Yes
Bond FE	Yes	Yes
Year FE	Yes	Yes

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Table A.2: Correlation with Acquisition Spreads: Placebo Tests

The table shows the relationship between reported credit spreads during crisis and credit spreads at acquisition for bonds valued by internal models. We estimate:

$$CS_{ij} = \delta CS_{ij}^{Acq} + \alpha_i + \alpha_j + \epsilon_{ij},$$

where CS_{ij} denotes the reported credit spread of bond i held by insurer j, CS_{ij}^{Acq} denotes the implied credit spread of bond i at the time of acquisition by insurer j, and α_i and α_j are bond and insurer fixed effects. The sample includes only the insurer-bonds pairs that were valued by internal models in 2008. Coefficient of interest is δ which measure the relationship between reported credit spread of a bond in a given year and its credit spread at acquisition. Standard errors are clustered at insurer level. Significance: * 10%; ** 5%; *** 1%.

	2005	2006	2007	2008	2009	2010	2011
	I	II	III	IV	V	VI	VII
CS_{ij}^{Acq}	0.157	0.162	0.133	0.305***	0.419***	-0.027	0.015
	(0.203)	(0.153)	(0.121)	(0.056)	(0.079)	(0.122)	(0.026)
R-squared	0.795	0.874	0.893	0.752	0.878	0.893	0.836
Observations	5061	5913	7171	8257	6864	5412	3622
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Insurer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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Table A.3: Misreporting within the Same Bond

The table shows how the cross-sectional dispersion in reported credit spreads of the same bond across insurers in 2008 depend on the valuation method and holding structure of the bonds. We estimate:

$$CS_{ij} = \delta IM_{ij} + \alpha_i + \alpha_j + \epsilon_{ij},$$

where CS_{ij} denotes the reported credit spread of bond i held by insurer j, IM_{ij} is a dummy variable for bond i that takes a value of 1 if insurer j valued the bond using an internal model, and α_i and α_j are bond and insurer fixed effects. The sample includes all bonds that were valued by at least one insurer using an internal model in 2008. We first estimate the model separately for bonds that held by just two insurer (Column I and II), less than 5 insurers (Column III and IV) and subsequently estimate the model on full sample (Column V and VI). Coefficient of interest is δ which compares the reported credit spread of a bond of an insurers that use internal model with the reported credit spread of an insurers that use an external source to value the same bond at the same time. Table shows standard errors in parentheses. Standard errors are clustered at insurer level. Significance: * 10%; ** 5%; *** 1%.

	Two Insurers		Less than 5 Insurers		All Insurers	
	I	II	III	IV	V	VI
IM_{ij}	-0.008**	-0.015***	-0.004*	-0.007***	-0.001	-0.000
	(0.004)	(0.005)	(0.002)	(0.003)	(0.001)	(0.002)
R-squared	0.914	0.926	0.933	0.938	0.952	0.953
Obs.	4124	4008	10879	10836	94371	94364
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes
Insurer FE	No	Yes	No	Yes	No	Yes

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Table A.4: Transactions in TRACE

Bonds that have more concentrated holding structures trade less than bonds that have less concentrated holding structures. We formally test this relationship after accounting for differences in bond and issuer specific characteristics by estimating the following specification:

$$Dummy_i^{TiN} = \delta(CO_i) + \beta X_i + \alpha_k + \epsilon_i, \tag{C.1}$$

where $Dummy_i^{TiN}$ is a dummy variable for bond i that takes a value of 1 if the bond had at least one transaction in 2008, CO_i is a dummy variable for bond i that takes a value of 1 if a bond is held by up to two insurers in 2008, X_i are bond level controls, and α_k are issuer fixed effects. Bond level controls include credit rating and maturity. The sample conditions on bonds that existed in 2008.[31] The variable of interest, δ, measures the difference in the probability of finding a transaction in TRACE between bonds with more concentrated holding structure and less concentrated holding structure. Table shows standard errors in parentheses. Standard errors are clustered at issuer level. Significance: * 10%; ** 5%; *** 1%.

We find that the probability of finding a transaction in TRACE for bonds with more concentrated ownership is 50 percentage points lower after controlling for rating and maturity (column I). In column II, we add issuer fixed effects, which helps control for other issuer characteristics not controlled by rating and maturity. δ is now identified by comparing bonds of the same issuer. We find that probability of finding a transaction is 22 percentage points lower for bonds with more concentrated ownership.

	$Dummy^{TiN}$	
	I	II
CO_i	-0.515***	-0.215***
	(0.017)	(0.016)
Constant	0.741***	
	(0.017)	
R^2	0.282	0.834
Observations	12994	9375
Issuer Fixed Effects	No	Yes
Controls	Yes	Yes

[31] As transactions of private placements are not reported in TRACE, we exclude them from sample.

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Table A.5: Fragmented State Level Reporting and Cross-sectional Dispersion

Table shows the average cross-sectional standard deviation of reported fair values and credit spreads in 2008. To measure the state level dispersion, we first compute the cross-sectional standard deviation of the reported fair values and credit spreads for each bond within a state. We then compute the mean for internal model (IM) and non-internal model (non-IM) valued bonds separately for all bonds within a state and then take an mean across US states. For state level analysis, a bond is classified as internal model if at least one insurer valued it using an internal model within a state. To measure the overall U.S. level dispersion, we compute cross-sectional standard deviation of the reported values for each bond across all states of U.S. and then compute the mean of all internal model (IM) and non-internal model (non-IM) valued bonds separately. For overall U.S. level analysis, a bond is classified as internal model if at least one insurer valued it using an internal model across any state.

	Within U.S. states		Overall U.S.	
	$\sigma(CS)$ (%)	$\sigma(FV)$ ($)	$\sigma(CS)$ (%)	$\sigma(FV)$ ($)
IM	1.1	4.26	1.55	4.5
Non-IM	0.27	0.83	0.7	1.2

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