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Corporate Bond Complexity

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We study how a firm's bond structure affects the pricing of its bonds and its base of bond investors. We define *bond complexity* as the tangle of contractual terms of all outstanding bonds of a firm, and find that it increases bond yield spreads. Specifically, a 1-standard deviation higher complexity is related to about 17 bps of higher yield spreads. To put this into context, a one-notch downgrade in credit rating in the same regression is estimated to cause a 62-bp increase in bond yields. The pricing effect of complexity is more pronounced during uncertain times. We also show that complexity induces a clientele effect, i.e., complex bonds are held mostly by informed investors or yield-seeking investors. Moreover, complex bonds tend to be subject to higher investor disagreement. Our results suggest that complexity makes it difficult to gather and process information on a bond's true value, and creates uncertainty about the overall degree of property rights of bond investors.

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Introduction

Asset complexity can complicate the accurate valuation of assets, increasing uncertainty about their value, and affecting their price, volatility, and liquidity (Brunnermeier and Oehmke, 2009; Carlin, Kogan, and Lowery, 2013). The notion of asset complexity has garnered growing attention from academia and practitioners alike since the recent global financial crisis. But the focus has been mostly on financially structured products – e.g., asset-backed securities (ABS) and collateralized debt obligations (CDO). The potential impact of complexity on primary assets has been largely overlooked thus far. In this paper, we aim to fill this gap by studying the role of asset complexity in corporate bonds.

While both corporate bonds and stocks base their payoffs on the same cash flows of the firm, bonds are more complex in terms of their contractual provisions. This is because not only bonds may have embedded optionality and special features, but also because if multiple bonds for the same firm are outstanding at the same time, the value of each one of them depends on the provisions embedded in all the others (e.g., Oehmke and Zawadowski, 2017). For example, AT&T had 74 bonds outstanding as of May 2013, and bond investors in any of them would have needed to examine all of them to assess real exposure to the firm's credit risk.

The key issue is that *bond-specific terms on one bond, meant to affect only the bond in question, can indirectly change the cash flow rights and protections of the others*. Whether a bond is convertible or callable may change the amount of cash available to the other bondholders, who must assess the probability that such bonds will continue to be around in the foreseeable future. Likewise, the trigger of a covenant on one bond may have consequences for the others.[1] The ability of the existing covenants to protect new bondholders depends on the existence of the bonds to which they are attached.

[1] Consider, for example, a firm with three bonds of differing maturities, each with a different type of covenant. The covenant on the first bond restricts the firm from engaging in share repurchases; the covenant on the second restricts the firm from engaging in M&As; and the covenant on the third restricts the firm from issuing collateralized debt. Clearly, each covenant has positive protective effects for all firm bonds. However, the fact that such covenants exist on different bonds with different features – e.g., maturity or collateralization – makes it challenging for bondholders to fully grasp the extent of the protection. What will happen if the bond with covenant protection expires? Will the bondholders with collateralized assets trigger the violation of covenants if they are breached? This involves a very complicated probability assessment analysis of many scenarios.

The requirement to consider all bonds can be daunting, especially when each bond has different contractual terms (e.g., maturity, rating, coupon, collateral, covenants, embedded options and features, etc.). We argue that this tangle of contractual conditions requiring *joint analysis of all outstanding bonds* (henceforth, "*bond complexity*") can entail a cumbersome and hard gathering and processing of information, which makes it difficult to assess the bond's value and creates uncertainty about the overall degree of property rights of bond investors. Complexity makes it more difficult to use "comparable pricing" – a key pricing determinant in corporate credit markets (Murfin and Pratt, 2019). Therefore, we expect that, while firms gain flexibility by issuing corporate bonds of varying contractual terms, the ensuing complexity will affect the pricing of the bonds.

In particular, we posit that, in the presence of information incompleteness in the corporate bond market,[2] the degree of corporate bond complexity will negatively affect bond prices because of adverse selection. Greater complexity hinders information processing. As a result, bond investors, who are less informed than issuers, will demand a discount on bond prices, or higher bond yields (Arora, Barak, Brunnermeier, and Ge, 2010; Carlin, Kogan, and Lowery, 2013; Duffie and Lando, 2001; Furfine, 2011).

We argue further that, in equilibrium, the higher uncertainty will induce a "clientele effect," where complex bonds are held mostly by two classes of investors: the most informed investors (those with superior information processing skills), and those looking for higher yields. In the latter case, we expect that bond complexity allows investors, constrained in their choice of rating and maturity and in terms of their ability to leverage, to increase performance. In other words, complexity represents a shield to invest in more risky assets while sidestepping the constraints imposed by regulation and mandates defined in terms of traditional ratings. Therefore, we expect regulation-constrained bond investors who "reach for high yields" (Becker and Ivashina, 2015) to invest in more complex bonds. This is similar in spirit to leverage-constrained fund

[2] See, e.g., Bessembinder, Maxwell, and Venkataraman, 2006; Edwards, Harris, and Piwowar, 2007; Goldstein, Hotchkiss, and Sirri, 2007; Bessembinder and Maxwell, 2009; Bao, Pan, and Wang, 2011.

managers who invest in higher beta stocks to attain higher returns (the "betting against the beta" phenomenon, see Frazzini and Pedersen, 2014).

We test these conjectures using the sample of (non-financial, non-utility) U.S. companies that issued corporate bonds publicly during the 1998-2018 period. Our analysis provides three main empirical findings on the link between bond complexity and bond yields, bond ownership, and bond uncertainty. First, we document a pricing effect of bond complexity.[3] We find the latter to be positively associated with yield spreads even after controlling for well-known determinants of yield spreads such as rating, maturity, and illiquidity. Specifically, a 1-standard deviation (SD) higher complexity is related to about 17 basis points (bps) of higher yield spreads. To put this into context, a one-notch change in credit rating in the same regression is estimated to cause a 62-bp increase in bond yields.

We address any potential endogeneity of our complexity measure by using exogenous shocks in a difference-in-differences setting, with two experiments: the founder Bill Gross's resignation from PIMCO, the prominent investment management firm, and the introduction of a new accounting standard, SFAS 160. In the first setting, we consider how Bill Gross's sudden resignation, during 2014Q3, triggered a large fund outflow, forcing PIMCO to sell its bonds to meet redemption demands. Given the size of PIMCO, and the depth and breadth of its bond market investments, this represented a negative capital supply shock for companies invested in PIMCO's portfolios (Zhu, 2021). The sudden portfolio reshuffling also represented an ideal exogenous shock, not related to company-specific characteristics. As a result, we argue that such selling pressure should drive down the market price of PIMCO-held bonds, with a larger impact for more complex bonds.

Our empirical results confirm this conjecture. The "treated" firms – i.e., those experiencing high PIMCO-related (fire) sales – exhibit increased yield spreads of about 27 bps after the founder's departure,

[3] We describe our firm-level measure of bond complexity in more detail in the Data section. In brief, it is designed to capture heterogeneity in contractual terms across different bonds of the same firm.

relative to control firms. Note that the impact is more pronounced for complex bonds, so that a 1-SD higher degree of complexity is related to about an 8-bp further increase in yield spreads.

In our second setting, we exploit the accounting-based shock introduced in 2008 by a new accounting standard, SFAS 160, which affected only a subset of ("treated") firms in our sample.[4] The new accounting standard mechanically increased the slack of the net worth covenant (Cohen, Katz, Mutlu, and Sadka, 2019). This made bond valuation even more difficult due to increased uncertainty about firm behavior and its impact on bondholders. Frankel, Lee, and McLaughlin (2010) posit that the economic consequence of SFAS 160 is as yet uncertain, and tricky for bondholders to understand due to its many costs and benefits. We expect such higher valuation difficulty to be amplified by bond complexity. Indeed, while the treated firm's bonds experience a 2-bp increase in yield spreads, the effect is more salient for firms with higher bond complexity. Specifically, a 1-SD higher complexity translates into a further 29-bp increase in yield spreads.

Once we can determine the link between bond complexity and yield spreads, we investigate whether and how complexity shapes the bond investor clientele. We begin by focusing on the link between complexity and investor informativeness. As we argue, complex bonds entail higher valuation uncertainty, and, hence, require a better level of information processing. In equilibrium, we should therefore observe that these bonds are held mostly by more informed investors, or those with superior information processing skills. We identify such investors using bond fund data from eMAXX with three different criteria: investment horizon, portfolio turnover, and portfolio concentration.

We document that our bond complexity measure is positively and statistically significantly related to all the three measures. Specifically, a 1-SD higher degree of complexity is related to a 1.4% increase in holding by short-term investors (corresponding to 6% of SD of the variable). For high-portfolio turnover investors, the number is 0.4% (3% of SD), and for high-portfolio concentration investors, it is 0.2% (2.9% of SD). For comparison, a one-notch downgrade in credit rating is estimated to cause 0.6%, 0.5%, and 0.3%

[4] Financial Accounting Standards No. 160 (SFAS 160) changed the treatment of non-controlling/minority interests in a consolidated entity. Prior to SFAS 160, minority interest was reported as debt – either in liabilities or the mezzanine section between liabilities and equity. The new regulation allowed firms to report it as equity rather than debt.

increases in bond ownership by short-term, high-portfolio turnover, and high-portfolio concentration investors, respectively. These results suggest that information processing is costlier for bonds of firms with more complex bond structures. Such bonds are therefore less attractive to investors without informational advantages.

As we noted earlier, a second class of investors may also be interested in loading on complex bonds: those reaching for yield (RFY) in choosing their investments (Becker and Ivashina, 2015; Choi and Kronlund, 2018). By offering yields higher than the ones offered by their peer bonds of similar maturity and rating, complex bonds are a good investment class for funds that are constrained in their choice of rating and maturity.[5] RFY investors may be the more informed ones we mentioned before, or simply less informed investors who are willing to take more risk in exchange for higher yields.

We test this conjecture in two ways. First, we define the RFY for a given bond as the difference between the bond's yield and the average yield of bonds with similar credit ratings and maturity, compute the firm's RFY as the value-weighted average of the RFY of its existing bonds, and document that bond complexity is positively related to the firm's RFY. This evidence suggests that complex bonds are a good investment for RFY-incentivized investors as they would prefer higher yields for the given rating and maturity. Next, we zoom on the investors and define their desire to reach for yield. In particular, we define the RFY for a bond investor as the portfolio holding-weighted average of the RFY of the bonds held by a given bond fund. The bond funds with a strong incentive of the RFY – "high RFY funds" – are the ones with the above sample median value of the fund RFY. Then, we calculate the proportion of the firm's bond held by high RFY funds. This bond ownership measure will capture the degree to which RFY-incentivized funds invest in a given firm's bonds. Using this measure, we document that bond complexity increases the bond ownership held by high RFY funds.[6] Specifically, a 1-SD increase in bond complexity is related to a 21-bp

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[5] Indeed, Célérier and Vallée (2017) find that banks use product complexity to cater to yield-seeking investors, especially in a low rate environment.

[6] High RFY funds are defined as bond funds for which the value of portfolio holding-weighted average of the *RFY* of the bonds they hold is above the sample median.

higher degree of firm RFY, and a 0.6% higher ownership held by high RFY funds. These results suggest that complexity and RFY are related: complex bonds, by offering higher yields relative to others with the same rating and maturity, induce those RFY-incentivized investors who value yields highly to invest more in them (*reaching for complexity*, or RFC).

Second, we focus on the link between investors' reaching for yield and the future return of complex bonds. If the tendency of bond funds to invest in complex bonds drives up current prices above the fundamental level, we expect the price to revert subsequently. This should lead to lower future returns (Frazzini and Pedersen, 2014; Chen and Choi, 2020). And indeed, we document a strong negative correlation of bond complexity with future returns. Specifically, a 1-SD higher degree of bond complexity for a given quarter is associated with about 4 bps per month of lower bond returns for the subsequent period (or 48 bps per annum).

Overall, these results support the hypothesis that investors who value yields are likely to invest in complex bonds. The fact that the results hold even after controlling for rating, maturity, and other bond characteristics suggests the investment is not determined solely by a general desire to invest in all high yield bonds. Rather, investors more selectively identify those with high yields due to complexity. This may be due to existing mispricing induced by lack of information, or by the desire to "hide" their actions behind complexity in the valuation of such bonds.

To confirm that complexity pertains to the difficulty in understanding (and, hence, the greater uncertainty/disagreement about) bond values, we provide some direct evidence. First, we attempt to capture bond value uncertainty by using two different empirical proxies: bond trading volume (Banerjee and Kremer, 2010) and bond holding dispersion across institutional investors (Nozawa, Qiu, and Xiong, 2021). We find that our bond complexity measure is positively and statistically significantly associated with both. Thus, complex bonds are subject to more disagreement about value among investors. As a result, they are traded more frequently and held more unequally among bond investors. More specifically, a 1-SD increase in complexity is associated with about an 0.08 higher log trading volume (4% of SD) for a given quarter, and a 0.11 (or one quarter of SD) larger dispersion in institutional investors' portfolio weights. For comparison, a one-notch downgrade in credit rating is estimated to cause about a 0.03 higher log trading volume and a 0.02 larger dispersion in investors' portfolio weights.

Second, we investigate whether the pricing effect of complexity is stronger during uncertain times, by using four proxies for macro uncertainty: global economic policy uncertainty (Baker, Bloom, and Davis, 2016), real uncertainty, financial uncertainty (Jurado, Ludvigson, and Ng, 2015), and the CBOE volatility index, the VIX. We find that bond complexity interacts positively with macro uncertainty regardless of the proxy variable used. So the positive association between complexity and yield spreads is amplified during uncertain times, or when the value of macro uncertainty is above the sample median. The economic magnitude of the coefficients on complexity is two to four times higher during times of uncertainty.

As a robustness test, we examine the possibility that our complexity measure may pick up the effect of the number of bond issues outstanding. In our sample, the two variables are strongly correlated. A higher number of bonds indicates a larger dispersion of bondholders, and can affect yield spreads via the channel of renegotiation cost (Davydenko and Strebulaev, 2007).[7] In order to disentangle these two channels, we explicitly control for the number of bond issues, and find that bond complexity remains statistically significant with positive coefficients. Thus, complexity is distinct from the pure number of bonds.

We control further for the Herfindahl index of bond issues' amount as a direct measure of bondholder dispersion. Our results also hold here, suggesting that bond complexity is not a pure proxy for the number of bonds. In fact, folk theorem would suggest that a higher number of bonds, by providing more signals, should reduce information uncertainty.

Our paper contributes to the literature in several key ways. First, our work contributes to a growing literature on asset complexity in financial markets by documenting the asset pricing implication of

[7] Davydenko and Strebulaev (2007) argue that bondholder dispersion, proxied for by the number of bonds outstanding, would increase the failure of renegotiation. It could therefore reduce ex ante the probability of a firm's strategic default and decrease bond yield spreads.

complexity on corporate bond prices. We note that one strand of the literature on the contingent claims pricing models of corporate bonds (e.g., Brennan and Schwartz, 1977; Jarrow, Li, Liu, and Wu, 2010) explores the price effect of bond-specific complexity (e.g., embedded call/put options, convertibility, etc.) at the *bond* level. However, to the best of our knowledge, we are the first to define and examine the complexity in bond structure at the *firm* level. In addition, unlike our paper, prior studies tended to limit their attention to structured financial products (Brunnermeier and Oehmke, 2009; Célérier and Vallée, 2017; Griffin, Lowery, and Saretto, 2014; Sato, 2014) or to an experimental setting (Carlin, Kogan, and Lowery, 2013).[8]

Second, our study is related to the recent literature on debt structure and debt heterogeneity. For example, Colla, Ippolito, and Li (2013) and Rauh and Sufi (2010) document that debt structure is heterogeneous across firms, and firms tend to specialize in certain types of debt. While these studies examine the economic factors that determine debt structure, we focus on the pricing implications. In addition, we do not take a firm's overall debt, but instead focus on one type of debt (corporate bonds), for which one might argue that there is less heterogeneity in their structure.

Third, our paper contributes to the burgeoning literature on how investors reach for yields. In the equity market, this has taken the form of investors "betting against beta" (e.g., Frazzini and Pedersen, 2014). In the debt market, it is described as "reaching for yield" (e.g., Becker and Ivashina, 2015; Choi and Kronlund, 2018; Rajan, 2011). The premise of both streams of literature is that investors take more risk than required by traditional pricing models – based on, e.g., market returns or ratings and maturity. We link such drives for yield to bond complexity. This allows us to identify any "mispricing" with respect to the standard model that is related to the degree of complexity of the bond profile within the structure of the claims in the overall firm portfolio.

[8] Carlin, Kogan, and Lowery (2013) find that complexity increases uncertainty regarding asset values, which exacerbates the adverse selection problem. They conduct an experiment to show that high complexity leads to increased volatility, lower liquidity, and decreased trade efficiency.

Fourth, by highlighting the important role of bond complexity in explaining institutional demand for corporate bonds, we contribute to the literature on corporate bond ownership and investor demand (e.g., Dass and Massa, 2014; Greenwood and Hanson, 2013; Massa, Yasuda, and Zhang, 2013). Our results also add to the empirical asset pricing literature on the cross-sectional determinants of credit spreads (e.g., Collin-Dufresne, Goldstein, and Martin, 2001; Elton, Gruber, Agrawal, and Mann, 2001) by showing complexity is an important factor in firms' credit spreads.

Lastly, by suggesting that information uncertainty critically affects bond investors, our results have important policy implications. We echo the view that standardization of corporate bonds may alleviate trading frictions and improve liquidity in corporate bond markets (BlackRock, 2013; Oehmke and Zawadowski, 2017). Our findings provide further support for regulators' proposals to make bonds publicly tradable in regulated exchanges, as opposed to privately exchanged over the counter.

2. Construction of Variables and Sample

Our data come from various databases. The bond issuance information comes from Mergent FISD, and includes: maturity, rating, coupon, offering date/amount, as well as various other bond contractual features (e.g., covenant, callable, putable, convertible, credit enhancement, etc.). The bond pricing data are combined from NAIC and TRACE. Institutional investors' bond holding data come from Lipper eMAXX.[9] We focus on non-financial straight corporate bonds, and exclude preferred bonds and government-sponsored enterprise bonds.

[9] The database contains detailed fixed-income holdings for nearly 20,000 entities, including U.S. and European insurance firms, U.S., Canadian, and European mutual funds, and leading U.S. banks and public pension funds. It provides information on the quarterly holdings of more than 40,000 fixed-income issuers, with USD $5.4 trillion in total fixed income at par value. We focus on U.S.-issued corporate bonds held by U.S. institutions. This sample has approximately 1,200 institutional investors every quarter, who hold a total face value of approximately USD $1.8 billion on average. For these institutions, eMAXX reports holdings based on regulatory disclosures to the National Association of Insurance Commissioners (NAIC) for insurance companies, and to the Securities and Exchange Commission (SEC) for mutual funds, asset managers, and public pension funds. It also reports voluntary disclosures by the major private pension funds. A detailed description of the data is provided in Dass and Massa (2014).

In the next section, we first outline how we construct our measure of bond complexity, followed by our sample construction method.

2.1 Bond Complexity

To construct our measure of bond complexity, we begin by constructing variables that capture heterogeneity in contractual features *across* firm bonds. This requires us to identify a firm's outstanding bonds (i.e., bonds that have been issued but have not matured or early redeemed in full yet) on the basis of the FISD table called "AMOUNT_OUTSTANDING." We record each bond's contractual terms based on the FISD table called "ISSUE." With this information in hand, we can create a dummy variable, *Contractual Feature* (*CF*), denoted by $\mathbb{I}_k$, for bond contractual feature k:

$$\mathbb{I}_k = \begin{cases} 1 & if \text{ bond contractual feature k is present/applicable} \\ 0 & if \text{ bond contractual feature k is absent/not applicable} \end{cases}, \qquad (1)$$

where

$$k \in \{redeem, call, put, exch, conv, cov, enh, sec, short, fore, fix\},$$

k refers to 11 different major categories of bond contractual features, for which we consider whether a bond is (*redeem*)*able*, (*call*)*able*, (*put*)*able*, (*exch*)*angeable*, or (*conv*)*ertible*. That is, if the bond is callable, the indicator variable, $\mathbb{I}_{call}$, equals 1, or 0 if non-callable. Similar definitions apply to our four remaining variables. We also consider the existence of bond (*cov)enants*, so that $\mathbb{I}_{cov}$ equals 1 if the bond has any covenant (regardless of its type) in its indenture, or 0 for no covenant at all. We also examine whether a bond has *credit (enh)ancements* (e.g., guarantees, letters of credit, etc.), or $\mathbb{I}_{enh} = 1$.

In addition to those seven readily available bond feature categories, we consider four more: *(sec)ured*, (*short)-term*, (*fore)ign currency*, or (*fix)ed coupons*. That is, $\mathbb{I}_{sec} = 1$ if the bond is senior secured, $\mathbb{I}_{short} = 1$ if the bond's remaining maturity is less than 5 years, $\mathbb{I}_{fore} = 1$ if the bond is U.S. dollar-denominated, and $\mathbb{I}_{fix} = 1$ if the coupon type if "fixed" as opposed to "variable."

The resulting bond-level contractual feature indicators (*CFs*) are then aggregated to construct two firm-level variables based on the first and second moments of their values across firm bonds. The first is

Contractual Feature Index (*CFI*), denoted by μ, which captures the overall presence of bond features. We define it in a similar spirit as the covenant index in Billett, King, and Mauer (2007): We calculate the average of the bond's *CFs* for each contractual feature category, denoted by μ_k, and then sum the averages before dividing them by 11:

$$\mu = \frac{\sum_{k \in \{redeem, call, put, exc \quad , conv, cov, enh, sec, short, fore, fix\}} \mu_k}{11}, \qquad (2)$$

where μ_k is the mean value of *CFs* for bond feature category k across the firm's N outstanding bonds:

$$\mu_k = \frac{\sum_{j=1}^{N} \mathbb{I}_{k,j}}{N}. \qquad (3)$$

The second variable is *Bond Complexity* (*BComp*), denoted by σ, which captures the heterogeneity (or variation) of *CFs* across a firm's bonds. We define this measure based on the average variance of *CFs*. We calculate the variance of *CFs* for each contractual feature k, ${\sigma_k}^2$, among N outstanding bonds, dividing the sum of the squares of the deviations of the *CFs* from their mean by N. We then compute the average of the eleven variances of *CFs*, and define our bond complexity measure as the square root of the average of sample variances of the bond's *CFs*, multiplied by 2.[10] That is, *BComp* is given as:

$$\text{BComp} = 2\sqrt{\sigma^2}, \qquad (4)$$

where

$$\sigma^2 = \frac{\sum_{k \in \{r, call, put, exch, conv, cov, enh, sec, short, fore, fix\}} {\sigma_k}^2}{11}, \qquad (5)$$

and

$${\sigma_k}^2 = \frac{\sum_{j=1}^{N} \left(\mathbb{I}_{k,j} - \mu_k\right)^2}{N}. \qquad (6)$$

[10] Mathematically, our bond complexity measure is essentially the same as within-group variation, a term used in ANOVA tests. Intuitively, it is in a similar spirit as the measure in Oehmke and Zawadowski (2017) that captures the overall heterogeneity of contractual features among different bond issues of a given firm. However, their measure only exploits six bond characteristics (i.e., putable, callable, convertible, fixed coupon, covenants, and credit enhancement), and is constructed differently. It is not a continuous variable like ours, as they employ a dichotomous variable to indicate whether the firm's bonds are homogenous (i.e., where all bonds have the same contractual features for all six dimensions) or heterogeneous (i.e., where *at least* one bond has all six contractual features that are not the same).

By construction, the value of σ ranges from 0 to 0.5, since it is the variance of a dichotomous variable (0 or 1).[11] We multiply σ by 2 so that *BComp* will range between 0 and 1. The value of 0 indicates no complexity because we have no heterogeneity in contractual terms across bonds, or there exists only one bond; the value of 1 indicates the maximum degree of complexity.

2.2 Sample Construction

Once we obtain the value for bond complexity (*BComp)* for all firms in the FISD database for the 1998Q2-2018Q1 period (except financial or utility firms), we augment the information with other bond characteristics in FISD, such as rating and maturity. All are aggregated at the firm level by taking the amount-weighted average of bond-level variables. Next, we merge them with the firm's bond yield spreads. These are computed at the firm level using quarter-end prices of corporate bonds in TRACE, NAIC, and Treasury bills, and quarter-end institutional bond holdings data in eMAXX, matched on 6-digit CUSIP numbers. We are left with 62,341 firm-quarter observations for the 1998Q2-2018Q1 period with non-missing independent variables. This sample consists of both public and private firms in the U.S. that offered public bonds. It will be used for the majority of our empirical analyses.

Table 1 reports the summary statistics of the variables in our final sample. The mean of the yield spreads is 397 bps, and the mean of the yield volatility, measured as the SD of daily yield spreads for a given quarter, is 0.84%. The average yield spreads are rather high, due to the presence of private firms in our sample. Among the other bond characteristics, the average bond in our sample has a BB+ credit rating, 8 years to maturity, is 6.7% coupon-bearing, and with 37% of covenant indices. We see a wide disparity in the number of bonds (*Bnum* ranges from 1 for P5 to 22 for P95), with an average of seven outstanding per firm.

Our summary statistics are generally in line with those from existing studies using data of public bonds issued by U.S. companies (private and public) from Mergent's FISD (e.g., Badertscher, Givoly, Katz, and

[11] Statistically speaking, σ^2 is the variance of the Bernoulli variable ($\mathbb{I}_{k,j}$) that attains the maximum value of 0.5 if the probability of $\mathbb{I}_{k,j} = 1$ is 0.5 (i.e., whether to have a bond feature is completely random).

Lee, 2019; Kovner and Wei, 2014). With respect to our bond complexity measure (*BComp*), the mean and SD are 0.35 and 0.20, respectively. We also observe a wide disparity in complexity across firms (0 for P5 and 0.61 for P95). Zero bond complexity indicates that the firm only has a single bond outstanding, or that there is no heterogeneity in any of the eleven contractual features.

3. Main Empirical Findings

3.1 Complexity and Bond Yield Spreads

We begin by focusing on the link between a firm's bond complexity and the average yield spreads of bonds issued by the firm. To this end, we estimate a panel data regression at the firm-quarter level that includes both firm- and quarter-fixed effects. We also use firm-level clustered standard errors:

$$YS_{i,t} = a + b \times BComp_{i,t} + \boldsymbol{c} \times \sum Controls_{i,t} + \alpha_i + \delta_t + \varepsilon_{i,t} \quad , \quad (7)$$

where $YS_{i,t}$ is bond yield spreads (in percent) of firm i for quarter t, measured by the value-weighted average of yield spreads of all outstanding bonds. A bond's yield spread is computed as its yield to maturity minus that of a Treasury bond with the same maturity. $BComp_{i,t}$ is our bond complexity measure of firm i for quarter t. We consider the following set of control variables: *Rating, Maturity, Illiquidity, Coupon, Size*, *Age*, *CovIndex,* and *CovMiss*, all of which are constructed at the firm level by aggregating bond-level observations with the value-weighted average: *Rating* is bond credit ratings,[12] *Illiquidity* is the proportion of zero trading days per quarter, *Maturity* is remaining time to maturity in years, *Size* is the natural logarithm of bond amount (in thousands) outstanding, *Coupon* and *Age* are, respectively, bond coupon rates (in percent) and bond ages (in log), *CovIndex* is the covenant index, as in Billett, King, and Mauer (2007),[13] and *CovMiss* is a dummy variable that equals 1 if *CovIndex* is missing.

[12] We assign a numerical number to rating notches ranging from 1 to 21, where AAA equals 1, AA+ equals 2, AA equals 3, AA- equals 4, and so on.
[13] This is defined as the sum of covenant dummies assigned to each of 15 different categories, where a covenant dummy equals 1 if a bond has the given covenant and 0 otherwise. We assign any missing data a value of zero.

Table 2 reports the regression results. We observe a strong positive correlation between bond complexity and bond yield spreads. This suggests that firms with more complex bond structures (or more heterogeneity across bonds) pay higher interest rates. This relationship remains statistically significant, with t-statistics ranging from 3.43 to 6.09, even after controlling for the larger number of bond characteristics. The economic magnitude of the effect is also sizable: A 1-SD higher complexity is correlated with about a 17-bp higher yield spread (in the case of Model 5). To put this number into context, we observe in our sample that a one-notch change in bond credit ratings is associated with a 62-bp increase in bond yields.

The estimates for the control variables in Table 2 are largely intuitive, but some deserve further explanation. First, *Maturity* carries a negative coefficient, which seems counterintuitive, but is actually consistent with the recent literature on bond rollover risk (e.g., Chen, Xu, and Yang, 2020; Hu, 2010). This strand of research attributes such a negative relationship between credit spreads and bond maturity to the heightened rollover risk of short-term bonds. Next, a positive coefficient on *CovIndex* appears at odds with the agency theory of covenants (e.g., Smith and Warner, 1979). But it is attributable to the fact that the presence of covenants proxies for a firm's credit risk (Bradley and Roberts, 2015). Finally, we note that the effect of bond complexity is diminished, but not subsumed, by the inclusion of *Rating*, which is highly correlated with *BComp*. That is, although our complexity measure may pick up some effects of credit risk (proxied for by *Rating*) on yield spreads, it still captures a different dimension of bond pricing effects.

To address the potential endogeneity of bond complexity with respect to bond pricing, and to assess whether bond yield-complexity relations are causal or a mere correlation, we use the two quasi-experiments discussed earlier. One is the sudden resignation of founder Bill Gross from PIMCO during 2014Q3; the other is the introduction of a new accounting standard, SFAS 160, during 2008. For each experiment, we estimate the same econometric specifications, or a DiD regression with triple interaction terms included:

$$YS_{i,t} = a + b_1\, BComp_{i,t} \times Treat_i \times Post_t + b_2\, BComp_{i,t} \times Treat_i + b_3\, BComp_{i,t} \times Post_t + b_4\, Treat_i \times Post_t \quad (8)$$

$$+ b_5\ BComp_{i,t} + b_6\ Treat_i + b_7\ Post_t + \boldsymbol{c} \times \sum Controls_{i,t} + \alpha_i + \delta_t + \varepsilon_{i,t},$$

where both *Treat* and *Post* are dummy variables whose definition are described separately for each experiment. We use the same set of control variables as those in equation (7), include firm- and quarter-fixed effects, and we cluster standard errors at quarter levels. The coefficients of our main interest are b_1 and b_4.

Bill Gross's sudden departure from PIMCO during 2014Q3 triggered large redemptions from all of PIMCO mutual funds. As founder and CIO, Gross had become one of the most famous fixed-income fund managers. PIMCO was forced to fire sale their bond holdings to meet the redemption demands. Given the size of PIMCO and the depth and breadth of its bond market investments, this represented a negative capital supply shock for companies who held bonds in PIMCO's portfolios. The sudden portfolio reshuffling also represented an ideal exogenous shock, not related to company-specific characteristics (as, for example, a downgrade of the company). We would expect the shock-induced selling pressure to decrease PIMCO-held bonds. Such an impact is more pronounced among complex bonds – because they are more difficult to understand and price in a short amount of time.

In estimating the DiD regression in equation (8), we focus on the subperiod of four quarters before and four quarters after Gross's departure during 2014Q3. Similarly to Zhu (2021), we define treated firms (*Treat=1*) as those whose bonds were overweighted by PIMCO portfolios at the end of 2014Q3, and control firms (*Treat=0*) as those whose bonds were overweighted by Prudential and Vanguard, the second and third largest bond investors, respectively, at that time after PIMCO. Our treated (control) firms have 3% of outstanding bonds in PIMCO (Prudential and Vanguard combined) portfolios as of the end of 2014Q3.[14] *Post* is a dummy variable that equals 1 for 2014Q4 to 2015Q3, and 0 for 2013Q3 and 2014Q3.

[14] As Zhu (2021) points out, the selection criterion of at least 3% of bond holdings is used because PIMCO's market share of corporate bonds at the time of Gross's departure was 3%.

Table 3 reports the results in the first three columns. We note several distinct findings. First, PIMCO-held bonds – for which the supply shock should be the worst – display an increase in yield spreads of about 37 bps (the interaction term, *Treat* × *Post* in Model 1), with statistical significance at the 1% level. This finding is in line with Choi, Dasgupta, and Oh (2020), who report a 14-bp increase in CDS spreads for PIMCO-held bonds compared to Prudential- or Vanguard-held bonds after Bill Gross's resignation. More important and new, we find this effect is reinforced by the degree of complexity of the bonds, as indicated by a positive regression coefficient on the three-way interaction terms, i.e., *BComp* × *Treat* × *Post* (Model 2). Specifically, a 1-SD higher degree of complexity is related to about an 8-bp further increase in yield spreads. Checking the validity of a parallel trends assumption for our DiD setting, we do not observe any significant difference in time trends of yield spreads prior to 2014Q3 for complex vs. non-complex bonds among treated firms. This is indicated by an insignificant coefficient on *Complexity* × *Treat* × *Pre* in Model 3. [15] This contrasts with the coefficient on *Complexity* × *Treat* × *Post*, which remains statistically significant at the 5% level. These results suggest that divergence in yield spreads across complexity only emerges after the shock.

Next, to bolster our experimental result with PIMCO, we consider the introduction of a new accounting standard in 2008, SFAS 160. SFAS 160 requires firms to reclassify minority interests as equity rather than liabilities, and it increases the net worth covenant slack by raising equity. We argue that these changes make it more difficult for the market to assess the value of bonds accurately, due to the increased uncertainty about firm behavior and its impact on bondholders. Frankel, Lee, and McLaughlin (2010) find that the economic consequence of SFAS 160 is uncertain, and complex for bondholders to understand due to the various costs and benefits associated with it. We expect such uncertainty to be greater for firms with more complex bond structures. Therefore, all else being constant, we should observe bond yield spreads to widen

[15] A dummy variable we call *Pre* equals 1 for 2014Q2 and 2014Q3 (i.e., the second half of the pre-resignation period), and 0 otherwise.

after the adoption of SFAS 160 as compensation for uncertainty-averse bondholders. The increase should be more pronounced for bonds of firms with more complex bond structures.

Estimating the DiD regression in equation (8), we focus on the subperiod of two years before and two years after 2008, when SFAS 160 was introduced.[16] In line with Cohen, Katz, Mutlu, and Sadka (2019), *Treat* indicates a firm affected by SFAS 160. We define *Treat* as a time-invariant dummy variable that equals 1 if a firm reports a positive minority interest at the end of 2008, and if at least one of its bonds has relevant (i.e., net worth) covenants present in its indenture, and 0 otherwise. *Post* indicates the post-SFAS 160 period, defined as a dummy variable that equals 1 for 2009 and 2010, and 0 for 2006 to 2008.

We report the SFAS 160 results in the last three columns of Table 3. Several observations are noteworthy. First, we confirm our conjecture that the bond yield spreads of treated firms increase after the adoption of SFAS 160 relative to those of control firms. This is shown by a significantly positive coefficient on the interaction term, *Treat* × *Post*, in Model 4. Specifically, treated firm's bonds experience a 68-bp increase compared to control firms after SFAS 160. Second, and more importantly, we document that the pricing impact is more pronounced among firms with more complex bond structures. This is shown by a significantly positive coefficient on the three-way interaction term, *Complexity* × *Treat* × *Post*, in Model 5. Specifically, the magnitude of the coefficient, 1.43 in Model 5, translates into a 1-SD higher complexity, and accounts for a 29-bp higher yield spreads among treated groups.

Similarly to the PIMCO case, we test for pre-trends of yield spreads between complex vs. non-complex bonds among treated firms in order to ensure the validity of a parallel trend assumption for our DiD setting. The coefficient on *Complexity* × *Treat* × *Pre* in Model 6 captures (non-)parallel trends in yield spreads for treated firms with more complex bonds. The result shows that its coefficient is statistically insignificant.

[16] Financial Accounting Standards No. 160 (SFAS 160) changed the treatment of non-controlling/minority interest in a consolidated entity. Before SFAS 160, minority interest was reported as debt (either in liabilities or the mezzanine section between liabilities and equity). The new regulation allowed firms to report minority interest as equity. The direct effect of this change was to impact the leverage ratios of firms (e.g., Mulford and Quinn, 2008; Leone, 2008; Deitrick, 2010; Cohen, Katz, Mutlu, and Sadka, 2016). Moreover, this shock directly affected the "distance to covenant violation" for companies with covenants on their bonds.

Thus, during the pre-SFAS 160 period, bond complexity does not appear to affect the difference in yield spreads between treated and control bonds.

To summarize, our DiD exercises reveal that the adverse shock to bond prices – the negative capital supply shock for PIMCO, and an uncertainty shock for SFAS 160 – is more severe for the bonds of firms with complex bond structures. These results corroborate our previous findings that bond complexity makes it more difficult for bond investors to understand bond values. Therefore, risk-averse investors are likely to react more adversely to these uncertainty shocks.

3.2 Complexity and the Bond Investor Base

Thus far, we have provided evidence that the degree of bond complexity of a firm affects the price of its bonds. In this section, we turn to the identity of bondholders, and assess whether bond complexity will affect the firm's bond investor base. We are particularly interested in how informed the base is, and whether that informativeness is affected by the degree of complexity of the firm's bond structure. Following the literature on lender behavior and information uncertainty (e.g., Sufi, 2007; Byun, Hwang, and Lee, 2011), we argue that a complex bond, given its higher valuation uncertainty, creates more space for informed investors. We expect that they will hold a higher proportion of its amount. For example, hedge funds and mutual funds are better at explicating bond information because they spend resources on processing existing public information to create more precise and valuable public information to trade upon (e.g., Kim and Verrecchia, 1994; Lin, Massa, and Zhang, 2014).

We test empirically for a relation between bond complexity and the proportion of informed bondholders, constructing the latter using bond fund holding data from eMAXX. We construct three proxy variables: *ST_Own*, *HT_Own*, and *Concen_Own*. *ST_Own* (*HT_Own*) is defined as the proportion of bond amount held by short-term (high-portfolio turnover) bond funds to the total bond amount. These variables are based on the standard literature positing that institutional investors with shorter trading horizons tend to be more informed (e.g., Yan and Zhang, 2009). We first calculate the proportion of bond amount held by short-term (high-portfolio turnover) funds at the bond level, and then aggregate them at the firm level by taking the bond amount-weighted average.[17] *Concen_Own* is defined as the proportion of bond amount held by bond funds with high (i.e., above the sample median) portfolio concentration. This is based on the idea that informed investors tend to concentrate more of their portfolios in assets for which they have better information (e.g., Kacperczyk, Sialm, and Zheng, 2005). We define concentrated funds as the bond fund for which the Herfindahl index of its holdings over the bond's credit rating categories is above the sample median. 54% of bonds' total amount of the average firm in our sample are held by short-term (vs. long-term) investors, 17% by investors with high (vs. low) portfolio turnover, and 3% by rating-concentrated funds.

Table 4 reports the results for the bond investor base, and shows that complexity is positively correlated with having informed bond investors. This holds for all the three definitions of being informed. Specifically, a 1-SD higher complexity is related to an increase in proportion of short-term investors' bond holdings by 1.4% (corresponding to 6% of SD), to high-portfolio turnover investors' holdings by 0.4% (3% of SD), and to high-portfolio concentration investors' holdings by 0.2% (2.9% of SD). These findings confirm the presence of a clientele effect of bond complexity: the higher the complexity of a firm's bond structure, the more likely its bonds will be held by more informed investors, due to their advantage of being able to process information about bonds' true value.

Next, we consider a second type of clientele: yield-seeking investors. Bond complexity is a barrier to less informed investors, but it can provide a good investment opportunity for those seeking high yields. As shown in our baseline results, complexity increases bond yields after controlling for maturity and rating class. This implies that many investors who are constrained along those terms, and cannot borrow due to capital requirements, could increase performance by investing in complex bonds. In other words,

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[17] We include finance companies, hedge funds, investment managers, and mutual funds as short-term institutional investors, using the code provided by eMAXX. Notably, it excludes other major bond investors, such as pension funds and insurance companies. Bond funds' portfolio turnover is computed as the lesser of purchases or sales divided by average total net assets. High-portfolio turnover funds are defined as the funds for which the value of the portfolio turnover is above the sample median.

complexity represents a shield with which to invest in more risky assets while sidestepping the constraints imposed by regulation and mandates. This is very similar to the intuition of "betting against the beta" (e.g., Frazzini and Pedersen, 2014), or the "reaching-for-yield" (RFY) investors (e.g., Becker and Ivashina, 2015). We therefore assess whether bond complexity is linked to bond investors' tendency to reach for yield.

We follow Choi and Kronlund (2017) and construct the RFY measure at the bond level, which is then aggregated at the firm level. This measure will indicate the extent to which the yield of a firm's bonds deviates from the benchmark yield. More specifically, for firm i, $RFY_{i,t}$ is computed as the value-weighted average of bond-level RFY ($RFY_{i,j,t}$) across all outstanding bonds of the firm, where $RFY_{i,j,t}$ is the deviation of the yield of the j^{th} bond of firm i from the yield of the benchmark bonds. That is,

$$RFY_{i,t} \equiv \sum_j w_{i,j,t} RFY_{i,j,t} = \sum_j w_{i,j,t} \left(y_{i,j,t} - y_{i,j,t}{}^{bc} \right) \quad , \qquad (9)$$

where $w_{i,j,t}$ is the weight of bond j's amount to the total amount of all of firm i's outstanding bonds, $y_{i,j,t}$ is the yield of bond j of firm i, and $y_{i,j,t}{}^{bc}$ is the benchmark yield applicable to bond j of firm i. The benchmark yield is the value-weighted average yield of all index-eligible corporate bonds within the same rating and maturity category as bond j in the FISD database, i.e., all IG (or HY) bonds that satisfy the inclusion criteria in the Barclays US Aggregate Bond Index (or Barclays Corporate High Yield Index). A higher (positive) value of RFY indicates the given bond offers investors higher yields than its peer bonds with similar rating and maturity.

Next, we define the proportion of firm i's bond ownership held by the particular investor type who reaches for yield ("High RFY Funds").[18] More specifically, we proceed as follows. For each bond j, we

[18] We identify "High RFY Funds" based on the RFY at fund level, where $RFY^F{}_{k,t}$ is above the sample average. For fund k, $RFY^F{}_{k,t}$ is computed as the holding-weighted average of bond-level RFY ($RFY_{k,l,t}$) across all bonds held by the fund for quarter t. That is,

$$RFY^F{}_{k,t} \equiv \sum_j w_{k,l,t} RFY_{k,l,t} = \sum_l w_{k,l,t} \left(y_{k,l,t} - y_{k,l,t}{}^{bc} \right), \qquad (10)$$

where $w_{k,l,t}$ is bond l's market weight in fund k's bond holdings, $y_{k,l,t}$ is the yield of bond l held by fund k, and $y_{k,l,t}{}^{bc}$ is the benchmark yield applicable to bond l for quarter t. A higher (positive) value of RFY^F indicates a stronger tendency of the fund to reach for yield (Choi and Kronlund, 2017).

define its ownership held the “High RFY funds” (the proportion of bond amounts held by “High RFY Funds” to total amounts outstanding). Then, for each firm i, we compute the value-weighted average of bond-level RFY_Own, ($RFY\_Own_{i,j,t}$) across all the outstanding bonds of the firm. This variable, $RFY\_Own_{i,t}$, proxies for the proportion of firm *i*’s bond ownership held by investors reaching for yield. That is,

$$RFY\_Own_{i,t} \equiv \sum_j w_{i,j,t} RFY\_Own_{i,j,t} = \sum_j w_{i,j,t} \left(\frac{AMT\ held\ by\ High\ RFY\ Funds}{AMT\ Outstanding}\right)_{i,j,t} \quad , \quad (11)$$

The higher value of $RFY\_Own_{i,t}$ indicates that a firm has a larger base of yield-chasing bond investors, potentially because the firm’s bonds offer the higher yield relative to others with the same rating and maturity (or, the higher value of $RFY_{i,t}$), and hence they are more attractive for those reaching for yield to invest in. In our sample, $RFY_{i,t}$ ($RFY\_Own_{i,t}$) has a mean of -0.16 (0.35) and a SD of 5.63 (0.30).

Once we construct the two measures of RFY ($RFY_{i,t}$ and $RFY\_Own_{i,t}$), we examine their link to bond complexity using the following panel regression. We include firm- and quarter-fixed effects and cluster standard errors at the firm level:

$$RFY_{i,t}\ (or\ RFY\_Own_{i,t}) = a + b \times BComp_{i,t} + \boldsymbol{c} \times \sum Controls_{i,t} + \alpha_i + \delta_t + \varepsilon_{i,t}, \qquad (12)$$

where the dependent variable is either $RFY_{i,t}$, the firm-level RFY measure for firm i, or $RFY\_Own_{i,t}$, the proportion of firm *i*’s bond amount held by the high RFY fund to total amount outstanding.

Table 5 reports our results. We find that bond complexity is positively associated with both the firm's RFY ($RFY_{i,t}$) and the proportion of bond amount held by high RFY funds ($RFY\_Own_{i,t}$). Specifically, a 1-SD higher bond complexity is correlated with 21-bp higher bond yields relative to other bonds in the same rating and maturity (column 1), and a 0.6% higher proportion of bond amount held by high RFY funds (column 2). These results suggest that complexity and RFY are related: complex bonds, by offering higher yields relative to others with the same rating and maturity, induce those RFY-incentivized investors who value yields highly but have regulatory constraints in terms of ratings to invest more in them (*reaching for complexity*, or RFC). The RFY investor’s RFC remains strong after we control for rating, maturity, and other characteristics. This suggests that the investment is determined not just by the desire to invest in all high yield bonds, but to more selectively identify those that have such high yields due to their complexity. This may be due to the existing mispricing induced by lack of information, as well as to a desire to "hide" their actions behind the complexity in the valuation of such bonds. Investors who load on complex bonds to reach for yields may be more informed. Or, they may be less informed investors who accept more risk in exchange for higher returns.

Next, we corroborate our result for bond complexity and RFY investors by examining the relation between *BComp* and future bond returns. Our rationale here is that, to the extent that high demand from fund investors for complex bonds drives up prices above the fundamental level, they will have lower future returns due to the prices reverting over time (Frazzini and Pedersen, 2014). To observe this more clearly, we approximate future bond returns, $R_{i,t+1}$, as a function of the bond yield, $Y_{i,t}$, and modified duration, $D_{i,t}$ (Campello, Chen, and Zhang, 2008; Chen and Choi, 2020):

$$R_{i,t+1} \approx Y_{i,t} - D_{i,t}\Delta Y_{i,t+1} \qquad (13)$$

Equation (13) shows a negative relationship between bond returns and bond yield changes after holding the current yield constant. That is, bond returns will remain the same as the current bond yield ($Y_{i,t}$) if it also remains constant (i.e., $\Delta Y_{i,t+1} = 0$). But an increase in bond yields ($\Delta Y_{i,t+1} > 0$) will lead to a reduction in returns concurrent with the extent of (positive) duration. As such, to the extent that overpricing (i.e., yields being too low) of complex bonds will experience an increase in yields due to a yield correction, their returns will decrease, holding the current level of bond yields and duration constant. The more complex the bond, the larger the increase in the yield, and hence the lower the return.

In order to test this conjecture, we regress bond returns on the lagged value of bond complexity, controlling for bond yield and duration as well as other control variables in the following panel regression. We include firm- and quarter-fixed effects, and cluster standard errors at the firm level:

$$FBRet_{i,t} = a + b\ BComp_{i,t} + c\ Yield_{i,t} + c\ Duration_{i,t} + \boldsymbol{e} \times \sum Controls_{i,t} + \varepsilon_{i,t}, \qquad (14)$$

where $FBRet_{i,t}$ is future bond returns for a given quarter t, computed as an average monthly return in percentage for the period of quarters $t+1$ to $t+4$. $Yield_{i,t}$ and $Duration_{i,t}$ are the bond yield and (modified) duration, respectively, for quarter t. The results are in Table 5, where we confirm the negative association between *BComp* and *FBRet* whether to control for duration (Models 3 and 4). Specifically, a 1-SD higher bond complexity is associated with around 4-bps per month (or 48 bp per annum) lower returns in the future.

3.3 Complexity and Bond Uncertainty

We have documented the pricing impact of bond complexity and its implication on bond investors. To provide greater assurance that our findings relate to valuation uncertainty, we provide further evidence. First, we examine whether bond complexity is associated with two different measures of bond uncertainty: bond trading volume – a proxy for investors' disagreement on asset value in the literature (e.g., Banerjee and Kremer, 2010) – and dispersion in institutional investor portfolio weights (Nozawa, Qiu, and Xiong, 2021).[19] If complex bonds entail more uncertainty, we expect a positive association between our bond complexity measure and those bond uncertainty measures.

Table 6, Panel A, reports our regression result for the relation between bond complexity and bond uncertainty. We confirm that bond complexity is positively and statistically significantly associated with all three uncertainty measures. Specifically, a 1-SD increase in complexity is associated with about a 0.08 (4% of SD) increase in log trading volume (*TrdVol*) for a given quarter. This implies complex bonds are subject to greater disagreement among investors, and are hence traded more frequently. It is also associated

[19] The dispersion of bond investors' holdings is measured by the coefficient of variation (CV) in portfolio weights across bond funds for firm i (Nozawa, Qiu, and Xiong, 2021):

$$CV_{i,t} = \frac{\sigma_{i,t}[w_{i,k,t}]}{E_{i,t}[w_{i,k,t}]}, \qquad (15)$$

where $w_{i,k,t}$ is fund *k*'s portfolio weights on the bonds issued by firm *i* in quarter *t*. If all investors hold well-diversified portfolios (e.g., the "bond market portfolio"), the value of CV will be 0, since the weights are equal across investors.

with a higher dispersion of investors' portfolio weights (CV) of 0.11.[20] For comparison, a one-notch downgrade in credit rating in the same regression is estimated to cause about a 0.03 higher log trading volume and a 0.02 larger dispersion in investors' portfolio weights.

Next, we compare the impact of bond complexity on yield spreads separately for the period with high- vs. low uncertainty. During highly uncertain times, we expect that bond complexity to aggravate the difficulty with which resource-constrained investors process information on a firm's bond. If this is the case, we should observe that the pricing impact of bond complexity is more pronounced. Following the literature, we consider three different proxy variables to capture uncertainty over time:[21] global economic policy uncertainty (Baker, Bloom, and Davis, 2016), real and financial uncertainty (Jurado, Ludvigson, and Ng, 2015), and the CBOE volatility index, VIX. The results, reported in Panel B of Table 6, show that, regardless of which proxy we use, the interaction term between bond complexity and the uncertain time indicator, $I_{Uncertinty}$ (a dummy that equals 1 for the period when the value of the uncertainty index is above the sample median, and 0 otherwise) carries highly significant positive coefficients. Specifically, the pricing effect of bond complexity is between two and four times higher for the period with higher macro uncertainty.

4. Robustness: Bondholder Dispersion

We have argued and shown that bond complexity captures bond valuation uncertainty arising from the heterogeneity of the contractual terms of all outstanding bonds of a firm, dubbed bond complexity. However, one may argue that it could also proxy for alternative features of bond structure. For example, since our measure of bond complexity is correlated strongly with the number of bond issues outstanding, our results may be merely picking up the effect of the number of issues, not necessarily bond feature heterogeneity. In

[20] As a robustness test, we also control for these two disagreement measures ($TrdVol$ and CV) in our baseline regression for bond yield spreads. The (untabulated) result shows that the significant effect of bond complexity remains unchanged.

[21] The data come from the author's website, https://www.policyuncertainty.com (global economic policy uncertainty index), and https://www.sydneyludvigson.com/macro-and-financial-uncertainty-indexes (real and financial uncertainty index).

fact, the number of bond issues could increase the complexity of bond structure mechanically without expanding the heterogeneity of bond contractual terms that we aim to capture here. Likewise, the number of bonds also captures bondholder dispersion, which in turn can affect bond yield spreads. In the standard literature (e.g., Bolton and Scharfstein, 1996), a larger number of bonds represents higher bondholder dispersion, making it difficult for bondholders to coordinate renegotiation. As such, firms with more bonds outstanding tend to commit to paying debt without strategic default, resulting in lower bond spreads (Davydenko and Strebulaev, 2007).

Therefore, to empirically distinguish bond complexity from bondholder dispersion, we now control for two relevant proxies from all of our previous regressions: the number of bond issues (*BNum*), and 1 – the Herfindahl index of outstanding bond issues (*BHHI*).[22] The result is reported in Table 7. We find that our earlier results of the effect of complexity on yield spreads (Model 1) and bond investor bases (Models 2 to 5) remain strongly positive and statistically significant, even after controlling for BNum (Panel A) or BHHI (Panel B). In contrast, neither proxy variable for bondholder dispersion yields consistent results across model specifications. For example, only some exhibit significant coefficients, with mixed signs at best.

We also revisit our results with regard to the conditional effect of complexity on macro uncertainty by controlling for either *BNum* $\times I_{Uncertinty}$ or *BHHI* $\times I_{Uncertinty}$ in order to explore whether our original interaction term, *BComp* $\times I_{Uncertinty}$, will be subsumed (Panel C). The result shows a relatively sharp contrast in estimated coefficients. The interaction term between complexity and macro uncertainty continues to carry a significantly positive coefficient. But the bondholder dispersion proxies (both *BNum* and *BHHI*) and macro uncertainty interact negatively. This means that the effect of bondholder dispersion on yield spreads diminishes during uncertain times, which is the opposite of the moderating effects by macro uncertainty. This result can be interpreted that more bonds imply more information – either because

[22] Herfindahl index$_i = \sum_j {B_{ij}}^2 \big/ \left(\sum_j B_{ij}\right)^2$, where B_{ij} is the face value at the offering of the j^{th} bond of firm i (Davydenko and Strebulaev, 2007; Oehmke and Zawadowski, 2017).

each bond is a distinct signal, or because companies that issue more bonds are larger and more established and therefore better known or followed by the market. Thus, the effect moves in the opposite direction – i.e., more bonds should reduce, as opposed to augment, the effect of complexity on bond yield spreads.

Conclusion

We study how the complexity in the contractual provisions of a company's bond structure affects bond pricing, investor bases, and uncertainty. We argue that bonds differ in their contractual terms (redeemable, exchangeable, coupon type, security level, etc.) as well as in which covenants they are subject to. Often, each bond of a company carries a different set of contractual features that empowers its owners, but may hinder the valuation process of other bond owners. This creates uncertainty about the overall degree of investor property rights. We argue further that bond complexity is priced and provides a key dimension of choice for asset managers who "reach for yields."

We test our hypotheses by focusing on a comprehensive sample of U.S. corporate bonds over the 1998-2018 period. We document that complexity is positively related to bond yield spreads. The pricing result is robust to addressing endogeneity using two different quasi-experiments: founder Bill Gross's sudden resignation from PIMCO, and the introduction of new accounting rule SFAS 160. In both cases, we show that the event exogenously increases yield spreads due to heightened bond uncertainty. More importantly, the yield spreads of complex bonds are affected the most by these shocks.

Once we determined a causal link between complexity and bond yield spreads, we focused directly on the link between complexity and the identity of bond investor bases. As expected, we document that higher complexity, by heightening bond uncertainty, is positively associated with bond ownership by informed investors, such as those with short-term investment horizons, high portfolio turnover, and high portfolio concentration. We also show that complexity is related to the reaching-for-yield phenomenon of bond investors. Thus, complexity increases bond RFY (i.e., a bond's yield beyond that of peers within the same rating and maturity). And complex bonds are more likely to be held by bond funds that exhibit the RFY tendency (i.e., tilting their portfolios toward high-RFY bonds). In other words, complexity increases the attractiveness of bonds for RFY investors.

We also find that complexity brings lower future returns, which can be interpreted as strong demand from complexity-seeking investors inflating current bond prices above fundamental levels. These results have important implications for our understanding of the RFY phenomenon. It is not necessarily based on higher risk taking, but on investments along a specific source of information: complexity.

Finally, we directly show that complexity increases bond valuation uncertainty, as measured by bond trading volume and the dispersion of bond investors' holdings. This result supports the economic rationale that complexity is priced due to heightened uncertainty to which investors are averse. They therefore demand a discount off bond prices. Overall, our results highlight that the heterogeneity of bond contractual terms makes firms' bonds more complex and difficult to understand.

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Appendix A: Construction of Bond Complexity Measure

Suppose there are $N_{i,t}$ (> 1) bonds outstanding for a given quarter t for firm i. For each bond j $(j = 1,2, \dots N_{i,t})$, we consider 11 main contractual features, and convert each feature k $(k = 1,2, \dots 11)$ to a numerical scale by assigning bond feature dummies $\mathbb{I}_{i,k,j,t}$:

k	Bond Features	Presence	$\mathbb{I}_{i,k,j,t}$
1	Covenants	'No'	0
		'Yes'	1
2	Redeemable	'No'	0
		'Yes'	1
3	Callable	'No'	0
		'Yes'	1
4	Putable	'No'	0
		'Yes'	1
5	Exchangeable	'No'	0
		'Yes'	1
6	Convertible	'No'	0
		'Yes'	1
7	Credit Enhancement	'No'	0
		'Yes'	1
8	Secured	'No'	0
		'Yes'	1
9	Foreign Currency	'No'	0
		'Yes'	1
10	Short Term (1 <= Maturity < 5)	'No'	0
		'Yes'	1
11	Fixed Coupon	'No'	0
		'Yes'	1

Our bond complexity measure for firm i at time t is defined as:

$$\text{Complexity}_{i,t} = 2 \times \sqrt{\frac{\sum_{k=1}^{11} \sum_{j=1}^{N_{i,t}} \left(\mathbb{I}_{i,k,j,t} - \mu_{i,k,t}\right)^2}{11 \times N_{i,t}}}$$

where,

$$\mu_{i,k,t} = \frac{\sum_{j=1}^{N_{i,t}} \mathbb{I}_{i.k,j,t}}{N_{i,t}},$$

$N_{i,t}$ is the number of bonds of firm i outstanding at quarter t, and $\mathbb{I}_{i,k,j,t}$ is an indicator function defined as 1 (or 0) if the k^{th}-bond contractual feature is present (or absent) in bond j of firm i at quarter t.

Table 1 Summary Statistics

This table presents the summary statistics for the main variables in the sample, which consists of all corporate bonds outstanding for all (except financial or utility) firms in the Mergent FISD database for the 20-year period from 1998Q2 to 2018Q1. *YS* is the value-weighted average of yield spreads in percentages of the firm's outstanding bond issues, where a bond's yield spread is computed as its yield to maturity minus a Treasury bond's with the same maturity. *BComp* is the firm-level variable that captures contractual heterogeneities across a firm's bond issues, and its exact definition is presented in the Appendix. *Rating* is the value-weighted average of credit ratings of the firm's outstanding bond issues, where we assign the numerical number to rating notches ranging from 1 to 21. AAA equals 1, AA+ equals 2, AA equals 3, AA- equals 4, and so on. *Illiquidity* is the value-weighted average of the proportion of zero trading days, and *Maturity* is the value-weighted average of time to maturities in years of the firm's outstanding bond issues. *Coupon* and *Age* is the bond's coupon rate (in percentage) and bond age (in log). *CovInd* is the value-weighted average of the covenant index (Billett, King, and Mauer, 2007). It is defined as the sum of the covenant dummies assigned to each of 15 different categories of covenants, where a covenant dummy equals 1 if covenant protections exist for each category. Covenant Index variables take a value of 0 in case of missing data. *CovMiss* is a dummy variable that equals 1 if Covenant Index variables are missing. *FBRet* is future bond returns, computed using average monthly returns in percentages for quarters t+1 to t+4. *ST_Own, HT_Own,* and *Concen_Own* are the proportion of bond amounts held by bond funds with short investing horizons, high portfolio turnover, and high rating concentration, respectively, among all institutional investors. Short-horizon investors include holdings by annuities/variable annuities, finance companies, hedge funds, investment managers, and mutual funds. High turnover investors are bond funds for which the value of portfolio turnover is higher than the sample median. Concentrated investors are bond funds for which the value of the Herfindahl index of portfolio holdings across credit rating categories is above the sample median. *BRFY* is computed as the difference between bond yields and the average yield of the benchmark, i.e., bonds with the same credit rating and maturity (Choi and Kronlund, 2018). *RFY_Own* is the proportion of the bond amount held by RFY bond funds, i.e., those for which the value of the RFY fund is above the sample median. *TrdVol* is the log of total trading volume in thousands of the firm's bonds for a given quarter. *RSplit* is a dummy that equals 1 if any bond has a rating split, i.e., different ratings assigned by S&P and Moody's. *CV* is the coefficient of variation of portfolio weights across bond funds capturing bond investor disagreement (Nozawa, Qiu, and Xiong, 2021). *BNum* is the number of a firm's outstanding bond issues. *BHHI* is 1 – the Herfindahl index of outstanding bond issues. *FU*, *RU*, and *PU* indicate financial, real, and policy uncertainty, and the VIX is the CBOE volatility index. $I_{\{U\}}$ indicates a dummy that equals 1 if the value of the respective uncertainty measure is higher than the sample median. All variables are winsorized at the 1% level.

	N	MEAN	STD	P5	P95
FBRet (%)	60,836	0.57	1.66	-1.59	3.04
YS (%)	65,178	3.97	5.00	0.41	11.64
BComp	65,178	0.35	0.20	0.00	0.61
Rating	65,178	10.94	4.05	5.00	17.00
Maturity	65,178	8.01	4.84	2.29	18.05
Illiquidity	65,178	0.60	0.21	0.27	0.94
Coupon	65,178	6.70	2.13	3.08	10.25
Age	65,178	4.59	4.39	0.45	15.11
Size	65,178	12.86	0.63	11.92	13.95
CovInd	65,178	0.37	0.18	0.00	0.67
CovMiss	65,178	0.08	0.25	0.00	1.00
ST_Own	64,357	0.54	0.23	0.13	0.90
Concen_Own	64,637	0.03	0.07	0.00	0.17
HT_Own	64,637	0.17	0.12	0.02	0.41
BRFY	64,995	-0.16	5.63	-4.97	3.19
RFY_Own	64,637	0.35	0.30	0.01	0.91
TrdVol	65,178	13.12	1.87	9.62	15.76
RSplit	29,218	0.74	0.44	0.00	1.00
CV	64,562	2.09	1.11	1.05	4.53
$I_{\{FU\}}$	65,178	0.39	0.49	0.00	1.00
$I_{\{RU\}}$	65,178	0.54	0.50	0.00	1.00
$I_{\{PU\}}$	65,178	0.57	0.50	0.00	1.00
$I_{\{VIX\}}$	65,178	0.38	0.49	0.00	1.00
BNum	65,178	7.40	8.53	1.00	22.00
BHHI	65,178	0.68	0.25	0.00	0.93

Table 2 Bond Yield Spreads: Baseline Regression

This table presents the results of panel regressions where we regress yield spreads on bond complexity, along with other control variables. The sample is at a firm-quarter level, and it spans 1998Q2 to 2018Q1. *YS* is the value-weighted average of yield spreads in percentages of a firm's outstanding bond issues, where a bond's yield spread is computed as its yield to maturity minus a Treasury bond's with the same maturity. *BComp* is firm-level bond complexity that captures contractual heterogeneities across a firm's bond issues, and its exact definition is in the Appendix. *Rating* is the value-weighted average of credit ratings of the firm's outstanding bond issues, where we assign a numerical number to rating notches ranging from 1 to 21. AAA equals 1, AA+ equals 2, AA equals 3, AA- equals 4, and so on. *Illiquidity* is the value-weighted average of the proportion of zero trading days, and *Maturity* is the value-weighted average of time to maturities in years of the firm's outstanding bond issues. *Coupon* and *Age* are a bond's coupon rate (in percentage) and bond age (in log). *CovInd* is the value-weighted average of the covenant index (Billett, King, and Mauer, 2007), defined as the sum of the covenant dummies assigned to each of 15 different categories of covenants. A covenant dummy equals 1 if covenant protections exist for each category. Covenant Index variables equal 0 in case of missing data. *CovMiss* is a dummy variable that equals 1 if Covenant Index variables are missing. t-statistics are in parentheses. Both firm- and quarter-fixed effects are included, and standard errors are clustered at the firm level. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable:	Bond Yield Spreads (YS) (%)				
	(1)	(2)	(3)	(4)	(5)
BComp	1.70***	0.88***	0.91***	0.92***	0.87***
	(6.09)	(3.43)	(3.55)	(3.81)	(3.56)
Rating		0.67***	0.68***	0.62***	0.62***
		(19.49)	(19.55)	(18.39)	(18.41)
Maturity		-0.11***	-0.11***	-0.08***	-0.08***
		(-12.76)	(-12.88)	(-11.97)	(-11.87)
Illiquidity			0.61***	0.19	0.26
			(3.54)	(1.10)	(1.48)
Coupon				0.45***	0.43***
				(12.23)	(12.04)
Age				0.01	0.02
				(0.96)	(1.18)
Size				0.07	0.07
				(0.63)	(0.63)
CovIndex					1.12**
					(2.47)
CovMiss					0.08
					(0.40)
Constant	3.36***	-2.86***	-3.27***	-6.55***	-6.88***
	(33.89)	(-7.26)	(-7.88)	(-4.35)	(-4.56)
Observations	64,760	64,760	64,760	64,760	64,760
R-squared	0.639	0.677	0.677	0.684	0.684
Firm FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Clustered SE	Yes	Yes	Yes	Yes	Yes

Table 3 Bond Yield Spreads: Quasi-Experiments

This table presents the results of two quasi-natural experiments: an exogenous shock introduced by the sudden resignation from PIMCO of founder Bill Gross during 2014Q3, and the introduction of a new accounting standard, SFAS 160, during 2008. The PIMCO sample focuses on four quarters before and four quarters after the event. *Treat* is a dummy variable that equals 1 if a firm's bond was held by PIMCO for more than 3% of the total amount outstanding during the third quarter of 2014, and 0 if it was held by Prudential or Vanguard for more than 3% of the total amount outstanding during 2014Q3. *Post* is a dummy variable that equals 1 for the period after 2014Q3, and 0 otherwise. *Pre* is a dummy variable that equals 1 for the periods of 2014Q2 and 2014Q3, and 0 otherwise. The SFAS 160 sample focuses on two years before and two years after the event. *Treat* is a dummy variable that equals 1 if a firm has relevant covenants (i.e., covenants stated in terms of equity) and positive minority interest, and 0 otherwise. *Post* is a dummy variable that equals 1 for the years after 2008, and 0 otherwise. *Pre* is a dummy variable that equals 1 for the year of 2008, and 0 otherwise. *YS* is the value-weighted average of yield spreads in percentages of a firm's outstanding bond issues, where a bond's yield spread is computed as its yield to maturity minus a Treasury bond's with the same maturity. *BComp* is firm-level bond complexity that captures contractual heterogeneities across a firm's bond issues. Its exact definition is in the Appendix. Included are the same set of control variables as those in Table 2. t-statistics are in parentheses. Both firm- and quarter-fixed effects are included, and standard errors are clustered at the quarter level. ***, **, and * represent statistical significance at 1%, 5%, and 10% levels, respectively.

Dependent Variable:	Bond Yield Spreads (YS) (%)					
	PIMCO			SFAS 160		
	(1)	(2)	(3)	(4)	(5)	(6)
Bcomp×Treat×Post		0.39*	0.55**		1.43*	1.68**
		(2.01)	(2.53)		(1.98)	(2.44)
Bcomp×Treat×Pre			0.28			0.53
			(1.51)			(1.11)
Treat×Post	0.37***	0.27***	0.24***	0.68***	0.02	0.01
	(5.10)	(5.16)	(4.52)	(4.63)	(0.09)	(0.04)
Treat×Pre			-0.04			0.02
			(-0.83)			(0.07)
Bcomp×Post		-0.08	-0.08		0.08	0.42*
		(-0.75)	(-0.63)		(0.30)	(1.84)
Bcomp×Pre			0.01			0.70***
			(0.14)			(5.46)
Bcomp×Treat		0.32	0.23		-1.06	-1.32
		(0.76)	(0.48)		(-1.27)	(-1.63)
Bcomp		-0.14	-0.15		0.09	-0.17
		(-1.49)	(-1.29)		(0.30)	(-0.56)
Constant	3.46*	3.71*	3.70*	4.45***	4.63***	4.61***
	(2.07)	(2.15)	(2.13)	(3.20)	(3.26)	(3.26)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,600	2,600	2,600	5,593	5,593	5,593
R-squared	0.909	0.909	0.909	0.850	0.850	0.851
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes

Table 4 Bond Investor Base: Informed Investors

This table presents the results of panel regressions where we examine the relation between bond complexity and investor informativeness. The sample is at the firm-quarter level, and the period spans 1998Q2 to 2018Q1. *ST_Own, HT_Own,* and *Concen_Own* are the proportion of bond amount held by bond funds with short investing horizons, high portfolio turnover, and high rating concentration, respectively, among all institutional investors. Short-horizon investors include holdings by annuities/variable annuities, finance companies, hedge funds, investment managers, and mutual funds. High turnover investors are bond funds for which the value of portfolio turnover is higher than the sample median. Concentrated investors are bond funds for which the value of the Herfindahl index of portfolio holdings across credit rating categories is above the sample median. *BComp* is a firm-level variable that captures contractual heterogeneities across a firm's bond issues, and its exact definition is in the Appendix. *Rating* is the value-weighted average of credit ratings of a firm's outstanding bond issues, where we assign the numerical number to rating notches ranging from 1 to 21. AAA equals 1, AA+ equals 2, AA equals 3, AA- equals 4, and so on. *Illiquidity* is the value-weighted average of the proportion of zero trading days, and *Maturity* is the value-weighted average of time to maturities in years of the firm's outstanding bond issues. *Coupon* and *Age* are the bond's coupon rate (in percentage) and bond age (in log). *CovInd* is the value-weighted average of the covenant index (Billett, King, and Mauer, 2007), defined as the sum of covenant dummies assigned to each of 15 different categories of covenants, where a covenant dummy equals 1 if covenant protections exist for each category. Covenant Index variables equal 0 in case of missing data. *CovMiss* is a dummy variable that equals 1 if Covenant Index variables are missing. t-statistics are in parentheses. Both firm- and quarter-fixed effects are included, and standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% levels, respectively.

Dependent variable:	ST_Own (1)	HT_Own (2)	Concen_Own (3)
BComp	0.07***	0.02***	0.01**
	(4.98)	(3.02)	(2.43)
Rating	0.01***	0.01***	0.00***
	(5.70)	(10.57)	(4.93)
Maturity	0.00***	-0.00**	-0.00***
	(3.87)	(-2.24)	(-5.77)
Illiquidity	-0.05***	-0.02***	-0.00
	(-6.27)	(-5.69)	(-0.13)
Coupon	0.00	0.00**	-0.00*
	(0.01)	(2.49)	(-1.70)
Age	-0.01***	-0.00***	0.00**
	(-11.52)	(-7.94)	(2.46)
Size	0.03***	0.01***	0.00
	(4.77)	(2.80)	(1.63)
CovIndex	-0.12***	-0.04***	-0.04***
	(-4.96)	(-4.16)	(-4.04)
CovMiss	0.02	0.00	-0.02***
	(1.16)	(0.19)	(-4.78)
Constant	0.23***	0.06*	-0.03
	(3.08)	(1.78)	(-0.84)
Observations	63,977	64,233	64,233
R-squared	0.569	0.375	0.612
Firm FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Clustered SE	Yes	Yes	Yes

Table 5 Bond Investor Base: Yield-Seeking Investors

This table presents the results of panel regressions where we examine the relation between bond complexity and investors' reaching-for-yield. The sample is at the firm-quarter level, and its period spans 1998Q2 to 2018Q1. *RFY* is computed as the difference between bond yields and the average yield of the benchmark, i.e., bonds with the same credit rating and maturity (Choi and Kronlund, 2018). *RFY_Own* is the proportion of the bond amount held by RFY bond funds, i.e., those for which the value of fund RFY is above the sample median. *FBRet* is future bond returns computed using average monthly returns in percentages for quarters t+1 to t+4. *BComp* is a firm-level variable that captures contractual heterogeneities across a firm's bond issues, and its exact definition is in the Appendix. *Rating* is the value-weighted average of credit ratings of the firm's outstanding bond issues, where we assign the numerical number to rating notches ranging from 1 to 21. AAA equals 1, AA+ equals 2, AA equals 3, AA- equals 4, and so on. *Illiquidity* is the value-weighted average of the proportion of zero trading days, and *Maturity* is the value-weighted average of time to maturities in years of the firm's outstanding bond issues. *Coupon* and *Age* are the bond's coupon rate (in percentage) and bond age (in log). *CovInd* is the value-weighted average of covenant index (Billett, King, and Mauer, 2007), defined as the sum of covenant dummies assigned to each of 15 different categories of covenants, where a covenant dummy equals 1 if covenant protections exist for each category. Covenant Index variables equal 0 in case of missing data. *CovMiss* is a dummy variable that equals 1 if Covenant Index variables are missing. *Yield* is the bond yield in percentages and *Duration* is the bond's modified duration. t-statistics are in parentheses. Both firm- and quarter-fixed effects are included, and standard errors are clustered at the firm level. ***, **, and * represent statistical significance at 1%, 5%, and 10% levels, respectively.

Dependent Variable:	RFY (%)	RFY_Own	FBRet (%)	
	(1)	(2)	(3)	(4)
BComp	1.07***	0.03**	-0.21**	-0.22**
	(2.93)	(2.44)	(-2.03)	(-2.13)
Rating	-0.12***	0.00***	-0.00	-0.00
	(-2.77)	(3.84)	(-0.46)	(-0.43)
Maturity	-0.05***	0.00	0.00	0.06***
	(-5.46)	(0.18)	(1.09)	(5.72)
Illiquidity	0.43	0.00	0.21***	0.23***
	(1.34)	(0.21)	(2.98)	(3.24)
Coupon	0.49***	0.02***	-0.01	-0.04***
	(10.34)	(16.40)	(-0.71)	(-2.81)
Age	-0.04**	-0.00**	-0.01	-0.00
	(-2.00)	(-2.03)	(-1.42)	(-0.81)
Size	0.04	0.00	0.01	0.03
	(0.31)	(0.59)	(0.17)	(0.73)
CovIndex	0.99*	-0.01	-0.10	-0.10
	(1.71)	(-0.43)	(-0.52)	(-0.53)
CovMiss	0.31	0.01	-0.07	-0.07
	(1.18)	(0.83)	(-0.65)	(-0.70)
Yield			14.45***	13.97***
			(17.72)	(17.06)
Duration				-0.11***
				(-6.04)
Constant	-3.18	0.12*	-0.38	-0.33
	(-1.62)	(1.84)	(-0.70)	(-0.60)
Observations	64,579	64,233	53,826	53,826
R-squared	0.259	0.756	0.396	0.398
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Clustered SE	Yes	Yes	Yes	Yes

Table 6 Bond Uncertainty

This table presents the results of panel regressions where we examine the relation between bond complexity and bond uncertainty. *TrdVol* is the log of total trading volume in thousands of a firm's bonds for a given quarter. *CV* is the coefficient of variation of portfolio weights across bond funds capturing bond investor disagreement (Nozawa, Qiu, and Xiong, 2021). *FU*, *RU*, and *PU* indicate financial, real, (Jurado, Ludvigson, and Ng, 2015), and policy uncertainty (Baker, Bloom, and Davis, 2016). The VIX is the CBOE volatility index. $I_{\{U\}}$ indicates a dummy that equals 1 if the value of the respective uncertainty measure is higher than the sample median. *BComp* is a firm-level variable that captures contractual heterogeneities across a firm's bond issues, and its exact definition is in the Appendix. Included are the same set of control variables as those in Table 2. t-statistics are in parentheses. Both fund- and quarter-fixed effects are included, and standard errors are clustered at the firm level. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A Bond Uncertainty

Dependent Variables:	TrdVol	CV
	(1)	(2)
BComp	0.41***	0.54***
	(4.44)	(5.57)
Controls	Yes	Yes
Observations	53,957	64,160
R-squared	0.428	0.333
Firm FE	Yes	Yes
Time FE	Yes	Yes
Clustered SE	Yes	Yes

Panel B Macro Uncertainty

Dependent Variables:	Bond Yield Spreads (YS) (%)			
	(1)	(2)	(3)	(4)
Uncertainty Index:	Policy Uncertainty	Real Uncertainty	Financial Uncertainty	VIX
BComp × $I_{Uncertainty}$	1.74***	0.72**	1.70***	1.93***
	(3.96)	(2.39)	(3.59)	(4.56)
BComp	0.37	0.68***	0.51*	0.47*
	(1.40)	(2.72)	(1.93)	(1.84)
Controls	Yes	Yes	Yes	Yes
Observations	64,760	64,760	64,760	64,760
R-squared	0.684	0.684	0.684	0.685
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Clustered SE	Yes	Yes	Yes	Yes

Table 7 Bond Complexity and Bondholder Dispersion

This table presents the results of panel regressions where we control for the effect of bondholder dispersion proxied for by *BNum* and *BHHI*. *BNum* is the number of a firm's outstanding bond issues. *BHHI* is 1 – the Herfindahl index of outstanding bond issues. *YS* is the value-weighted average of yield spreads in percentages of the firm's outstanding bond issues, where a bond's yield spread is computed as its yield to maturity minus a Treasury bond's with the same maturity. *BComp* is a firm-level variable that captures contractual heterogeneities across a firm's bond issues, and its exact definition is in the Appendix. *ST_Own, HT_Own,* and *Concen_Own* are the proportion of bond amounts held by bond funds with short investing horizons, high portfolio turnover, and high rating concentration, respectively, among all institutional investors. Short-horizon investors include holdings by annuities/variable annuities, finance companies, hedge funds, investment managers, and mutual funds. High turnover investors are bond funds for which the value of portfolio turnover is higher than the sample median. Concentrated investors are bond funds for which the value of the Herfindahl index of portfolio holdings across credit rating categories is above the sample median. *RFY_Own* is the proportion of the bond amount held by RFY bond funds, i.e., those for which the value of RFY funds (Choi and Kronlund, 2018) is above the sample median. *FU*, *RU*, and *PU* indicate financial, real, (Jurado, Ludvigson, and Ng, 2015), and policy uncertainty (Baker, Bloom, and Davis, 2016). The VIX is the CBOE volatility index. $I_{\{U\}}$ indicates a dummy that equals 1 if the value of the respective uncertainty measure is higher than the sample median. Included are the same set of control variables as those in Table 2. t-statistics are in parentheses. Both firm- and quarter-fixed effects are included, and standard errors are clustered at the firm level. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A Number of Bond Issues

Dependent Variable:	YS	STOwn	HTOwn	ConcenOwn	RFYOwn
	(1)	(2)	(3)	(4)	(5)
BComp	0.76***	0.07***	0.01**	0.02***	0.02**
	(3.09)	(5.48)	(2.42)	(3.43)	(2.11)
BNum	0.01**	-0.00**	0.00	-0.00***	0.00**
	(2.25)	(-2.28)	(0.26)	(-2.70)	(2.22)

Panel B Herfindahl Index of Bond Issues

Dependent Variable:	YS	STOwn	HTOwn	ConcenOwn	RFYOwn
	(1)	(2)	(3)	(4)	(5)
BComp	0.50**	0.09***	0.01***	0.03***	0.03**
	(1.97)	(6.31)	(2.64)	(4.75)	(2.06)
BHHI	0.61**	-0.05***	-0.00	-0.02***	0.00
	(2.55)	(-3.83)	(-0.72)	(-4.32)	(0.26)

Panel C Effect of Macro Uncertainty

Dependent Variable:	Bond Yield Spreads (YS) (%)							
	(1) Policy Uncertainty	(2) Real Uncertainty	(3) Financial Uncertainty	(4) VIX	(5) Policy Uncertainty	(6) Real Uncertainty	(7) Financial Uncertainty	(8) VIX
BComp × $I_{Uncertainty}$	2.67***	1.03***	2.97***	2.90***	3.25***	1.20***	3.42***	3.01***
	(5.49)	(3.09)	(5.57)	(6.17)	(6.39)	(3.34)	(5.90)	(6.01)
BNum × $I_{Uncertainty}$	-0.03***	-0.01***	-0.05***	-0.04***				
	(-5.05)	(-2.82)	(-5.46)	(-4.72)				
BHHI × $I_{Uncertainty}$					-1.01***	-0.33**	-1.22***	-0.77***
					(-3.96)	(-2.26)	(-4.93)	(-3.72)
BComp	0.03	0.50*	0.10	0.13	-0.49*	0.19	-0.16	-0.10
	(0.10)	(1.94)	(0.38)	(0.49)	(-1.77)	(0.71)	(-0.59)	(-0.36)
BNum	0.03***	0.02***	0.04***	0.04***				
	(3.21)	(2.71)	(5.87)	(5.48)				
BHHI					1.25***	0.78***	1.07***	0.90***
					(4.48)	(3.22)	(4.20)	(3.64)