

# SEARCH FRICTIONS AND PRODUCT DESIGN IN THE MUNICIPAL BOND MARKET

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**ABSTRACT.** This paper shows that product design shapes search frictions and that intermediaries leverage this channel to increase their rents in the context of the U.S. municipal bond market. The majority of bonds are designed via negotiation between a local government and its underwriter. They are then traded in a decentralized market, where the underwriter often also acts as an intermediary. Exploiting variations in state regulations that limit government officials' conflicts of interest, we provide evidence that the underwriter benefits from designing and trading complex bonds, which induces an increase in search frictions. Interestingly, a simpler bond may not necessarily benefit the government, as bond complexity affords flexibility in debt repayment. Motivated by these findings, we build and estimate a model of bond origination and trading to quantify the welfare implications of a policy mandating bond standardization.

**Keywords:** Complexity, Decentralized market, Intermediaries, Negotiation, Product design, Revolving-door regulation, Search frictions, Standardization, Vertical relations

## 1. INTRODUCTION

Search frictions are present in many markets, including real estate, used goods, healthcare, and over-the-counter financial markets. In these markets, the search process may be more costly for niche products, those with unique features that are hard

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to evaluate and decide on. Do some producers benefit from designing such products, possibly at the expense of other market participants? If so, should the government intervene and directly regulate product design? This paper studies these questions in the context of the U.S. municipal bond market, with a \$4 trillion market capitalization, on which state and local governments rely to finance public infrastructure projects like schools and bridges. The issue of bond design is particularly salient for municipal bonds where the US Securities and Exchanges Commission has warned that the complexity of bonds increases frictions for investors. Lessons from our study is not limited to this market; for example, the proliferation of highly customized and increasingly complex products in insurance, annuity, and mortgage markets has recently ignited a policy debate concerning whether a standardization mandate could be beneficial (Bernard, 2016).

Most municipal bonds are issued via negotiation, where an issuing government and an underwriter negotiate over bond design and the terms of sale. The underwriter is typically an investment bank, whose primary role is to purchase the entire bond from the government and resell it to investors at origination. As for bond design, the simplest one would only specify the length of maturity and fixed interest rate paid on a semiannual base, but nonstandard provisions, such as floating interest rates and unique redemption clauses, are often introduced. Employing an instrumental variable approach, this paper first provides new empirical evidence that the underwriter has incentive to complicate bond design. This finding may offer a rationale for policies that regulate bond design directly. However, we show that a plain-vanilla bond is not necessarily preferable to the government, which values flexibility afforded by complex bonds. This motivates us to build and estimate a model of bond origination and trades to quantify the effects of a standardization mandate, a policy that has received a keen interest from policy communities.

In the municipal bond market, the underwriter of a bond is often a leading intermediary, or dealer, in the bond's trades after origination. This is in part because the underwriter can leverage information on who initially purchased its bonds and who owns them when acting as a dealer. Given the lack of electronic trading and the decentralized nature of bond transactions, this information is deemed very valuable to locate interested investors (O'Hara, 2011). This advantage of the underwriter can be pronounced when a bond is complex and requires involved communications with a potential buyer. A part of trading costs for dealers is time and efforts to educate and persuade their investor clients (Feldstein and Fabozzi, 2008), and the additional costs

associated with a complex bond can be higher for dealers other than the underwriter because they are more likely to face investors who do not own or even are unaware of the bond. For this reason, an underwriter may improve its competitive advantage vis-à-vis other intermediaries in the trading market for a bond by adding nonstandard provisions to the bond.

To study this incentive and its policy implications, we combine rich issue-level data with proprietary transaction-level data for bonds issued via negotiation by local governments during 2010–2013. When studying the drivers and impacts of bond design, confounding factors can complicate identification. To address this challenge, we use panel variation in state-level conflict-of-interest regulations. We argue that, while not directly affecting the trading market for municipal bonds, these regulations may affect the incentives of government officials when negotiating with an underwriter, reducing the latter’s influence over bond design. Given that gifts and political donations are regulated at the federal level, we focus on revolving-door practices, where a government official takes a job upon leaving office at a firm related to his/her work while in office. These practices are regulated at the state level, typically by setting a “cool-off” period during which such employment is not allowed. Using a difference-in-difference approach, we find that adopting revolving-door regulations in a state, especially those targeting local officials, reduces prevalence of nonstandard provisions in municipal bonds by 6% on average.

Exploiting revolving door regulations as an instrument, we show that when a bond includes more nonstandard provisions, the underwriter intermediates a larger share of the bond’s trades and reaps a higher gross profit as a dealer, which we measure as the difference between the value of bonds sold and purchased. These results, combined with the finding that revolving-door regulations reduce nonstandard provisions, illustrate that underwriters benefit from them. We also explore the trade-off involved in bond design more broadly. On the one hand, we find that the flexibility introduced by nonstandard provisions is valuable for the government, since adding them in a bond decreases its default risk. On the other hand, our results show that these provisions increase trading frictions, possibly raising the government costs.

These empirical findings suggest that the welfare implications of a direct government intervention in bond design, such as a standardization mandate, are not straightforward. To quantify the welfare implications for each market participant, we build and estimate a model of bond design and decentralized trading with intermediaries. In the model, a forward-looking underwriter and a government official,

who acts on behalf of a bond-issuing government, negotiate over the bond’s price, the coupon rate, and its complexity, driven by nonstandard provisions. The underwriter then buys the bond at the agreed price and resells it to investors and other dealers. Continuous-time trading among investors and dealers continues until maturity. The underwriter’s payoff is the profit from the initial resale and intermediation of subsequent trades of the bond. The payoff of the government official reflects the cost of paying the (endogenous) interest and returning the principal to investors. This cost is allowed to differ by the bond’s complexity, in order to capture the benefits of flexibility afforded by nonstandard provisions. In addition, the official may partially internalize the underwriter’s payoff, depending on revolving-door regulations.

In this model, a dealer chooses the rate at which to meet investors, given a search cost. Search costs and the bond’s valuations by investors and dealers may depend on the bond complexity, as well as other observed and unobserved attributes such as the coupon rate and the financial health of the issuer. This feature of the model adds to the literature on product design and search frictions, which studies how product design may change with the extent of search frictions (Bar-Isaac, Caruana and Cuñat, 2012; Menzio, 2023; Albrecht, Menzio and Vroman, 2023). Our model, however, treats search frictions as endogenous: we allow for the various provisions in a bond, which are determined at origination, to directly affect a dealer’s costs of finding investors and helping them learn whether that bond suits their financial goals. Here, we allow a dealer’s search costs to depend on the size of its client network. This feature of the model reflects anecdotal evidence that it is easier for a dealer to trade a bond with investors who have already traded it than those who have not. It also enables us to embed a mechanism through which the underwriter may exploit its exclusive right to sell the bond to investors at issuance, when trading it as a dealer.

To estimate the model, we follow a multi-step strategy. First, we estimate bond-specific dealer costs and investor demand by matching the predicted trading prices and quantities to their counterparts in the data and by exploiting the optimality in the endogenously chosen rate of meeting for each dealer and the observed timing of trades. Second, we estimate how these model primitives depend on bond attributes, including endogenous ones—the coupon rate and complexity—using the revolving-door regulations as instruments. Importantly, this approach enables us to incorporate rich unobserved heterogeneity. Third, we rely on the first order conditions characterizing the equilibrium coupon rate and complexity to estimate the preferences of government officials involved in the negotiations, including both the marginal cost

of paying bond obligations and the extent to which these officials internalize the underwriter’s payoff during negotiations.

The model estimates reveal that trading frictions are sizeable. For a median bond, the average dealer’s search costs amount to 10% of its gross profits. Moreover, we find that there are strong network effects in search and that these network effects create a cost advantage for the underwriter. The estimates suggest that the underwriter’s search cost is 49.8% lower than the cost of an average dealer to attain the same meeting rate with investors. We also find that nonstandard bond provisions both increase search costs for all dealers and strengthen the underwriter’s cost advantage. The demand estimates suggest that complex bonds are niche products that investors “either love or loathe”: complexity increases the dispersion of investor valuations, with little changes in the average valuations. Lastly, we find that the government cost of paying back its debt to investors is convex in bond complexity and the minimum cost is attained with some, nonzero complexity for most bonds, reflecting the value of the flexibility afforded by complexity for the issuer.

Based on the parameter estimates, we simulate a standardization mandate, prohibiting any nonstandard provisions in bonds. This policy would reduce search frictions and increase the rate at which transactions occur, with a median change of +33%. The increased liquidity, in turn, drives a substantial increase in investors’ welfare, in median by 8%. Whether standardization can ultimately reduce the cost of capital for the issuing governments depends on the negotiated coupon rate. The median change in coupon rate is -22.7 basis points, leading to a saving of 9% of the total interest payments. In this respect, we offer an important contribution to the policy debate on how to lower the cost of investment in public infrastructure. Despite the interest savings, our results suggest that most local governments are unlikely to prefer this policy over the status quo because standardization reduces their ability to flexibly tailor the bonds based on their projected cash flow and circumstances.

We also find that there is large heterogeneity in the policy’s impact on the negotiated coupon rate, with an interquartile range going from -99.6 basis points to +8.8, and that the interest savings are concentrated in low-income counties, especially those without revolving-door regulations. We show that this heterogeneity reflects the effects of standardization on the underwriter’s incentives to negotiate for a higher coupon rate, depending on the market conditions surrounding search frictions and dealer competition. These results suggest that it is important to consider underwriters’ incentives when formulating a policy regulating bond design.

**Related Literature.** The paper focuses on the incentives of underwriters to increase search frictions by adding various nonstandard provisions at origination. The idea that producers may benefit from an increase in search costs is not new (Diamond, 1971). One way of raising search costs is to make shopping complicated, difficult, or confusing, as documented by Ellison and Ellison (2009) in the context of online retail practices, and Ellison and Wolitzky (2012) argue that engaging in such obfuscation practices can be individually rational. In financial markets, evidence suggests that more complex retail products yield higher markups to the banks that issue them (C  lerier and Vall  e, 2017) and lower realized returns to investors (Ghent, Torous and Valkanov, 2019).<sup>1</sup> Our paper contributes to this literature, by providing consistent empirical findings in the context of the municipal bond market.

In addition, we shed light on a novel mechanism explaining why market participants might want to increase frictions. While the extant literature has focused on competition among producers, we study competition among intermediaries, and show that nonstandard bond provisions help position the bond’s underwriter at an advantage, compared to other dealers. In this regard, we also contribute to the literature on how vertical relations affect product design (Asker and Bar-Isaac, 2014; Ho and Lee, 2019; Hristakeva, 2022).

We show that this novel mechanism is amplified when government officials’ interests are aligned with those of the underwriter, exploiting time-varying state-level regulations on revolving-door practices. These findings add to the literature on conflict of interest in financial markets (Lucca, Seru and Trebbi, 2014; DeHaan, Kedia, Koh and Rajgopal, 2015; Shive and Forster, 2017; Egan, 2019; Egan, Matvos and Seru, 2019; Bhattacharya, Illanes and Padi, 2019; Tenekedjieva, 2020), and particularly the municipal bond markets (Butler, Fauver and Mortal, 2009; Garrett, forthcoming).<sup>2</sup>

Lastly, our methods relate to the literature on the structural analyses of decentralized asset markets (Gavazza, 2016; Allen, Clark and Houde, 2019; Pint  r and Uslu, 2022; Coen and Coen, 2022). Our model for over-the-counter (OTC) market is based on   sl   (2019), which incorporates (time-varying) heterogeneity across dealers and investors that hold continuous, unrestricted amounts of assets. These features

<sup>1</sup>See Bonelli, Buyalskaya and Yao (2021) on product differentiation of mutual funds and Vokata (2021).

<sup>2</sup>There is a large literature on the US municipal bond market, recently reviewed by Cestau, Hollifield, Li and Sch  rhoff (2019a). While many studies mainly focus on the trading market, some notable studies also look at bond issuance, underwriters’ incentives, and competition in the primary market (Green, 2007; Green, Hollifield and Sch  rhoff, 2007; Bethune, Sultanum and Trachter, 2019; Cestau, Green, Hollifield and Sch  rhoff, 2019b; Garrett, Ordin, Roberts and Su  rez Serrato, 2023).

are not only empirically relevant, but also important for understanding liquidity, a key part of the trade-off determining bond design. Coen and Coen (2022) also build on Üslü (2019) and estimate their model using the sterling corporate bond trading data to study a different question, the effects of heterogeneous traders on liquidity.

## 2. INSTITUTIONAL BACKGROUND: DESIGNING MUNICIPAL BONDS

When designing a bond, its issuer has various options, from employing a simple bond with a fixed interest rate and maturity to a more complex version with several nonstandard features, such as flexible maturity periods through call options and variable or floating interest rate, to name a few. This practice is not limited to municipal bonds; corporations and other government agencies such as Fannie Mae and Freddie Mac issue bonds that incorporate nonstandard features listed above (Edwards, Harris and Piwovar, 2007). The present section discusses a key trade-off when designing a bond: on the one hand, including a nonstandard provision may reduce the financial cost of paying back the bond’s principal and interest; on the other hand, it may raise the interest cost for the issuing government because it complicates bond valuation, increasing trading frictions and reducing the value of the bond at origination (Harris and Piwovar, 2006; Wang, Wu and Zhang, 2008). We then describe who designs a municipal bond and how, and two important factors—the underwriter’s dual role and conflicts of interest—in the bond issuance process that may distort bond designs.

**2.1. Trade-offs: Flexibility vs. Liquidity.** An issuing government can include nonstandard features when designing a bond to introduce flexibility in paying its debt. As an example, a call provision allows the issuer to redeem bonds before the maturity date under stated conditions. A sinking fund provision, which requires that the issuer retire a specified portion of debt each year by purchasing it on the open market, helps the issuer spread the costs of retiring bonds over time, as opposed to making one large payment at maturity. Another example is to set a nonstandard interest payment schedule, which may help balance the issuer’s cash flows.

Such flexibility gains from nonstandard provisions may come at a cost. In particular, nonstandard features may make it costly to understand the risks associated with a bond’s cash flows, thus complicating pricing and making the trading process difficult for investors. Anecdotally, purchasing a municipal bond often entails meetings between an investor and a sales representative at a dealer firm. During such a meeting, the investor learns about the bond attributes, how they affect the bond’s

market value, and how they interact with his financial needs and the risk of his portfolio. When a bond includes more nonstandard provisions, these meetings become more lengthy and involved, thus increasing trading frictions.

The notion that nonstandard provisions can adversely affect liquidity has been brought up in the policy community. For example, the following excerpt from a 2014 speech of a then-commissioner at the US Securities and Exchanges Commission (SEC), Michael S. Piwowar, illustrates it lucidly:

“Despite the potential benefits of increased standardization for both investors and issuers, municipalities continue to issue exceedingly complex bond offerings. [...] improvements to liquidity from issuing simpler bonds should result in higher valuations and lower issuance costs. These factors alone should help drive the municipal bond market towards greater standardization rather than into the complexity that we see in current issuances.”

In turn, low liquidity can increase the issuer’s interest costs to the extent that investors value their resale opportunities. Investors typically buy and hold municipal bonds until maturity, but many sell them before maturity as their value gets adjusted due to, for example, changes in their financial circumstances. Thus, a bond’s low liquidity must be compensated by its high yields, leading to high interest costs to its issuer.<sup>3</sup>

In the municipal market, the negative effects of nonstandard, complex bond features on liquidity can be pronounced for two reasons. First, pricing municipal bonds is nontrivial because trades occur in an over-the-counter market with a relatively low frequency. The average daily trading volume in 2019 was \$11.5 billion, about 0.3 percent of the market size. Second, individual investors are dominant and the cost of collecting and processing information on bonds is likely to be higher for individual investors than institutions. Out of \$3.7 trillion municipal bonds outstanding in 2012, a large fraction (74%) is owned by individual retail investors, through both direct investment in individual municipal securities (45%) and indirect investment via mutual funds and exchange-traded funds (29%).<sup>4</sup> This is in part because most municipal bond interest payments are exempt from federal and state income taxes (for in-state residents), as well as local income taxes in some cases. These tax advantages are

<sup>3</sup>See, for example, Ang, Bhansali and Xing (2014) and Schwert (2017) on estimating the impacts of liquidity or transaction costs on municipal bond pricing.

<sup>4</sup>The rest is owned by banks and insurance companies (10% and 12% each). These statistics are based on the “Financial Accounts of the United States” by the Federal Reserve.



attractive to individual investors, especially those who fall into high tax brackets, while lowering yields to institutions. This point relates to the importance of dealers' knowledge of potential buyers or sellers in this market. An industry textbook, O'Hara (2011), describes how salespeople in a dealer firm facilitate trades by offering their clients the right security given their knowledge of client portfolios and goals.

**2.2. Who design bonds and how?** The issuing government is primarily involved in designing a bond issue, determining maturity structure, redemption provisions, security provisions, and other features. At origination, an underwriter (or the syndicate of underwriters) purchases the entirety of the bonds and undertakes initial marketing. Depending on the mode of sale—a competitive bidding or negotiation—the underwriter can also play a substantial role in designing the bond issue. In a competitive sale, the issuer designs a bond issue prior to posting a notice of sale. Upon the notice, financial institutions may bid to purchase the bond issue as is, and the one providing the lowest interest cost gets awarded the bonds. In a negotiated sale, the issuer selects an underwriter without (sealed) bidding, but typically through a (competitive) request for proposal process, and sells the bonds directly to the underwriter.<sup>5</sup> As we describe below, in this type of deal, the underwriter is heavily involved in bond design. For this reason, this study focuses on negotiated deals. Negotiated sales are prominent; the percentage of negotiated sales in the recent years (2009–2019) ranges from 44% to 59% (Wu, 2020).<sup>6</sup> In negotiated sales, prior to purchasing the bonds, the underwriter usually spends several months negotiating with the issuer and/or its financial advisor, pricing the bonds, and deciding which attributes to include in its contract. This way, the bonds are designed to meet the demands of the underwriter and its clients, as well as the needs of the issuer. During this process, the underwriter may seek orders from investors to buy the bonds through a presale, before their terms have been fully set, which may help the underwriter and the issuer gauge the demand and establish the final bond pricing and terms.

We find that for negotiated deals, the underwriting market is fairly concentrated, especially for smaller issuers.<sup>7</sup> Regardless of issue sizes, repeat relationships between

<sup>5</sup>In a negotiated sale, the criteria for selecting an underwriter can include subjective factors such as the quality of proposal, credentials, and experience. In addition, the underwriter's prior experience with similar projects and/or the issuing government can also be a factor.

<sup>6</sup>Which method of sales is cheaper to issuers has been a long-standing question. See, for example, Cestau, Green, Hollifield and Schürhoff (2019b) and the references therein.

<sup>7</sup>The mean state-level Herfindahl-Hirschman index (HHI) per year during 2006–2017 is 0.12, and top 3 firms in a state cover 45% of the market on average. Many underwriters with the largest market share in a state are renowned investment companies, operating across states (e.g., Citigroup,

an issuer and an underwriter are notoriously common. For example, Chen, Cohen and Liu (2022) finds that the top lead underwriter, who has underwritten the most dollar volume of bonds for each issuer, on average, underwrote 87.7% of an issuer’s total bond volume, based on the bonds issued during 2002–2007.

**2.3. A Potential Source of Distortion: the Underwriter’s Dual Role.** As described above, for the majority of bonds, the underwriter is directly involved in bond design. We next argue that underwriters may prefer more nonstandard provisions in a bond than issuers and their taxpayers because of their dual role: they participate both in the origination process and in the secondary market as dealers. According to US Government Accountability Office (2012), the top 10 underwriting firms underwrote over 70% of primary market volume in 2010–11, and these top 10 broker-dealer firms executed about 55% of secondary market trades during the same period. The profits from the secondary market are significant compared to the underwriter fee. Based on our calculations, the average underwriter’s gross profit from intermediating trades as a dealer within four years after origination, for the negotiated bonds of 2010–2013 in our sample, is 1.75% of the face value of a bond.<sup>8</sup> This is much larger than the average underwriter’s fee on negotiated bonds during the same period, as reported in Braun (2015), 0.54% of a bond’s face value. It is notable that underwriters do not have a fiduciary duty to their issuer clients, although they must deal fairly with and not deceive or defraud their clients.

In this market, electronic trading is not widespread. Therefore, if one wants to buy or sell a municipal bond through the secondary market, it is typical to use dealers who are familiar with the bond, especially the (lead) underwriting firm, which has information on who bought the bonds at origination and who owns the bonds long after the issue date (O’Hara, 2011): “A dealer that was involved in the original underwriting syndicate is the logical choice [for a dealer to buy or sell large quantities of municipal bonds through the secondary market] because it knows which clients bought bonds at the time they were issued. The lead underwriter that ran the syndicate books has even more information: It knows not only where the bonds it sold went, but also who bought every other bond in the entire issue. Secondary market order flow tends to gravitate to that firm, too, so it often has the best picture of who

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JP Morgan, etc.). Among relatively small deals (less than \$10 million), the market becomes more concentrated: mean HHI is 0.24, and top 3 firms covering 64% on average.

<sup>8</sup>We define a dealer’s “gross profit” from intermediating trades of a bond as the value of total sales minus purchases of the bond. See Section 4.2 and Table 4. Li and Schürhoff (2019) estimate that the average dealer markups on round-trip transactions is 2%, based on data from 1998–2012.

owns the bonds long after the issue date. Traders will call the known holders first as they start searching for buyers or sellers of those particular bonds.” This knowledge creates an advantage for underwriters especially when trading complex bonds. For these bonds, dealers may need to spend a lot of time and effort to educate and persuade investors. However, this process is easier for underwriters, who can locate and contact investors who already own and are familiar with the bond.

**2.4. Conflict of Interest and Revolving-door Regulations.** Bond design may also be affected by the incentives of the government officials involved in bond issuance. The officials may not necessarily represent the interests of taxpayers, and one possible reason is that they may be captured by the underwriters. Besides gifts and political donations, underwriters may also influence government officials through “revolving-door” practices, i.e., hiring them when they leave office. Anecdotally, the following quote from a former state senator from Indiana, in his interview with the Center for Public Integrity in 2006 (Bogardus, 2006), is enlightening. “I can stay in the state Senate, which I’ve been in for 16 years, attend meetings at night and weekends, and stand for re-election at \$25,000 a year with per diem, or I can go out in the hall and not have to go to meetings at night, only follow the legislation that my clients care about, and make \$200,000 a year... You can only resist that for so long. I have to start thinking about my financial future or my children’s education.”

Revolving-door practices may benefit the underwriter through two channels: first, the implicit or explicit promise of a lucrative job in the private sector can be essentially equivalent to a bribe; second, firms may have special access and inside information or connections to sitting government officials via their government hires. Some ex-government officials are hired for government relations. For example, some of the registered lobbyists hired by financial companies in the 2010 Chicago lobbying records include bankers involved in municipal bond underwriting with prior government experience, such as a Cook County Treasurer or a Program Coordinator at the Illinois Development Finance Authority.<sup>9</sup>

It is notable that regulations of revolving-door practices differ across states, while regulations of gifts and campaign contributions are governed by federal institutions

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<sup>9</sup>Quantitative studies on municipal government lobbying are very scant. As a case study, noting that the state of Illinois does not have any revolving-door regulations, we reviewed the list of lobbyists registered in the city of Chicago in 2010 and obtained a lobbyist’s employment history at LinkedIn. Out of twelve lobbyists hired by financial companies involved in municipal bond underwriting, we find that three previously worked at the local government, and two of whom had no time gap when transitioning from the government.

(the MSRB, the FINRA, and the SEC).<sup>10</sup> Specifically, some state laws restrict a former public officer or employee from engaging in lobbying activities on a matter in which he was involved while in office for a period of time, typically one or two years, after leaving public service. We exploit variations of state-level revolving-door regulations across states and time and study how these affect negotiations between underwriters and officials of the bond issuing government.

### 3. DATA

We draw data on bond attributes from Mergent and SDC Platinum Financial Securities Data and historical transaction data from Municipal Securities Rulemaking Board (MSRB). We complement these data with bond-issuing government attributes: government type (e.g., county, city, etc.) from Electronic Municipal Market Access; government finances from the Census; demographic and economic attributes of the residents associated with the issuer from the American Community Survey and Bureau of Economic Analysis; political environment measured by the voting records for the recent Presidential elections from CQ Press Voting and Elections Collection; local newspaper availability based on Gentzkow et al (2014); and state partisan composition from National Conference of State Legislatures (NCSL). Lastly, based on Ethics Legislation Database by NCSL, we compile state revolving-door regulations.

**3.1. Scope of the Study and Selection.** We focus on tax-exempt general obligation or revenue bonds, issued in 2010–2013 by local governments, which were sold via a negotiation process. We follow all secondary-market transactions of these bonds during 2010–2014. By focusing on negotiated bonds, we study the role of underwriters in the determination of bond design and search frictions in the secondary market. Out of 26,623 issues of tax-exempt general obligation or revenue bonds by local governments during the period of study, 55% of them (14,582) were sold via a negotiation, 42% (11,208) via competitive bidding, 1% (320) via other methods such as a private placement, and the sale method for the rest (2%, 514) is not specified. We further narrow down our sample by focusing on bond issues with at least one

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<sup>10</sup>MSRB Rules G-20 and G-37 regulate municipal securities dealers’ giving gifts to government officials and campaign contributions. These rules are enforced by the FINRA and the SEC, and based on the FINRA’s online database since 2005, we identify 43 cases violating these two rules.

trade in the secondary market, leading to the final sample of 13,118 bond issues, with the total face value \$266.9 billion, in nominal USD.<sup>11</sup>

To the extent that local governments choose the method of sale, restricting our sample to negotiated bonds might lead to biased results. As an example, our analysis does not account for governments’ response to a (counterfactual) policy in terms of their use of a negotiated sale as opposed to a competitive one. However, we argue that the extent of this selection bias is limited because regulations and market conditions surrounding various players involved in bond issuance, such as underwriters and financial advisors, mostly dictate the sale method. As an example, some states impose restrictions on the use of negotiated sale (Cestau et al., 2019b), and local governments may also have *de facto* or *de jure* restrictions.<sup>12</sup> Local market factors also matter, such as the composition of potential investors (individuals vs. institutions) and the availability of interested underwriters.

Consistent with this, Appendix C.1 documents that a large majority of local governments (83%) that issued at least two new-money bonds during an extended period (2004–2014) used either method of sale only, not both. Table A5 shows that local government attributes, as opposed to bond attributes, explain a large variation in the method of sale; in OLS regressions of a negotiated sale dummy, the adjusted  $R^2$  dramatically increases when (time-varying) issuer attributes and issuer fixed effects are controlled for. In addition, we do not find evidence that revolving-door regulations affect the method of sale, when we control for local conditions (Column (4) in Table 3).<sup>13</sup> Moreover, Appendix C.2 provides evidence that our findings are not driven by issuers’ selecting into our sample of negotiated sales, nor by unobserved (time-invariant) issuer-specific factors affecting both the method of sale and bond design.

**3.2. Summary Statistics and Bond Complexity.** Table 1 presents summary statistics of key variables used in our analyses for the sample of 13,118 bond issues. The average size of capital raised by an issue is \$20.3 million, and the length of maturity

<sup>11</sup>Of the initial sample of 14,386 negotiated bonds issued in 2010-2013, 8.8% (1,267) have no trades at all. We drop these bonds because both our motivating evidence and structural estimation rely on transaction data, which are not available for these bonds.

<sup>12</sup>Fruits et al. (2008) provide various examples, including a 2006 debt policy and procedure of Memphis, TN, requiring the approval by the Deputy Director of Finance for negotiated sale; a “tradition” of restrictions on negotiated sale maintained by the municipalities in the New England region; and certain officials’ voluntary disinclination to use negotiated sale.

<sup>13</sup>On a related note, Garrett et al. (2023) reports that the share of bonds sold via auction as opposed to negotiation at the state level, in terms of either count or par value, is not responsive to changes in effective personal income tax rates.

TABLE 1. Summary Statistics

	Mean	SD		Mean	SD
<i>Key issue attributes</i>			<i>Nonstandard, complex features</i>		
Face value (in million USD)	20.345	53.878	Multiple bonds in an issue	0.972	0.166
Maturity (in years) <sup>a</sup>	8.366	4.335	Call options	5.017	5.227
Revenue bond	0.208	0.406	Sinking fund provisions	0.931	1.735
Newly issued (vs. refunding)	0.250	0.433	Nonstandard interest frequency	0.007	0.099
Interest rate (in %) <sup>a</sup>	2.960	1.045	Variable/floating interest rate	0.028	0.306
<i>Revolving-door regulation</i>			Num. of nonstandard features	6.953	5.937
Affecting state officials	0.829	0.376	Complexity index <sup>b</sup>	1.463	0.456
Affecting local officials	0.281	0.450			

*Notes:* This table is based on the 13,118 negotiated issues of general obligation or revenue bonds with any secondary market trades originated by local governments in 2010–2013. *a.* When an issue contains multiple bonds, we take a simple average across the bonds within the issue. *b.* This index is the simple average number of nonstandard provisions (in terms of call and sinking fund provisions, as well as interest payment frequency and type) across the bonds within an issue, plus a dummy indicating that the issue includes multiple bonds.

is on average 8.4 years. Most bonds are backed by the credit and taxing power of the issuing government; the rest, 21%, are supported by the revenue from a specific project. Moreover, 25% of the bonds in our sample, called new-money bonds, finance a new project, while the remaining bonds are issued to finance an existing project that has been funded by its original bond.<sup>14</sup> The average coupon rate is 2.96%, slightly higher than the average 10-year treasury rates during the same period, 2.54%.

A bond issue, on average, comprises of 12.1 bonds with different maturities and attributes. Following Harris and Piwowar (2006), we focus on five different bond attributes that are particularly difficult to price and evaluate for investors: (i) multiple or serial bonds (as opposed to a single bond) per issue, (ii) provisions that allow the government to redeem or “call” the bond, (iii) sinking fund provisions, (iv) interest payment frequencies other than every six months, and (v) a floating or variable interest rate. We call these features “complex” or “nonstandard.”<sup>15</sup> Table 1 shows that

<sup>14</sup>We control for this bond attribute throughout our analysis as it can affect the search process and investor demand, amongst others.

<sup>15</sup>Harris and Piwowar (2006) measures bond complexity by counting the number of complexity features, which include “indications of whether the bond is callable, has a sinking fund, has special redemption or extraordinary call provisions, has a nonstandard interest payment frequency (different from semiannual), pays interest on a nonstandard accrual basis, or is credit enhanced” (p. 1369) for each bond. Due to data limitations, we do not include special redemption or extraordinary call provisions and credit enhancements; the former is unavailable, and the latter is incomplete in the Mergent database. Except for these two complexity features, we look at all complexity features considered by Harris and Piwowar (2006).

most issues (97%) include multiple bonds. Call options are relatively common, in the sense that over 5 bonds within an issue have call provisions on average. On the other hand, provisions on sinking fund or nonstandard interest rates are less common. We construct the *complexity index* of a bond issue by computing the average number of the latter four provisions across the bonds within the issue, and then adding a dummy indicating that the issue includes multiple bonds.<sup>16</sup>

#### 4. MOTIVATING EVIDENCE

This section explores the determinants of bond design. We first show that revolving-door regulations decrease the prevalence of nonstandard provisions in municipal bonds. Building on this evidence and exploiting the panel variation in these regulations, we shed light on the underwriters' incentives in bond design by looking at the effect of nonstandard provisions on the underwriter's market share and profits as a dealer. Finally, we show that nonstandard provisions lower the issuing government's default risk, while increasing trading frictions for investors.

**4.1. Bond Design and Revolving-door Regulations.** To identify the causal impacts of nonstandard bond provisions on market outcomes, we rely on an instrumental variable framework based on panel variation in revolving-door regulations. Revolving-door regulations may reduce the underwriter's sway over the officials who negotiate on behalf of the government at origination, thus reducing the underwriter's influence over bond design. Through this channel, these regulations may affect bond design.

Between 2010 and 2013, three states, Arkansas (2011), Indiana (2010), and Maine (2013), enacted legislation regulating post-government employment of state officials. During the same period, two states, New Mexico (2011) and Virginia (2011), expanded the set of officials subject to their existing revolving-door regulations to include local officials, in addition to state officials.<sup>17</sup> We construct two dummy variables capturing the scope of the revolving door legislation in place:  $\text{LocalReg}_i$  indicates there was a revolving-door regulation covering local government officials when bond  $i$  was issued, while  $\text{StateReg}_i$  indicates the presence of a regulation covering state officials.

<sup>16</sup>In computing the complexity index for an issue, we add a dummy for multiple or serial bonds to the average number of nonstandard provisions per bond for the issue to reflect the idea that, for example, an issue with five bonds, each with a different non-standard provision, is likely to be harder to price than a single bond issue with one non-standard provision. Our complexity index for the issue of five bonds is 2, which is greater than the complex index for the issue with one bond, 1.

<sup>17</sup>See Appendix B.1 for the five pieces of state legislation on regulating post-government employment.

To document the impact of revolving-door regulations on bond design, we estimate the following regression model:

$$\log(s_i + 1) = \beta_1 \text{LocalReg}_i + \beta_2 \text{StateReg}_i + \gamma \mathbf{X}_i + \kappa_{c(i)} + \theta_{t(i)} + \epsilon_i, \quad (1)$$

where  $\mathbf{X}_i$  includes the face value, the maturity length, the security type (general obligation or revenue), the type of the issuing government (county, city, school districts, or other special districts), and variables representing or related to the financial health of the issuing government, such as the government’s revenue-to-expenditure ratio and local unemployment rate. We denote the county where the issuing government is located by  $c(i)$  and the monthly period of the issuance by  $t(i)$ . As for the outcome variable,  $s_i$ , we employ the complexity index, as described earlier in Section 3. Our coefficients of interest,  $\beta_1$  and  $\beta_2$ , represent the change in the extent of bond complexity for the average bond issued after the regulation came into effect, controlling for observed bond attributes, county fixed effects, and year-month time fixed effects.

The results, displayed in Table 2, show that limiting revolving-door practices, in particular of local officials, decreases bond complexity by 6%.<sup>18</sup> The effect of revolving-door regulations only targeting state government officials is smaller (2% vs. 7% in Column 3), and statistical significance vanishes with more control variables (Column 4). Note that state officials are not directly involved in the bond origination negotiations, although they can indirectly influence the negotiations by, for example, state budget allocations to local governments. When we look at how the effects of revolving-door regulations on bond design evolve over time, we find that the effects are higher and statistically significant after the regulations were in place for more than three years (Figure A1 in Appendix B.4).

This finding is consistent with the idea that revolving-door regulations may reduce the degree of collusion between underwriters and officials, as long as including nonstandard provisions in a bond benefits the underwriter, possibly at the expense of the government and its taxpayers.<sup>19</sup> In Appendix B.3, we provide additional evidence for this mechanism by showing that the impact of these regulations intensifies with

<sup>18</sup>This result is robust to controlling for issuer fixed effects (Table A6 in Appendix C.2) and linear state-specific time trends. In addition, the result is robust to using alternative measures of bond complexity, where we weigh each of the five components considered in the complexity index,  $s$ , differently. Indeed, all components of the complexity index tend to decrease with the regulations individually (Table A3 in Appendix B.2).

<sup>19</sup>This finding motivates our model where revolving-door regulations can, in equilibrium, affect bond design. Appendix D.1 provides a further discussion on our modeling choice, and D.2 discusses comparative statics that revolving-door regulations reduce the level of complexity in bonds.



TABLE 2. Do Revolving-door Regulations Affect Municipal Bond Design?

	Bond complexity index (log)			
	(1)	(2)	(3)	(4)
Local officials regulated	-0.072*** (0.012)	-0.064*** (0.012)	-0.073*** (0.012)	-0.064*** (0.013)
State officials regulated			-0.020** (0.008)	-0.010 (0.011)
Bond attributes <sup>a</sup>	Yes	Yes	Yes	Yes
Issuer financial health attributes <sup>b</sup>	No	Yes	No	Yes
Year-month FE, County FE	Yes	Yes	Yes	Yes
Number of observations	13,118	13,086	13,118	13,086
$R^2$	0.645	0.647	0.645	0.647

*Notes:* This table reports OLS estimates, based on the negotiated issues of general obligation or revenue bonds with any secondary market trades originated by local governments in 2010–2013. Standard errors are adjusted for clustering at the state level, and are provided in parentheses;  $*p < 0.10$ ,  $**p < 0.05$ ,  $***p < 0.01$ . *a.* Bond attributes include the logarithm of the total face value, fixed effects for the maturity length at the year level, two dummy variables on the type of assets to pay the debt (limited general obligation and revenue, relative to unlimited general obligation, respectively), and a dummy indicating whether the issue is new or refinancing. We also include dummy variables on the issuer type (city, school districts, and other special-purpose governments). *b.* Issuer attributes related to its financial health include demographic and economic variables at the county level (median household income, senior population, poverty rate, population growth rate, unemployment rate) and government finance variables (the average and standard deviation of annual government revenues, the fraction of taxes in government revenue, and the fraction of government revenue sourced from federal and state governments.)

(i) an underwriter’s sway over the government officials, (ii) its rent from underwriting more complex bonds, and (iii) the lack of watchdogs like local newspapers.

*Exogeneity Assumption as an Instrument.* Having shown that revolving-door regulations impact bond design, Section 4.2 uses changes in these regulations as an instrument to explore the incentives of underwriters and the trade-off of building complexity in bonds. For this approach to be valid, state revolving-door regulations must not directly affect the trading market. Here, we argue that this condition is likely to hold.

First, the revolving-door regulations are enacted at the state level, and our analysis is at a municipal bond level. While specific local circumstances may prompt state-wide legislation, such circumstances may not be necessarily relevant for other localities. In addition, we do not find evidence for a pre-trend (Figure A1 in Appendix B.4). Anecdotally, based on local news articles around the timing of the enactment

of state legislation on revolving-door regulations, we find that concerted local media efforts against corruption seem to have been an important driver for the reforms.<sup>20</sup>

Second, although the government ethics reform legislation often comes with various provisions other than revolving door regulations, such as strengthening disclosure requirements or imposing gift restrictions for public officials, these tend to be irrelevant for municipal bond underwriters and dealers, who are also regulated by federal institutions (the MSRB, the FINRA, and the SEC), as discussed in Section 2.4.

Third, we do not find evidence that revolving-door regulations impact government officials' behaviors related to the ability to pay back government debts. We look at the credit ratings of the bonds that were issued prior to 2010, at the end of each year from 2010 to 2013.<sup>21</sup> Adapting the specification of (1), we show that revolving-door regulations do not affect the credit ratings of existing bonds (Column (1) of Table 3).<sup>22</sup>

Fourth, we document that the impact of revolving-door regulations on the availability of bonds for investors is also limited. Specifically, we look at local governments' bond issuance behavior in three dimensions: the amount of capital raised by municipal bonds, the average length of bond maturity, and the ratio of bonds sold via negotiation. We aggregate these variables at the government-year level and adapt the specification of (1) where the revolving-door regulation dummies indicate that the respective regulation was in place during the entire year. As shown in the last three columns of Table 3, and we do not find evidence that revolving-door regulations affect local governments' bond supply.

Lastly, given our argument that regulations can limit underwriters' influence in bond negotiations, the complexity of auctioned bonds should not decrease as revolving-door regulations are enacted, because underwriters cannot directly affect

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<sup>20</sup>For example, the Maine Monitor (Christ and Schalit, 2012) reported that an "F" grade from the 2012 State Integrity Investigation, conducted by a nonprofit investigative journalism organization (the Center for Public Integrity), spurred the 2013 legislation regulating revolving-door practices. Similarly, the editorial section of the *Indianapolis Star* on Nov 17, 2009 states that Pat Bauer, the then-Speaker of the Indiana State House, unexpectedly announced his own reform package, including a one-year waiting period before legislators could become lobbyists, five days after the editorial board of the newspaper informed the speaker's aides that 23 Indiana newspapers were preparing to launch an ethics reform campaign.

<sup>21</sup>The ratings of a bond may change until it reaches its maturity, and these ratings reflect the financial health and the ability of the issuer to pay the remaining balances of a bond, which are partially determined by government officials' decisions in managing revenues and expenses.

<sup>22</sup>Here a bond can be observed multiple times, and all explanatory variables, including the fixed effects, are measured at the time when a bond is observed, as opposed to when it was issued.

TABLE 3. Revolving-door Regulations and Bond Management/Issuance

	Rating of existing bonds <sup>b</sup> (1)	Annual issuance amount (log) <sup>c</sup> (2)	Length of maturity (log) <sup>d</sup> (3)	Ratio of negotiation <sup>d</sup> (4)
Local officials regulated	-0.133 (0.121)	-0.192 (0.130)	0.151 (0.094)	-0.082 (0.058)
State officials regulated	-0.087 (0.107)	0.243 (0.237)	-0.020 (0.052)	-0.019 (0.021)
Bond attributes <sup>a</sup>	Yes	No	No	No
Issuer financial health <sup>a</sup>	Yes	Yes	Yes	Yes
Year FE, County FE	Yes	Yes	Yes	Yes
Number of observations	195,234	62,588	21,963	21,714
$R^2$	0.278	0.073	0.358	0.432

*Notes:* This table reports OLS estimates. Standard errors are adjusted for clustering at the state level, and are provided in parentheses; \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . a. See the notes in Table 2 for the details on the control variables. b. We use all bonds that were issued prior to 2010 by the local governments in our sample. The dependent variable is the credit rating of each bond. Note that during the four years of our study period (2010–13), we observe these bonds up to four times (depending on the maturity). c. The unit of analysis is government-year based on 15,673 governments over four years, 2010–13. The total number of observations used in the regressions are slightly less than  $15,673 \times 4$  because some of the controls are not available; the results are robust to including all observations and dropping some controls. The outcome variable is the logarithm of the total money raised via municipal bonds plus one. d. We use all government-year observations with any tax-exempt general obligation or revenue bond issuance. The outcome variables are the logarithm of the average length of maturity among the bonds issued by the government during the given year (Column 3) and the ratio of bonds sold via negotiation, in terms of the amount of money raised (Column 4).

bond design for such bonds. This is confirmed by Table A6 in Appendix C.2, which shows the OLS results based on the specification of (1) for auctioned bonds.

**4.2. Incentives in Bond Design.** A bond’s underwriter tends to be a dominant player in the bond’s intermediation market long after its initial sale: the underwriter’s market share for the average bond it underwrote is 12.2% while the other dealers have an average market share of 3%. The results in Section 4.1 suggest that the underwriter might have an incentive to influence bond design in favor of more complex bonds.

To study whether the underwriter’s role as an intermediary can be a driver of these incentives, we rely on the following model:

$$y_i = \beta_s \log(s_i + 1) + \beta_r r_i + \gamma \mathbf{X}_i + \kappa_{c(i)} + \theta_{t(i)} + \epsilon_i, \quad (2)$$

for different market outcomes  $y_i$ . To address the endogeneity of bond design, we estimate a 2SLS specification that treats the complexity index,  $s_i$ , and the coupon

rate,  $r_i$ , as endogenous bond attributes.<sup>23</sup> We instrument these variables using the two revolving-door regulation dummy variables, interacted with county/state-level attributes.<sup>24</sup> To control for different time trends depending on these county/state attributes, we include their interaction with year-month fixed effects. We also control for issuer/bond characteristics, and county and year-month fixed effects, as in (1).

We begin by estimating (2) using as outcome variable the underwriter’s share in the market for secondary transactions of bond  $i$ .<sup>25,26</sup> Column (2) of Table 4 indicates that increasing the complexity index from its average value (1.46) to the 75th percentile (1.69) raises the underwriter’s market share by 3.2 percentage points, corresponding to an increase of 26% compared to the average. In the primary market, the underwriter has the unique advantage of learning about the investors’ interests in a bond before other dealers have a chance to do so. The results suggest that this knowledge can give the underwriter a sizable edge for complex bonds, enabling it to quickly locate potential buyers and sellers and increase its market share vis-a-vis other dealers. Note, however, that the underwriter may not necessarily benefit from raising its market share, if it coincides with a smaller market size. However, Column (4) in Table 4 confirms that it is not the case, and shows that the underwriter’s gross profit is higher for complex bonds.<sup>27</sup>

We next provide empirical evidence on the trade-off between flexibility and liquidity associated with nonstandard provisions (see Section 2.1). To highlight the benefits of flexibility introduced by nonstandard provisions, we estimate specification (2) using as the outcome variable  $y_i$  the number of negative “credit watch” incidences during the first five years after origination, that is when the Standard & Poor’s rating agency detects an event or a trend that is likely to result in lowering the credit rating. We use these negative credit events as a proxy for default risk because defaults are

<sup>23</sup>Our 2SLS estimates for  $\beta_s$  are robust to excluding the coupon rate.

<sup>24</sup>Table 4’s notes contain the full list of instruments. We include interactions to address the limited variation in the binary revolving-door regulation dummies, a choice informed by the heterogeneous effects of these regulations documented in Table A4.

<sup>25</sup>Appendix A.4 describes the procedure to identify trades by an underwriter of a bond.

<sup>26</sup>We focus on all dealers’ purchases of the bond from investors within four years after the bond’s origination. The reason why we focus on purchases, not sales, is that the underwriter may be a big seller to investors in the secondary market simply because it is selling its remaining inventory from the primary market. Using an alternative window does not qualitatively affect the results.

<sup>27</sup>Recall that the analysis is done at the issue level, aggregating the outcomes of all bonds within an issue. If investors cherry-pick simpler bonds within an issue, we would observe secondary market outcomes reacting relatively less to our issue-level complexity measure, leading to, possibly, an underestimation of the impact of complexity.

TABLE 4. Underwriter Incentives in Bond Design

	Underwriter's Market Share <sup>c</sup>		Gross profit <sup>d</sup>	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)
Complexity index (log)	0.082** (0.022)	0.368** (0.181)	2.105*** (0.3670)	6.162** (2.140)
Coupon rate	Yes	Yes	Yes	Yes
Bond attributes <sup>a</sup>	Yes	Yes	Yes	Yes
Issuer financial health attributes <sup>a</sup>	Yes	Yes	Yes	Yes
Year-month FE, County FE	Yes	Yes	Yes	Yes
Heterogeneous time trend <sup>b</sup>	Yes	Yes	Yes	Yes
Mean of the dependent variable	0.126	0.126	1.752	1.752
SD of the dependent var.	0.254	0.254	5.526	5.526
Number of observations	9,321	9,321	11,564	11,564
First stage F-stat <sup>e</sup>	-	6.6	-	10.5

*Notes:* This table reports both OLS and 2SLS estimates, based on the negotiated issues of general obligation or revenue bonds with any secondary market trades by local governments in 2010–2013. The instruments include dummy variables for revolving-door regulations, interacted with the Herfindahl-Hirschman index for the market of financial advisors at the state level, with the fraction of secondary transactions by individual investors at the state- and security-type level, with the length of the maturity, as well as with whether or not the state government is under divided control. Standard errors are adjusted for clustering at the state level, and are provided in parentheses. <sup>\*</sup> $p < 0.10$ , <sup>\*\*</sup> $p < 0.05$ , <sup>\*\*\*</sup> $p < 0.01$ . *a.* These controls are identical to those in Table 2. *b.* We include year-month FEs interacted with the county/state-level attributes used for the instruments. *c.* The “market share” is defined as the ratio of the underwriter’s purchases from investors to all dealers’ purchases from investors within four years after origination. *d.* The “gross profit” is defined as the value of total sales minus that of total purchases made by the underwriter within four years after origination, per a face value of \$100. In the regression, we winsorize this variable. *e.* The first stage F-stat is computed following Sanderson and Windmeijer (2016) to account for the fact that we have two endogenous variables.

extremely rare in this market.<sup>28</sup> In our sample, on average, a bond experiences 0.094 negative credit events for the first five years of its life-cycle. The results in Column (2) reveal that nonstandard provisions have a substantial impact on the bond’s default risk: a 1% increase in the bond complexity index lowers the number of negative credit incidences by 0.008, which corresponds to a decrease of 8.6% over the mean, 0.094.

To look at the impact of nonstandard bond provisions on trading frictions faced by investors, we estimate (2) using as an outcome variable the bond’s intermediation spread: the logarithm of the average dealer-to-investor sale price minus the logarithm

<sup>28</sup>According to a Moody’s report, “US Municipal Bond Defaults and Recoveries, 1970-2016,” the 10-year cumulative default rate is 0.15% for rated municipal bonds, and is 10.29% for rated global corporate bonds.

TABLE 5. Trade-off in Bond Design for Government Cost

	Number of negative rating events <sup>a</sup>		Intermediation spread <sup>b</sup>	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)
Complexity index (log)	-0.0034 (0.049)	-0.813** (0.389)	0.009** (0.002)	0.046** (0.018)
Coupon rate	Yes	Yes	Yes	Yes
Bond attributes	Yes	Yes	Yes	Yes
Issuer financial health attributes	Yes	Yes	Yes	Yes
Year-month FE, County FE	Yes	Yes	Yes	Yes
Heterogeneous time trend	Yes	Yes	Yes	Yes
Mean of the dependent variable	0.094	0.094	0.012	0.012
SD of the dependent variable	0.291	0.291	0.022	0.022
Number of observations	13,085	13,085	11,078	11,078
First stage F-stat <sup>c</sup>	-	9.38	-	10.5

*Notes:* This table reports both OLS and 2SLS estimates, based on the negotiated issues of general obligation or revenue bonds with any secondary trades originated by local governments in 2010–2013. The instruments and controls are the same as those in Table 4. Standard errors are adjusted for clustering at the state level, and are provided in parentheses. \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . *a.* The “negative rating event” refers to a “credit watch” incidence associated with a probable downgrade of the bond’s credit rating during the first five years after origination, as detected by the Standard & Poors. *b.* The “intermediation spread” is the logarithm of the average dealer-to-investor sale price minus the logarithm of the average dealer-from-investor purchase price. *c.* The first stage F-stat is computed following Sanderson and Windmeijer (2016) to account for the fact that we have two endogenous variables.

of the average dealer-from-investor purchase price. Intuitively, a bond’s intermediation spread measures the cost for an investor to participate in the bonds’ trading market; this is the amount of money an investor would lose if they were to buy and immediately sell a bond. In our sample, the average intermediation spread is 0.012 or 120 basis points (bps). This is large, compared to the bid-ask spread of corporate bonds in 2010–2013, 30-60 bps (Figure 13 of Mizrach (2015)). The estimated coefficient for  $\beta_s$ , presented in Column (4), indicates that increasing the complexity index from its average value (1.46) to the 75th percentile (1.69) raises the bond’s intermediation spread by 17 bps, corresponding to a 14% increase over the average.<sup>29</sup>

By taking an IV approach, we document a causal relationship between a bond’s complexity and multiple market outcomes. This relationship might be confounded by unobserved factors in a standard OLS approach. For instance, an issuer anticipating

<sup>29</sup>Consistently, when we look at the total volume of secondary trades for a bond, specifically the total number of transactions in which a dealer purchased the bond from investors in the first four years after origination, we find that increasing bond complexity decreases trading volume.

potential financial hardships may find call options attractive as a way to reduce interest payments, which may lead to a positive correlation between bond complexity and negative credit rating events, as shown in Column (1). As another example, larger and more established issuers tend to have a more volatile revenue structure and also tend to attract more dealers in the secondary market. This pattern may induce a negative correlation between complexity and the underwriter’s market dominance (or the intermediation spread), because these issuers would benefit from using nonstandard provisions to protect themselves against the uncertainty in their cash flows.

In summary, our results point to a potential distortion in bond design driven by the underwriter’s incentives, and suggest that such a distortion affects investors and the issuing government through search frictions and cost of paying debt. These facts, taken together, create a possible rationale for government intervention regulating bond design directly. Our structural analysis allows us to quantify the welfare implications of one such policy, a standardization mandate, which has been at the center of an active debate in policy circles.

## 5. MODEL

**5.1. Setup.** Consider a municipal government contemplating the issuance of a bond of size  $A \in \mathbb{R}_+$ , maturity  $T \in \mathbb{R}_+$ .<sup>30</sup> An underwriter and an official acting on behalf of the government negotiate over the purchase price,  $F \in \mathbb{R}_+$ , the expected interest rate,  $r \in \mathbb{R}_+$ , and the extent to which the bond contract includes various nonstandard provisions, summarized by a one-dimensional index,  $s \in \mathbb{R}_+$ .<sup>31</sup> In exchange of the payment of  $F$ , the underwriter is awarded the entire bond.

To fully capture how non-standard provisions can affect the incentives of both the underwriter and the issuer, the key model primitives characterizing the trading market and the issuer preferences/costs are allowed to depend on various issuer and bond-specific attributes, in addition to  $(A, T, s, r)$ , such as the overall financial solvency of the issuer and the projected revenue streams of the bond’s infrastructure project. Some of these attributes are not necessarily observed or easily measurable

<sup>30</sup>Consistent with the evidence in Table 3, we assume the bond amount and maturity are exogenously determined by the government’s finances and the nature of the infrastructure project.

<sup>31</sup>Here, we abstract away from the issuing government’s decision concerning the mode of sale, which is largely determined by local regulations and external factors as discussed in Appendix C.1. Moreover, we also abstract away from the choice of underwriter, which is often limited by a lack of competition and long-term relationships, as discussed in Section 2.2. Appendices C.3, G.2, and G.3 show that our counterfactual results are robust to these modeling choices.

by the researcher. Thus, although all issuer and bond attributes are known to market participants, we allow the researcher not to observe all of them. To the extent that the underwriter and issuer factor in the unobserved attributes when designing the bond, accounting for them is important in understanding the effects of bond design on the market outcomes. We denote the attributes observed by the researcher, which include  $(A, T)$ , as  $\mathbf{x} \in \mathcal{X} \subset \mathbb{R}^{dim(\mathbf{x})}$  and those not observed as  $\xi \in \Xi \subset \mathbb{R}^{dim(\xi)}$ .

In the negotiations at origination, the government's bargaining power is represented by  $\rho_G$ . The outside options for the government and the underwriter, denoted as  $J_G(\mathbf{x}, h)$  and  $J_U(\mathbf{x}, h)$ , are common knowledge. We normalize the cost of underwriting to zero.<sup>32</sup> The underwriter's payoff is the value from the initial sales and the subsequent trades of the bond,  $V_U(s, r; \mathbf{x}, \xi)$ , minus the payment to the government:

$$V_U(s, r, \mathbf{x}, \xi) - F. \quad (3)$$

The issuer uses  $F$  to finance its projects, and bears the cost of paying the principal  $A$  and the interest  $rAT$ . Their payoff is captured by

$$F - c_0(s, \mathbf{x}, \xi)A(1 + rT) + \theta_d s. \quad (4)$$

The coefficient  $c_0(s, \mathbf{x}, \xi)$  represents the minimal attainable marginal cost to make the bond payments. We allow this cost to be different from one to capture the idea that movements in the issuer's cash flow may affect the marginal cost of debt payment. For example, the cost of making a payment is larger when the issuer has less cash available. By the same token,  $c_0$  can also depend on the bond complexity  $s$ , since nonstandard provisions allow the issuing government to postpone or advance the future payments depending on their reserves; similarly, the option of calling back (a part of) the debt allows the government to exploit a low market interest rate to decrease its interest payments. In addition, we allow the issuer to benefit directly from having nonstandard provisions in the bond through the last term in (4),  $\theta_d s$ . This term captures, amongst others, the issuer's dynamic incentives concerning bond design. For example, since a bond's design affects the issuer's default risk (Column (2) of Table 5), it can, in turn, influence the cost of issuing future bonds.

The government officials may take into account the underwriter's incentives, in addition to the issuer's payoff. Specifically, we assume that the official's payoff is a weighted sum of the payoff of the government and the underwriter's value of the bond,

<sup>32</sup>As long as the cost of underwriting and the underwriter's outside option do not depend on endogenous bond attributes,  $(s, r)$ , this normalization is without loss of generality because the underwriting cost does not affect negotiation at origination.



with a weight representing her collusive relationship with the underwriter, denoted by  $\psi \geq 0$ .<sup>33</sup> We allow the weight,  $\psi$ , to vary with the presence of revolving-door regulations, denoted by a dummy variable  $h \in \{0, 1\}$ , in addition to the observed circumstances surrounding the relationship between the underwriter and the issuer, following Table A4. To summarize, the official's payoff is

$$F - c_0(s, \mathbf{x}, \xi)A(1 + rT) + \theta_d s + \psi(\mathbf{x}, h)V_U(s, r, \mathbf{x}, \xi). \quad (5)$$

In the trading market, there is a large population of investors and dealers, each represented by a point in an interval with measure  $m_I(\mathbf{x}) > 0$  and  $m_D(\mathbf{x}) > 0$ . Once the bond is issued, investors meet dealers and trade in continuous time with finite horizon  $[0, T]$ . Let  $\tau$  denote the remaining time until the maturity of the bond  $\tau = T - t$ . Note that in  $\tau = T$  (or  $t = 0$ ), the underwriter owns the entirety of the bond. All agents discount payoffs at rate  $\delta$ .

Investors and dealers receive flow utility from holding the bond before maturity. Investors' flow payoff from holding  $a \in \mathbb{R}$  unit of the bond, given the coupon rate  $r$ , depends on their taste type,  $\nu \in \mathbb{R}_+$ , and is specified as:

$$v_I(a, \nu, s, r, \mathbf{x}, \xi) = \nu \log(r)a - \kappa_I(\mathbf{x}, \xi)a^2, \quad (6)$$

where the linear term captures the value of the interest, while the quadratic term reflects the opportunity cost of tying up the amount  $a$  in the bond.<sup>34</sup>

We assume that the value of the interest is concave in  $r$  to capture the issuer's solvency problem and risk associated with a high coupon rate. At each instant, the investor draws a new type with probability  $\alpha(\mathbf{x}, \xi)$ , from a distribution  $F_{\nu|(\tau, s, \mathbf{x}, \xi)}$ . The taste type distribution can depend on bond design: some bond attributes may increase or decrease investors' average valuations of a bond, while other attributes

<sup>33</sup>As discussed in Appendix D.2, under this specification, the equilibrium bond design depends on  $\psi$ , and thus it also depends on revolving-door regulations. An alternative model would allow the official to take into account the underwriter's entire payoff,  $V_U(s, r, \mathbf{x}, \xi_M) - F$ , subject to a constraint on  $F$ . This constraint reflects that a particularly low bond price,  $F$ , may draw attention from watchdogs. Appendix D.1 shows that this model is observationally equivalent to our model, which is simpler and computationally convenient.

<sup>34</sup>Since the role of investor substitution is limited by the dominance of retail investors and the geographical nature of demand, we abstract away from directly modeling the portfolio problem that investors face. Instead, we let the quadratic cost  $-\frac{1}{2}\kappa_I a^2$  in (6) reflect the opportunity cost of tying up amount  $a$  in the bond when facing other assets as substitutes (Appendix G.1.1). To ensure that the estimates are robust to this modeling choice, we allow for  $\kappa_I$  to be bond-specific, and for the type of an investor to be flexibly heterogeneous both across investors and bonds. Appendix G.1.2 discusses the implications of this modeling approach for the counterfactual analyses.

may influence the dispersion of valuations, appealing to a niche or “mass market” (Johnson and Myatt, 2006).

The flow payoff of a dealer from holding the bond before the maturity is:

$$v_D(a, s, r, \mathbf{x}, \xi) = \nu_D(\mathbf{x}, \xi) \log(r)a - \kappa_D(\mathbf{x}, \xi)a^2, \quad (7)$$

where  $\nu_D \log(r)a$  reflects the payoff from receiving the interest payments, given the flow utility parameter  $\nu_D > 0$ . We capture factors constraining dealers’ ability to expand their asset holdings by  $\kappa_D \geq 0$ . The payoff of holding  $a$  bonds at the end of the maturity is  $\omega_I a$  for an investor and  $\omega_D a$  for a dealer.

Dealers meet investors and other dealers to trade. Upon meeting, the Nash bargaining weights for determining trading prices and quantities are  $\rho_D$  and  $\rho(\mathbf{x}, \xi)$ , respectively, for inter-dealer and investor trades. Note that the assumption of Nash bargaining implies that the negotiated quantity maximizes the joint gains from trade, while the price divides these gains. The rate at which dealers meet each other,  $\lambda_D(\mathbf{x}, \xi)$ , is exogenously given and is constant across the dealers and over time.<sup>35</sup> On the other hand, the rate at which a dealer meets an investor,  $\lambda$ , is chosen by each dealer at costly search efforts.

A dealer’s cost of meeting investors at rate  $\lambda$  is:

$$\phi_0 \exp[-\phi_1(s, \mathbf{x}, \xi) \log(b + 1)] \exp(\lambda), \quad (8)$$

which depends on two components. The first component captures pre-existing dealer-specific cost (dis)advantage:  $\phi_0 \geq 0$  is a search cost type, which each dealer draws from a distribution that varies with bond attributes,  $F_{\phi_0|(s, \mathbf{x}, \xi)}$ .<sup>36</sup> The second component captures how a dealer’s client network impacts its search costs. We denote the size of a dealer’s client network by  $b$  and measure it by the dealer’s cumulative number of trades with investors for the bond.

Allowing for network effects in search (i.e.,  $\phi_1 > 0$ ) is motivated by the institutional features in Section 2.3: for a dealer, it is easier to trade a bond with an investor if they have already traded it with each other before. Such an investor is familiar with the bond, while the dealer needs to spend extra time and effort to help a first-time investor of the bond figure out whether the bond suits her needs. This implies that dealers with a larger client network might face lower costs.

<sup>35</sup>As  $\lambda_D$  increases, the inter-dealer market can approximate no search frictions. In estimation, we do not impose an upper bound for  $\lambda_D$ .

<sup>36</sup>In estimation, the realized value of  $\phi_0$  is allowed to depend on the dealer’s prior experience in local bond trades.

Note that both  $F_{\phi_0}$  and  $\phi_1$  are allowed to depend on bond attributes, including the complexity index,  $s$ . For example, the more complex a bond becomes, the more difficult and time-consuming it can be for dealers, including an underwriter, to meet and communicate with an extra investor. Moreover, nonstandard provisions may change the value of a dealer's client network, by affecting the network parameter  $\phi_1$ .

**5.2. Equilibrium in the Trading Market.** This section characterizes the equilibrium in the trading market for any given bond with  $(s, r, \mathbf{x}, \xi)$ . The dependence of primitives and equilibrium objects on  $(s, r, \mathbf{x}, \xi)$  is suppressed here for ease of notation.

The state of a dealer,  $u \equiv (a, b, \phi_0)$ , is summarized by their inventory of the bond,  $a$ , cumulative trade with investors  $b$ , and initial search type  $\phi_0$ . An investor's state,  $y \equiv (a, \nu)$ , consists of her inventory  $a$  and taste type  $\nu$ . We denote the equilibrium price and quantity for a trade between two dealers of states  $u$  and  $u'$  at  $\tau$  by  $p_D(\tau; u, u')$  and  $q_D(\tau; u, u')$ ; and similarly, those for a trade between a dealer of state  $u$  and an investor of state  $y$  by  $p_I(\tau; u, y)$  and  $q_I(\tau; u, y)$ . The equilibrium distributions of dealers' and investors' states at time  $\tau$  are denoted by  $\Phi_D(\tau; u)$  and  $\Phi_I(\tau; y)$ .

The value function of a dealer with state  $u$  at  $\tau > 0$ , denoted as  $V(\tau; u)$ , satisfies:

$$\begin{aligned} \dot{V}(\tau; u) = & -\delta V(\tau; u) + v_D(a) + \lambda_D \int_{u'} \left\{ V(\tau; a + q_D(\tau; u, u'), b, \phi_0) - V(\tau; u) \right. \\ & \left. - p_D(\tau; u, u') \right\} d\Phi_D(\tau; du') + \max_{\lambda} \left[ \lambda \int_y \left\{ V(\tau; a - q_I(\tau; u, y), b + 1, \phi_0) \right. \right. \\ & \left. \left. - V(\tau; u) + p_I(\tau; u, y) \right\} d\Phi_I(\tau; dy) - \phi_0 \exp(-\phi_1 \log(b + 1)) \exp(\lambda) \right], \end{aligned} \quad (9)$$

The first term on the right-hand side of (9) captures the dealer's discounting; the second term is its flow utility; the third term is the expected change in the continuation utility associated with a trade with another dealer randomly drawn from  $\Phi_D(\tau; u)$ , which occurs with Poisson intensity  $\lambda_D$ ; and the fourth term represents the expected change in the continuation utility associated with a trade with an investor. The dealer chooses meeting rate  $\lambda$  subject to a search cost, and the trading partner's state is drawn randomly from  $\Phi_I(\tau; y)$ .

Based on the first order condition for  $\lambda$  in (9), the equilibrium meeting rate is:

$$\begin{aligned} \lambda(\tau; u) = & \log \left( \frac{1}{\phi_0 \exp(-\phi_1 \log(b + 1))} \int_y \left\{ V(\tau; a - q_I(\tau; u, y), b + 1, \phi_0) \right. \right. \\ & \left. \left. - V(\tau; u) + p_I(\tau; u, y) \right\} d\Phi_I(\tau; dy) \right). \end{aligned} \quad (10)$$

Let  $W(\tau; a, \nu) \equiv W(\tau; y)$  denote the value function of an investor:

$$\begin{aligned} \dot{W}(\tau; y) = & -\delta W(\tau; y) + v_I(y) + \alpha \int [W(\tau; a, \nu') - W(\tau; y)] f(\nu'|\tau) d\nu' \\ & + \frac{m_D}{m_I} \int_u \lambda(\tau; u) \left\{ W(\tau; a + q_I(\tau; u, y)) - W(\tau; y) - p_I(\tau; u, y) \right\} \Phi_D(\tau; du). \end{aligned} \quad (11)$$

The first term on the right-hand side of (11) represents the investor's discounting; the second term is her flow utility; the third term is the expected change in the investor's continuation utility associated with a change in her taste type, which occurs with probability  $\alpha$ ; and the fourth term is the expected change in the continuation utility associated with a trade. The potential trading partner is randomly drawn, and the likelihood of drawing a dealer with state  $u$  is  $\frac{m_D}{m_I} \lambda(\tau; u) \Phi_D(\tau; du)$ . At maturity ( $\tau = 0$ ), the agents receive the face value of their inventory. The after-tax payoff for the dealer is  $V(0; u) = \omega_D a$ , and for the investor  $W(0; a, \nu) = \omega_I a$ .

An equilibrium in the trading market consists of (i) a path for the distribution of agents' states, (ii) value functions for investors and dealers, (iii) dealer-to-investor meeting rates, and (iv) trading prices and quantities. At equilibrium, the distribution of agents' states is consistent with the transitions induced by meeting rates and trading quantities; the value functions satisfy (9)-(11) and the terminal values at maturity, given the distribution of agents' states; trading prices and quantities are the Nash bargaining outcomes; and the meeting rate is optimal given the dealers' value functions. Appendix E provides a formal definition of equilibrium, as well as equations characterizing the equilibrium trade prices and quantities, (A.16)–(A.19).

Given the equilibrium meeting rates and trading quantities, (A.20) and (A.21) in Appendix E provide a law of motion for the equilibrium path of the state distributions of dealers and investors. Note that such a recursive characterization of the state distribution is essential to ensure that the model is computationally tractable, since it allows us to compute the market equilibrium without simulating the model.

**5.3. Equilibrium Bond Design and Sources of Inefficiency.** Note that the underwriter's payoff from trading,  $V_U(s, r, \mathbf{x}, \xi)$ , is  $V(T; A, 0, \phi_{0,U}|s, r, \mathbf{x}, \xi)$ , where we make the dependence of the value function on the bond attributes explicit and  $\phi_{0,U}$  denotes the initial search cost type of the underwriter. Under the assumption that the underwriter and official negotiate over bond attributes and the price based on

Nash bargaining, the solution  $(s^*, r^*, F^*)$  satisfies

$$-\frac{\partial}{\partial s} c_0(s^*, \mathbf{x}, \xi) A(1 + r^* T) + \theta_d = -\{1 + \psi(\mathbf{x}, h)\} \frac{\partial}{\partial s} V_U(s^*, r^*, \mathbf{x}, \xi), \quad (12)$$

$$c_0(s^*, \mathbf{x}, \xi) AT = \{1 + \psi(\mathbf{x}, h)\} \frac{\partial}{\partial r} V_U(s^*, r^*, \mathbf{x}, \xi), \quad (13)$$

$$\frac{F - c_0(s^*, \mathbf{x}, \xi) A(1 + rT) + \theta_d s^* + \psi(\mathbf{x}, h) V_U(s^*, r, \mathbf{x}, \xi) - J_G(\mathbf{x}, h)}{V_U(s^*, r, \mathbf{x}, \xi) - F - J_U(\mathbf{x}, h)} = \frac{\rho_G}{1 - \rho_G}. \quad (14)$$

The purchase price,  $F^*$ , divides the surplus of the negotiation according to (14). This surplus is determined by the negotiated bond attributes,  $(s^*, r^*)$ , which are set to maximize the weighted sum of the government official's payoff and the underwriter's payoff from trades, as represented by (12) and (13).

These equations present how bond design resolves multiple trade-offs affecting all market participants. Increasing the level of bond complexity may benefit the issuer due to payment schedule flexibility and dynamic considerations  $\theta_d$  (the left-hand side of (12)). At the same time, more nonstandard provisions may increase search frictions and lower liquidity, in addition to affecting investor taste distribution. Similarly, the negotiated coupon rate affects the issuer's marginal cost of debt payment (the left-hand side of (13)) as well as the investors' marginal benefit from the bond's cash flows and resale. While investors do not enter the negotiation directly, their incentives are reflected in the underwriter's marginal valuation, scaled by the extent of conflict of interest  $\psi$  (the right-hand side of (12) and (13)).

Search and bargaining frictions may lead the underwriter to fail to fully internalize how bond design affects investor valuations, possibly distorting the choice of complexity and coupon rate. In addition, these distortions can be amplified by collusion between the government officials and the underwriter, which is captured by  $\psi$ . One specific channel through which the underwriter's incentives might distort the prevalence of nonstandard provisions is the network effects in search. The underwriter has an advantage from its exclusive right for the initial sales of the entire bond, enabling it to build its client network ahead of other dealers. More nonstandard provisions can further enlarge the extent of this competitive advantage vis-à-vis other dealers through their impact on the network effect parameter  $\phi_1$ .

Overall, how the underwriter's incentives affect the negotiated bond complexity and coupon rate, and thus the capital cost of the issuing government, depends on investor preferences for liquidity, government preferences for flexibility, and the market structure among the dealers for secondary transactions. While nonstandard provisions may increase search frictions and thus decrease the total size of the surplus

from trading the bond, but they can also help the underwriter secure a larger share of that surplus by increasing network effects. Our counterfactual analysis allows us to quantify how these two forces play in different market and government conditions, and investigate the welfare implications of a policy to standardize municipal bonds.

## 6. ESTIMATION

This section describes what we observe in the data, the model primitives, and our multi-step estimation strategy, along with the identifying assumptions.

**6.1. Observables.** We employ data on both bond origination and transaction. First, in terms of bond origination, for each bond issue  $i$ , we observe the endogenous bond attributes: the complexity index  $s_i$  defined in Section 3, which corresponds to  $s$  in the model, and the coupon rate  $r_i$ . To capture the rich heterogeneity across bond and issuing governments, we also observe various exogenous bond attributes ( $\mathbf{x}_i$ ). Moreover, we observe the presence of state revolving-door regulations at the time of origination, as represented by a dummy,  $h_i$ .

Second, we observe all the transactions for a given bond issue until its maturity or the end period of our data, whichever is earlier. Specifically, if a  $j^{th}$  transaction on bond  $i$  is between two dealers ( $d_{ij} = 0$ ), we observe the price  $p_{ij}$ , the quantity  $q_{ij}$ , and the time of the transaction  $t_{ij}$  with the corresponding time until the maturity,  $\tau_{ij} \equiv T_i - t_{ij}$ , as well as both dealers' asset holdings and past transactions ( $a_{ij}$ ,  $a'_{ij}$ ,  $b_{ij}$ , and  $b'_{ij}$ ). If the transaction is between a dealer and an investor ( $d_{ij} = 1$ ), we observe similar information on the transaction, except that we do not observe the investor's asset holding and past transactions.

Finally, we observe the geographical specialization of the dealer(s) involved in each transaction. Specifically, based on a dealer's transaction history prior to the bond's origination during our period of study,  $g_{ij}$  indicates that the dealer in the  $j^{th}$  transaction for bond  $i$  has experience trading bonds from the same county ( $g_{ij} = 0$ ); or it has experience trading bonds from the same state, but not from the same county ( $g_{ij} = 1$ ); or it has no experience trading bond from the same state ( $g_{ij} = 2$ ).<sup>37</sup> Table A10 presents summary statistics of the variables used in the estimation.

**6.2. Model Primitives.** There are three groups of model primitives that we estimate. First, we recover how search costs, investor preferences, and government

<sup>37</sup>We find that the definition of a dealer's geographical experience is robust to the period used because dealers' trading patterns are very persistent over time.

costs depend on complexity ( $s$ ) and exogenous bond attributes ( $\mathbf{x}, \xi_M, \xi_G$ ). This includes (i) the initial search cost type distribution,  $F_{\phi_0|(\mathbf{s}, \mathbf{x}, \xi_M)}(\cdot | s, \mathbf{x}, \xi_M)$ ; (ii) the search network parameter,  $\phi_1(s, \mathbf{x}, \xi_M)$ ; (iii) the investor taste type distribution,  $F_{\nu|(\tau, s, \mathbf{x}, \xi_M)}(\cdot | \tau, s, \mathbf{x}, \xi_M)$ ; and (iv) the government cost of paying debt,  $c_0(s, \mathbf{x}, \xi_G)$  together with the direct marginal benefit of nonstandard provisions,  $\theta_d$ .

Second, we estimate the parameters of the trading market that do not depend on bond design. These parameters include the dealers' utility parameters ( $\kappa_D, \nu_D$ ), the investors' cost of holding inventory  $\kappa_I$  and their liquidity shock  $\alpha$ , the inter-dealer meeting rate  $\lambda_D$ , and the dealers' bargaining power against investors  $\rho$ . Note that, since bond design does not affect these parameters, our counterfactual analysis does not require understanding how these parameters vary by bond attributes. For this reason, we estimate the bond-specific realizations of these parameters: for each bond  $i$  we estimate  $(\kappa_{D,i}, \nu_{D,i}, \kappa_{I,i}, \alpha_i, \lambda_{D,i}, \rho_i)$ .<sup>38</sup>

Finally, we estimate how the officials' utility weights for the underwriter change with the revolving-door regulations, specifically  $(1 + \psi(\mathbf{x}, 0))/(1 + \psi(\mathbf{x}, 1))$ . Note that we do not estimate the bargaining parameter at origination  $\rho_G$ , and the outside options of either bargaining party. The main consequence is that we cannot compute the bond price  $F$  from the underwriter to the government in our counterfactual simulations.<sup>39</sup> Instead, we focus on the profits of the underwriter from trading bonds and the government's costs of paying the debt, as opposed to each party's payoffs.

We assume  $m_I(\mathbf{x})/m_D(\mathbf{x})$  is constant for assets issued by the same state, and we set it as the highest number of trades for the bonds issued in the state within three months of the origination of a given bond, divided by the total number of dealers in that state. We also set the discount rate  $\delta = 0.05$  and the inter-dealer bargaining parameter  $\rho_D = 0.5$ . Moreover, we set  $\omega_D = 0.75$  and  $\omega_I = 1$  to reflect the different tax treatment for retail investors and institutions (Section 2.1).

**6.3. Estimation Strategy.** We estimate the model primitives in three steps.

**6.3.1. Step 1: Trading Market Parameters for Each Bond.** In the first step, we leverage bond transaction data to estimate the trading market parameters for each bond separately. Given our moderate sample size, we make parametric assumptions on the distributions of the investor taste type and the dealer search cost type,

<sup>38</sup>More precisely, for each bond  $i$  we estimate  $\kappa_{D,i} \equiv \kappa_D(\mathbf{x}_i, \xi_{i,M})$ ,  $\nu_{D,i} \equiv \nu_D(\mathbf{x}_i, \xi_{i,M})$ ,  $\kappa_{I,i} \equiv \kappa_I(\mathbf{x}_i, \xi_{i,M})$ ,  $\alpha_i \equiv \alpha(\mathbf{x}_i, \xi_{i,M})$ ,  $\lambda_{D,i} \equiv \lambda_D(\mathbf{x}_i, \xi_{i,M})$ , and  $\rho_i \equiv \rho(\mathbf{x}_i, \xi_{i,M})$ .

<sup>39</sup>We can estimate the outside options, after setting  $\rho_G = 0.5$ , using the optimality condition for  $F$ , (14). This, however, requires additional functional-form assumptions, given our sample size.

$F_{\phi_0|(s, \mathbf{x}, \xi_M)}(\cdot|s, \mathbf{x}, \xi_M)$  and  $F_{\nu|(\tau, s, \mathbf{x}, \xi_M)}(\cdot|\tau, s, \mathbf{x}, \xi_M)$ . Specifically, we assume that  $\nu$  follows a Gamma distribution with mean  $\gamma_1(s, \mathbf{x}, \xi_M)$  and standard deviation  $\gamma_2(s, \mathbf{x}, \xi_M)$  for all  $\tau \in [0, T]$ . We also assume that the realization of  $\phi_0$  for a given dealer and a bond depends on the bond attributes and the dealer's geographical specialization,  $g$ . Since there are three types of geographical specialization, the support of  $F_{\phi_0|(s, \mathbf{x}, \xi_M)}$  is reduced to the three values,  $\phi_{0,g}(s, \mathbf{x}, \xi_M)$  for  $g = 0, 1, 2$  and the probability of each value is set by the observed distribution of dealers' geographic specialization. With this, we denote the trading parameters to be estimated as

$$\theta_i \equiv \left\{ (\gamma_{k,i})_{k=1,2}, \kappa_{I,i}, \alpha_i, (\phi_{0,g,i})_{g=0,1,2}, \phi_{1,i}, \nu_{D,i}, \kappa_{D,i}, \lambda_{D,i}, \rho_i \right\},$$

with a slight abuse of notation.<sup>40</sup>

To estimate the parameter  $\theta_i$  for each bond  $i$ , we first nonparametrically estimate the equilibrium distribution of dealer states,  $\Phi_{D,i}$ , from the observed states of dealers over time. Then, we use a nested fixed point algorithm to solve for the value functions of dealers and investors, the equilibrium meeting rate, the equilibrium trading prices and quantities, and the distributions of investors' states (Rust, 1987). Finally, we use these equilibrium objects to compute and minimize an objective function based on transaction timing, price, and quantity in the simulated and observed equilibria.

We rely on an objective function consisting of three components, defined in Appendix F.1.1. The first component captures the squared differences between the observed and the simulated values of the average inter-dealer trading price and quantity and their covariance with the dealer's inventory, which help us pin down dealer preference parameters,  $\nu_{D,i}$  and  $\kappa_{D,i}$ . For example, consider two dealers with the same geographic specialization but different levels of inventory. If the marginal cost of holding inventory,  $\kappa_{D,i}$ , is large, the inventories of these dealers after their trade will be close to each other because the quantity traded maximizes the gains from trade. In addition, the flow value of holding the bond for a dealer,  $\nu_{D,i}$ , determines the price difference between inter-dealer and dealer-to-investor trades.

The second component of the objective function captures the squared differences between the observed and the simulated values of the average trading price and quantity for dealer-to-investor transactions, their variance, and their covariance with the dealer's inventory and trading network, respectively. The over-time and across-dealer

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<sup>40</sup>To clarify, the investors' type distribution parameters for bond  $i$  are  $\gamma_{k,i} = \gamma_k(s_i, \mathbf{x}_i, \xi_{M,i})$  for  $k = 1, 2$ , and the dealers' initial search cost type distribution parameters are  $\phi_{0,g,i} = \phi_{0,g}(s_i, \mathbf{x}_i, \xi_{M,i})$  for  $g = 0, 1, 2$ .



variation in the dealers' inventory and its correlation with trading prices is useful for identifying the bargaining parameter  $\rho_i$ .<sup>41</sup> Given this, we use the observed distribution of trading prices to identify the investor type distribution  $(\gamma_{1,i}, \gamma_{2,i})$ .<sup>42</sup> Finally, note that the exogenous passage of time, along with the fact that the model is finite-horizon, helps identification; for example,  $\alpha_i$  shapes the overall volume of trade after the initial reallocation of assets from the underwriter to investors.

The third and last component captures the log-likelihood of the timing of transactions for each dealer (either with an investor or a dealer), conditional on the dealer's state. Note that the observed timing of trades can be used to directly compute the distribution of meeting rates because the investor taste type is continuously distributed, bonds are perfectly divisible, and short-selling is allowed in our model, which ensures that when two agents meet, they can always find a mutually beneficial trade.<sup>43</sup> Therefore, the observed inter-dealer meeting frequency pins down the inter-dealer meeting rate,  $\lambda_{D,i}$ . The extent to which a dealer's search intensity for investors increases as the dealer's client network  $b$  expands is governed by the strength of the network effects, measured by  $\phi_{1,i}$ . With that, the observed baseline meeting frequency with investors for each dealer is informative of the initial search cost parameter,  $\phi_{0,i}$ , as it varies by the dealer's geographic specialization  $g$ .

*6.3.2. Step 2: Trading Market Parameters as a Function of Bond Attributes.* Given the bond-specific first-step estimates, we employ an instrumental variable (IV) approach to estimate how investor demand and search costs depend on the endogenous complexity  $s$ , as well as other observed and unobserved bond attributes. We denote by  $\mathbf{x}_M \subset \mathbf{x}$  the vector of observables affecting these objects, which include all the exogenous control variables used in Table 2, such as the bond's face value, the time to maturity, issuer financial, economic and demographic attributes at the

<sup>41</sup>As an example, in the extreme case where the dealer's bargaining power is zero, the price would be uncorrelated with the dealer's state, after controlling for the quantity and the timing of the trade.

<sup>42</sup>Recall we do not observe investors' inventory, while we observe dealers' inventory. This can make the identification of inventors' preferences difficult. For example, an investor may pay a relatively low price for a bond because she has drawn a low-taste type or because she has a large inventory of that bond. However, the market clearing condition introduces a constraint on the joint distribution of investors' asset holdings and tastes, which, combined with our data on all transactions on a given bond, helps us identify investor preference parameters.

<sup>43</sup>Our estimated model suggests that short-selling is rare. Given our estimates, when taking the average over bonds and periods, 4% of investors have negative inventory, and are thus engaged in short-selling.

time of bond  $i$ 's origination, as well as month and county fixed effects. Redefining  $\xi_M \equiv \{(\xi_{\gamma_k})_{k=1,2}, (\xi_{\phi_{0,g}})_{g=0,1,2}, \xi_{\phi_1}\} \in \mathbb{R}^6$ , we assume that the investors' demand parameters depend on the bond attributes according to:

$$\log \gamma_k(s, \mathbf{x}, \xi_M; \theta_s) = \theta_{\gamma_k, s} \log(s+1) + \theta_{\gamma_k, x} \mathbf{x}_M + \xi_{\gamma_k}. \quad (15)$$

As for search cost parameters, we consider the following specification for  $g = 0, 1, 2$ :

$$\log \phi_{0,g}(s, \mathbf{x}, \xi_M; \theta_{\phi_0}) = \theta_{\phi_0, s} \log(s+1) + \theta_{\phi_0, x} \mathbf{x}_M + \theta_{\phi_0, g} + \xi_{\phi_{0,g}}, \quad (16)$$

and

$$\log \phi_1(s, \mathbf{x}, \xi_M; \theta_{\phi_1}) = \theta_{\phi_1, s} \log(s+1) + \theta_{\phi_1, x} \mathbf{x}_M + \xi_{\phi_1}. \quad (17)$$

To identify and estimate the parameters in (15)–(16),  $(\theta_\gamma, \theta_{\phi_0}, \theta_{\phi_1})$ , we assume that the unobserved bond attributes related to the trading market,  $\xi_M$ , are mean zero conditional on  $\mathbf{x}_1$  and revolving-door regulations  $h$ :

$$\mathbb{E}(\xi_M | \mathbf{x}_M, h) = 0. \quad (18)$$

The argument is that the status of these regulations does not directly enter into the primitives of the trading market, providing a source of variation in bond complexity and coupon rates, exogenous to unobserved bond market attributes,  $\xi_M$ .

We leverage this orthogonality condition and estimate  $(\theta_\gamma, \theta_{\phi_0}, \theta_{\phi_1})$  by running IV regressions of the first-step bond-level estimates  $\log \hat{\gamma}_i$ ,  $\log \hat{\phi}_{0,i}$ , and  $\log \hat{\phi}_{1,i}$ , respectively. As for instruments for  $s_i$ , we employ  $(\mathbf{x}_{M,i}, h_i)$  as well as interactions between  $h_i$  and some of the bond attributes  $\mathbf{x}_{M,i}$ , following Section 4.2. Once we obtain  $(\hat{\theta}_\gamma, \hat{\theta}_{\phi_0}, \hat{\theta}_{\phi_1})$ , then we solve for  $\hat{\xi}_{M,i}$  from (15)–(17) for each bond  $i$ , since all other terms in the equation are either observed or have been estimated.

**6.3.3. Step 3: Government Preferences.** In the last step, we estimate the government preferences relying on the optimality conditions for bond attributes in Nash bargaining, (12)–(13), which reflect the incentives of both the issuer and the underwriter.<sup>44</sup> The latter's incentives are captured by the derivatives of the underwriter's value function,  $V_U$ , which has been estimated in the previous steps. This allows us to recover the government preference parameters while holding fixed the underwriter's incentives concerning the endogenous bond attributes,  $(s, r)$ .

<sup>44</sup>Since we do not observe the bond price determined at the issuer-underwriter negotiations,  $F$ , we cannot exploit the optimality condition with respect to  $F$ , (14).

We cannot jointly identify the scale of the marginal cost of financing ( $c_0$ ), the direct marginal benefits from bond complexity ( $\theta_d$ ), and the conflict-of-interest parameter ( $\psi$ ).<sup>45</sup> For this reason, we normalize  $\psi(\mathbf{x}, h = 1) = 0$  for all  $\mathbf{x}$ ; in other words, we assume that the revolving-door regulations are effective in the sense that officials place zero weight on the underwriter's incentives.<sup>46</sup>

We allow  $c_0$  to vary flexibly with bond complexity, observed bond and issuer attributes  $\mathbf{x}_G \subset \mathbf{x}$  and unobserved government cost shocks,  $\xi_G \equiv \{\xi_s, \xi_r\} \in \mathbb{R}^2$ , as follows. Specifically,  $\mathbf{x}_G$  includes all variables of  $\mathbf{x}_M$  except for the county-month fixed effects; instead, this vector contains state and year fixed effects, respectively.

$$c_0(s, \mathbf{x}, \xi_G; \theta_c) = \theta_{c,s_1} s \mathbf{x}_G + \theta_{c,s_2} s^2 + \theta_{c,x} \mathbf{x}_G + s \xi_s + \xi_r. \quad (19)$$

The underwriter's influence over government officials might vary with the local circumstances in which they operate. Therefore, we allow the officials' weight for the underwriter when they are not subject to the revolving-door regulations to depend on (i) the past work relationship between the issuer and the underwriter, measured by the number of bond issuance incidences in the eight years prior to a given bond issuance, (ii) the presence of the local media, captured by the number of local daily newspapers covering the issuer's county, and (iii) whether or not the local government issued at least one bond in the past eight years.<sup>47</sup> Inclusion of these variables in  $\psi$  is motivated by our findings in Appendix B.3. We denote the vector of these three variables by  $\mathbf{x}_\psi \subset \mathbf{x}$ , and consider the following specification:

$$\psi(\mathbf{x}, h = 0; \theta_\psi) = \exp(\theta_\psi \mathbf{x}_\psi). \quad (20)$$

To separately identify  $\psi$  from  $c_0$  and  $\theta_d$ , we exploit variation in the data that would affect the trading market and, accordingly, the underwriter's incentives, but not the government costs. Such variation can be generated by  $\xi_M$  if we assume that  $\xi_M$

<sup>45</sup>Assuming that  $\psi \geq 0$  and thus  $\psi + 1 > 0$ , we can divide (12) and (13) by  $1 + \psi$  and see that it wouldn't affect the choice of  $(s, r)$ , demonstrating that a scale normalization is needed.

<sup>46</sup>As discussed in Appendix F.2.2, the equilibrium bond design and coupon rate, as well as all ensuing equilibrium outcomes in the trading market, are invariant to this normalization under our main counterfactual scenario. As for welfare implications, the only object that is affected by our normalization is the scale of the government costs and its level change under our counterfactual scenario. Given our normalization, these are multiplied by the value of  $1 + \psi(\mathbf{x}, 1)$ ; the larger  $\psi(\mathbf{x}, 1)$  is, the higher the costs and its level change. Thus, one may consider our government cost estimates as a lower bound, or the most conservative estimates. Note, however, that the percentage change to government cost is again invariant to this normalization.

<sup>47</sup>Our assumption that these variables do not affect  $c_0$  and the primitives of the trading market, and the assumption that  $\mathbf{x}_M$  and  $\mathbf{x}_G$  does not affect  $\psi$  is not necessary for identification, but reduces the dimension of parameters.

is uncorrelated with  $\xi_G$ . Instead of making that assumption, we introduce additional instrument  $\mathbf{z}$ , and assume that the mean of the unobserved shock to government preferences,  $\xi_G$ , is zero conditional on  $(\mathbf{x}, h, \mathbf{z})$ :

$$\mathbb{E}(\xi_G | \mathbf{x}, h, \mathbf{z}) = 0. \quad (21)$$

The variable  $\mathbf{z}$  captures the bond supply in neighboring counties; as shown in Table A11 in the Appendix, new bonds from neighboring counties available at the time of the issuance of bond  $i$  affect the investors' opportunity cost of holding that bond,  $\kappa_{I,i}$ . Therefore, variation in  $\mathbf{z}$  can lead to variation in the underwriter's values from trades, which reflects investors' opportunity cost, and, accordingly, negotiated bond attributes,  $(s, r)$ , while holding  $(\mathbf{x}, h)$  constant.<sup>48</sup> On the other hand, we argue that the financial and political circumstances unique to nearby governments that determine the attributes of their new bonds may not enter into a given local government's preferences, once we control for other observed attributes of the government. Lastly, separately identifying  $c_0$  and  $\theta_d$  relies on our specification that  $\theta_d s$  captures the broader benefits of complexity for the government and thus does not vary with the specific bond's payments,  $A(1 + rT)$ .<sup>49</sup>

Employing (21) and assuming that the estimation error from the previous steps is uncorrelated with  $(\mathbf{x}, \mathbf{z}, h)$ , we build a GMM estimator for  $(\theta_c, \theta_d, \theta_\psi)$  by plugging our specifications of (19) and (20) and the estimates from the previous steps into the first-order conditions of (12)–(13) to solve for  $(\xi_s, \xi_r)$ . Appendix F.2.1 presents the moment conditions used for the estimator.

## 7. ESTIMATION RESULTS

This section describes the estimates of the key model primitives, based on the approach described in the previous section. The distribution of the first-step estimates of the bond-level trading market parameters are reported in Appendix F.1.2, where the model's goodness of fit is also discussed.<sup>50</sup> We report bootstrap standard errors

<sup>48</sup>Specifically,  $\mathbf{z}$  consists of the average complexity and coupon rate of the bonds issued by municipalities of the same type (county, city, school district, or other district) in the same state, but not in the same county, within six months prior to a given bond's issuance. When regressing a bond's complexity index and coupon rate on  $\mathbf{z}$ , controlling for  $\mathbf{x}$ , we find that F statistics of the instruments  $\mathbf{z}$  are 17.19 and 21.03, respectively.

<sup>49</sup>Misspecification of the functional form for the objective function of the government official will bias the estimates. As an example, the direct benefits from a bond's complexity that do not enter linearly would not be captured by  $\theta_d s$  and could be, in principle, incorporated in the  $c_0$  and  $\psi$  estimates.

<sup>50</sup>The estimation is based on 927 bonds drawn from our full sample of 13,118 bonds. The estimated sample includes all bonds from the five states that introduced revolving-door regulations during the

TABLE 6. Dealers' Monthly Search Cost Estimates

	Average dealer	Underwriter
Average search cost	\$2,625	\$3,045
Average search cost at $\lambda = 1$	\$1,911	\$960
Initial search cost at $\lambda = 1$ , $\phi_0$	\$3,216	\$3,609
Average cost advantage from client network, $\exp(-\phi_1 \log(b + 1))$	0.50	0.34
Average meeting rate	0.19	0.23

*Notes:* This table presents the equilibrium search costs and meeting rates of a bond with the median values of the first-step trading market parameters,  $\hat{\theta}_i$ .

based on 200 bootstrap samples where resampling is at the dealer level. See Appendix F.3 for the details on the bootstrapping procedure.

**7.1. Search Frictions and Underwriter Cost Advantage.** The bond-level estimates of the trading cost parameters reveal that search frictions in the market for municipal bonds are sizable. To see this, we consider a bond with the median values of the trading market parameter estimates from the first step ( $\hat{\theta}_i$ ), and simulate the model of bond trades to compute the dealers' search costs. Table 6 shows that the average dealer pays \$2,625 to find and meet investors every month. This estimate is 10% of the dealers' monthly gross profits, measured as the difference between the value of bonds sold and purchased.

Additionally, we find a dealer's knowledge of the local market is critical in lowering its search costs. Figure 1(A) shows that the initial monthly search cost for a dealer who has experience trading bonds originated from the same county ( $\phi_{0,0}$ ) to meet one investor per year is on average \$1,477, less than a third of the cost for a dealer with no experience of trading bonds from the same state ( $\phi_{0,2}$ ).<sup>51</sup> This result is consistent with the local nature of the municipal bond market, driven by the preferential tax treatment of owning in-state bonds.

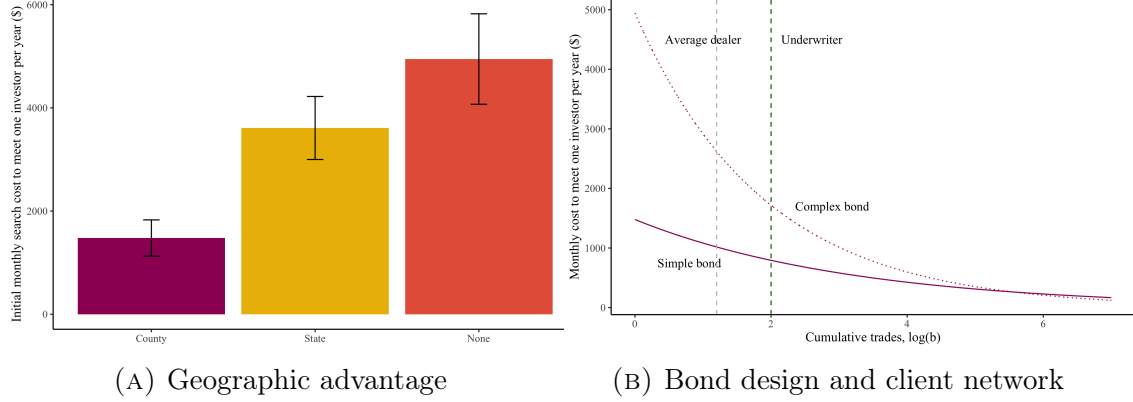
Table 6 also presents the extent of the underwriter search advantage in equilibrium. The underwriter meets, on average, 0.23 investors per month, which is 20%

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period of our study (AR, IN, ME, NM, and VA) and the counties at the borders of these states. Given that the first-step estimation is done at the bond level, focusing on a subsample helps with the computational burden. In doing so, we choose this sample so that we can exploit the panel variation in the revolving-door regulations. Table A9 in Appendix F.4 shows that the summary statistics of key bond and issuer attributes of this estimation sample are similar to those of the entire sample.

<sup>51</sup>Given (8), the parameter value of  $\phi_0$  represents the monthly search cost of meeting one investor per year ( $\lambda = 1$ ) initially, i.e., when a dealer has not yet started trading the bond ( $b = 0$ ).

FIGURE 1. Determinants of Dealer Search Costs



*Notes:* In panel (A), each bar represents the average estimate of  $\phi_0$  for each type of dealers, where the type is determined by their prior history of trading bonds during one year before a given bond's origination. Panel (B) presents the estimated search cost functions of (8) at  $\lambda = 1$  for two bonds with low and high levels of complexity (25<sup>th</sup> and 75<sup>th</sup> percentiles) and median values of other attributes, in the logarithm of the cumulative number of trades. The two dashed, vertical lines represent the logarithm of the average cumulative number of trades of the underwriter and an average dealer.

more frequent than the average dealer. This is because of the large competitive advantage for the underwriter. The monthly cost of maintaining the rate of meeting one investor per year is \$960 for the underwriter, which is about half of the cost for other dealers on average. As a result of the higher meeting rate, the monthly average search costs are higher for the underwriter (\$3,045) than an average dealer (\$2,625).

The table decomposes the average search cost at  $\lambda = 1$  into two parts: the initial search cost at  $\lambda = 1$  ( $\phi_0$ ) and the average value of cost advantage from client network,  $\exp(-\phi_1 \log(b+1))$ . The underwriter's  $\phi_0$  is slightly higher than that of an average dealer (\$3,600 vs. \$3,200). However, we find that the average value of  $\exp(-\phi_1 \log(b+1))$  is 0.34 for the underwriter, 32% lower than that of an average dealer.<sup>52</sup> Combining these two search cost components ( $\phi_0$  and  $\exp(-\phi_1 \log(b+1))$ ), we find that at a given rate of meeting an investor, the underwriter's cost is 49.8% lower than an average dealer's cost. This cost advantage, driven by the underwriter's exclusive sales at the beginning of trading, more than offsets its initial geographical disadvantage. Thus,

<sup>52</sup>The network parameter estimate,  $\hat{\phi}_{1,i}$  is on average 0.436 (Table A8 in Appendix F.1.2), and out of 927 bonds used in the estimation, the  $\hat{\phi}_{1,i}$  estimates of 82% of the bonds is statistically greater than zero at the 95% level. Note that we do not impose  $\hat{\phi}_{1,i} > 0$  in our estimation procedure. Therefore, it is remarkable that a dealer's client network, built by trading the bond with investors, lowers the dealer's search costs.

TABLE 7. Search Cost and Investor Demand as a Function of Bond Attributes

	Search Cost		Investor Valuation	
	Initial $\log \hat{\phi}_{0,i}$ (1)	Network $\log \hat{\phi}_{1,i}$ (2)	Mean $\log \hat{\gamma}_{1,i}$ (3)	SD $\log \hat{\gamma}_{2,i}$ (4)
Complexity index (log)	3.791 (2.002)	1.662 (0.543)	-0.0851 (0.696)	4.599 (1.004)
Bond/issuer attributes <sup>a</sup>	Yes	Yes	Yes	Yes
Year-month FE, County FE	Yes	Yes	Yes	Yes
Heterogeneous time trend <sup>a</sup>	Yes	Yes	Yes	Yes
Number of observations	2,753	927	927	927

*Notes:* This table presents the parameter estimates of (15), (16) and (17) from the IV regression of the second step of our estimation:  $\theta_{\phi_0,s}$  (Column 1),  $\theta_{\phi_1,s}$  (Column 2),  $\theta_{\gamma_1,s}$  (Column 3), and  $\theta_{\gamma_2,s}$  (Column 4). The bootstrap standard errors are in parenthesis. The instruments are dummy variables for revolving-door regulations and their interactions with the fraction of secondary transactions by individual investors at the state- and security-type level, the county-level electoral competitiveness, and the issuing government's experience originating municipal bonds. a. These controls are the same as the ones employed in Tables 5.

the underwriter's dominance in a bond's trading is primarily driven by the economy of scale in search. Note that our estimation results are consistent with the narrative that prevails in the industry (Section 2.3).

**7.2. Search Frictions and Nonstandard Provisions.** The second-step estimates,  $\hat{\theta}_\phi$ , as specified in (16) and (17), show how bond attributes affect search costs, while accounting for the endogeneity of bond design. Table 7 presents the parameter estimates related to bond complexity. We find that including more nonstandard provisions in the bond contract increases both the initial search cost and the network effect parameters. Increasing the bond complexity index in a bond contract by 1% increases  $\phi_0$ , which measures the level of search costs, by 3.79% (Column (1)) as well as the magnitude of the network effect parameter,  $\phi_1$  by 1.66% (Column (2)). Given these estimates, increasing the bond complexity from its median value to the 75th percentile leads to a 43% increase in  $\phi_0$  and a 19% increase in  $\phi_1$ .

Figure 1(B) visualizes these estimates by plotting an average dealer's monthly cost of meeting one investor per year as a function of its cumulative trade for a given bond,  $b$ . We consider two bonds with a small and large number of nonstandard

provisions, which we call, respectively, “simple” and “complex” bonds.<sup>53</sup> The estimates indicate that the monthly search cost in the beginning (at  $b = 0$ ) is lower for the simple bond, but as the dealers’ trading network increases, the search costs become similar between the two bonds. This is because the decrease in the marginal search costs with respect to cumulative trade is much higher for the complex bond. These patterns illustrate that although nonstandard bond provisions increase the search costs for all dealers, they can create a cost advantage through economies of scale. The underwriter, who can quickly develop a large client network thanks to their exclusive initial sales, can take full advantage of the stronger network effect for the complex bonds. At the average number of cumulative trades for an average dealer, search costs are much higher for the complex bond than for the simple one, but such a difference is smaller at the average cumulative trade of underwriters.

**7.3. Investor Demand.** We assume that the investor taste type  $\nu$  follows Gamma distribution with mean  $\gamma_1$  and standard deviation  $\gamma_2$ , both of which depend on  $(s, \mathbf{x}, \xi)$ . Table 7 shows that nonstandard provisions do not substantially affect the average investors’ valuation for the bond (Column 3), while substantially increasing the dispersion (Column 4). These results imply the fraction of investors with extreme valuations for a bond is higher as the complexity of the bond increases, consistent with the idea that complex bonds are niche products that investors “either love or loathe,” along the lines of Johnson and Myatt (2006) and Bar-Isaac et al. (2012), while simple bonds may cater to a broader range of investors.

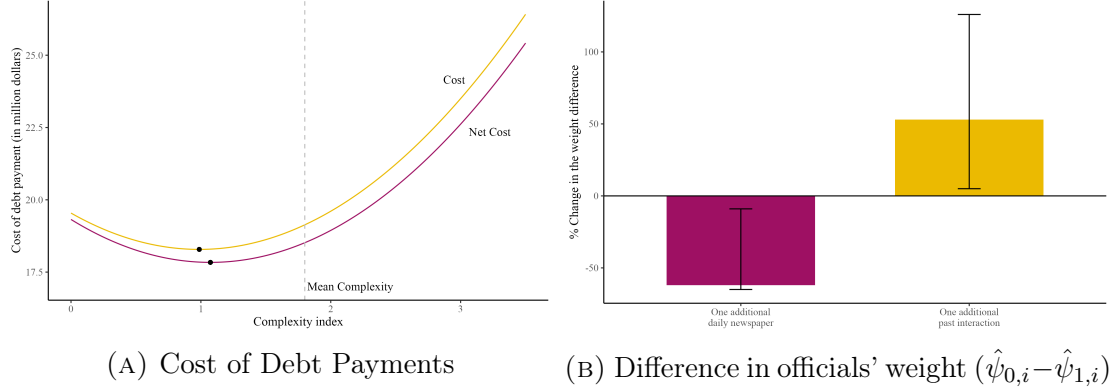
**7.4. Government Preferences.** Given our estimates of the government side parameter  $\theta_c$  and unobserved cost shocks  $(\xi_{s,i}, \xi_{r,i})$ , the median value of the issuers’ marginal financial cost  $\hat{c}_{0,i}$  is 0.65, and is statistically significant at the 1% level.<sup>54</sup> Moreover, we find a large heterogeneity across issuers in the estimated  $\hat{c}_{0,i}$ , which has an interquartile range of (0.33, 1.37). As discussed in Section 5, this heterogeneity may reflect differences in the issuers’ cash flows that affect their cost of making the bond payments. In line with this interpretation, we find that several factors that increase (decrease) the availability of funds for the issuer decrease (increase)  $\hat{c}_{0,i}$ . For example,

<sup>53</sup>Specifically, we rely on the second-step parameter estimates  $(\theta_{\phi_0}$  and  $\theta_{\phi_1})$  and specifications (16) and (17), to compute the search parameters associated to two bonds with the median value of the estimated unobserved search cost factors,  $\hat{\xi}_{\phi_0,1}$  and  $\hat{\xi}_{\phi_1,i}$  and, respectively, a complexity index of 1 (the 25<sup>th</sup> percentile in our data) and 2.14 (the 75<sup>th</sup> percentile).

<sup>54</sup>Note that  $c_0$  is less than one for most bonds. This may, in part, reflect the extent to which the bond-originating officials internalize future payments when originating a bond. It is an interesting avenue for a future study to decompose  $c_0$ , but it is beyond our current scope of analysis.



FIGURE 2. Government Preferences



*Notes:* The yellow line in Panel (A) plots the relationship between the complexity index and the estimated cost of debt payment for the average revenue bonds issued by special districts. The purple line looks at the cost minus the estimated direct benefit from bond complexity,  $\hat{\theta}_d s$ . The black dots on the (net) cost function indicate the minimum points. Panel (B) presents how the difference,  $\hat{\psi}_{0,i} - \hat{\psi}_{1,i}$ , depends on the number of local daily newspapers in an issuer's county and the number of the past bond origination deals that the underwriter had with the issuer.

the elasticity to the local unemployment rate, which may directly affect government cash flow through local taxes/fees and expenses for those in need, is 1.3.<sup>55</sup> We also find that a 1% increase in the volatility (as measured by the standard deviation) of an issuer's annual revenues would increase the value of complexity  $\partial c_0 / \partial s$  by 1.2%, which is consistent with the idea that the predictability of an issuer's cash flow may affect the need for re-adjusting a bond's payment schedule and, therefore, the value of the flexibility afforded by non-standard provisions.

We find that the number of nonstandard provisions that minimize the issuer's costs, holding the coupon rate fixed, is non-zero for 86% of the issues in our sample, capturing the value of the flexibility.<sup>56</sup> Panel (A) in Figure 1 showcases this pattern for the average revenue bond issued by special districts in our sample, by plotting how the government financial costs vary with the complexity of the bond contract. The figure also shows that issuing a bond with nonstandard provisions directly benefits issuer, as captured by  $\theta_d s$ , by \$0.333 million on average, which is statistically significant at

<sup>55</sup>To compute the elasticity, we simulate  $\hat{c}_{0,i}$  for each bond  $i$  when a given bond attribute (e.g., unemployment rate) increases by 1% while holding all other (observed and unobserved) attributes fixed, and then take the percentage change in the average value of  $\hat{c}_{0,i}$ .

<sup>56</sup>To see this from a different angle, the average derivative of the government cost with respect to complexity, evaluated at 0, is negative and significant at the 10% level.

the 5 percent level.<sup>57</sup> This amount corresponds to 27% of the median total interest payment per bond and 6.53% of the median par value in the sample.<sup>58</sup>

Lastly, we find evidence that the revolving-door regulations are effective in reducing the incentives of government officials to internalize the interests of the underwriter. We find that the difference between the weight without vs. with revolving-door regulations,  $\hat{\psi}_0 - \hat{\psi}_1$ , is 0.042 and is statistically significant at the 1 percent level.<sup>59</sup> We find that local newspapers can help rein in the influence of underwriters: as shown in Panel (B) of Figure 1, the difference  $\hat{\psi}_0 - \hat{\psi}_1$ , would decrease, with a median change of 62%, if each county had one extra daily newspapers. Additionally, conflict of interest seems to increase as an issuer works with a given underwriter; the difference  $\hat{\psi}_0 - \hat{\psi}_1$  would increase, with a median change of 53%, if the issuer-underwriter relationship were strengthened further by one extra bond issuance in the past together.

## 8. STANDARDIZATION POLICY

Whether or not standardization of financial products, especially municipal bonds, can be beneficial has received a keen interest in policy communities.<sup>60</sup> Using our estimated model, we study how the market would react to a mandate imposing local governments to only issue “plain vanilla bonds”, by limiting the use of nonstandard provisions, while the coupon rate is negotiated with the underwriter. This exercise

<sup>57</sup>Note that our model abstracts away the dynamic incentives of underwriters to attract and retain issuers as clients on the primary market when negotiating over bond design. Without observing the underwriter fee, one cannot distinguish between the dynamic incentives of the issuer and the underwriter, separately. With that, the estimated  $\theta_d$  may reflect a combination of the dynamic incentives of both players.

<sup>58</sup>Our main interpretation of  $\theta_d$  is the reduction in the probability of default and hence future “default costs” brought by extra flexibility. Defaulting on a bond would lead to, amongst other things, a downgrade of future bonds, increasing future borrowing costs. For example, in December 2018, Platte County, Missouri resisted a bail-out of revenue bonds issued for a shopping center, and the announcement led to an immediate rating downgrade for the county. With that, increasing complexity by one standard deviation decreases future expected borrowing costs by \$0.126 million, which corresponds to 0.5% of the median annual interest expenditures by the local governments in our sample.

<sup>59</sup>Note that we identify  $(1 + \psi_0)/(1 + \psi_1)$  given our data, and its estimate is 1.042. Given our normalization of  $\psi_1 = 0$ , the difference,  $\psi_0 - \psi_1$ , is 0.042. This estimate implies that without revolving-door regulations, the underwriter’s value would account for 12.3% of the government officials’ payoff.

<sup>60</sup>For example, in his 2015 statement (entitled “Statement on Making the Municipal Securities Market More Transparent, Liquid, and Fair”) representing the U.S. Securities and Exchange Commission, Luis A. Aguilar, a then-commissioner, advocated a consideration of policies to make municipal bonds more standardized: “For exchanges to thrive in the municipal securities market, municipal securities would likely have to become much more standardized. Other members of the Commission have advocated this, and it is an approach that merits serious consideration... The staff should study what steps the Commission can take to help simplify municipal offerings...”

TABLE 8. Effects of the Standardization Policy

	Current Median	Change under Standardization		
		Median	25 <sup>th</sup>	75 <sup>th</sup>
Interest rate (basis point)	318.0	−22.7	−99.6	+8.8
Average dealer’s meeting rate (yearly)	1.690	+33%	+5.8%	+59.8%
Investor surplus	300.1	+8%	−7.6%	+29.1%
Issuer costs				
Interest payment (\$K)	1,361.1	−9.0%	−29.6%	+3.4%
Marginal financial cost ( $c_0$ )	0.680	+5.0%	−1.3%	+21.1%
Total issuer cost ( $c_0 A(1 + rT) - d_0 s$ , \$K)	5,080.6	+10.6%	+2.0%	+31.6%

*Notes:* The numbers are based on the 386 stratified sample bonds. We consider a standardization policy where nonstandard provisions are allowed at a minimal level. The table presents the median and the interquartile range of the level or the percentage changes, relative to the current policy, regarding the negotiated interest rate, the annual rate of meeting with investors, investor surplus, and the issuer costs.

is not only relevant for policy considerations, but also for quantifying how underwriters’ dual role in this market affects investors’ welfare and local governments’ financial costs, depending on multiple—sometimes counteracting—economic forces shaping their negotiation at issuance.<sup>61</sup>

**8.1. Overall Effects of a Standardization Policy.** To study the overall effects of a policy that limits the use of nonstandard provisions in municipal bonds, we focus on a stratified sample of 386 of the estimated bonds, for which the distribution of three key bond attributes—complexity index, coupon rate and transaction frequency—matches that of the entire sample.<sup>62</sup> Table 8 presents the distribution of the effects of the standardization policy.

First, the policy showcases that nonstandard provisions reduce liquidity in the market for municipal bonds. We find that standardization would reduce search costs

<sup>61</sup>Computational limitations prevented us from calculating standard errors for the counterfactual results in this section. While readers should consider this limitation when interpreting findings, the distribution of the simulated policy effects across 386 bonds with substantial heterogeneity (shown in Table 8) suggests that the overall policy effects described in Section 8.1 are likely robust to estimation noise. Nevertheless, the distributional impacts of standardization discussed in Section 8.3 remain more vulnerable to such noise.

<sup>62</sup>Appendix F.4 describes the stratification procedure in detail and shows that, in Table A9, this stratified sample is representative of the entire sample in many bond and issuer attributes, beyond those three attributes targeted in the stratification process.

and substantially increase the rate at which transactions occur, with a median percentage change to the meeting rate for an average dealer equal to +33%.<sup>63</sup>

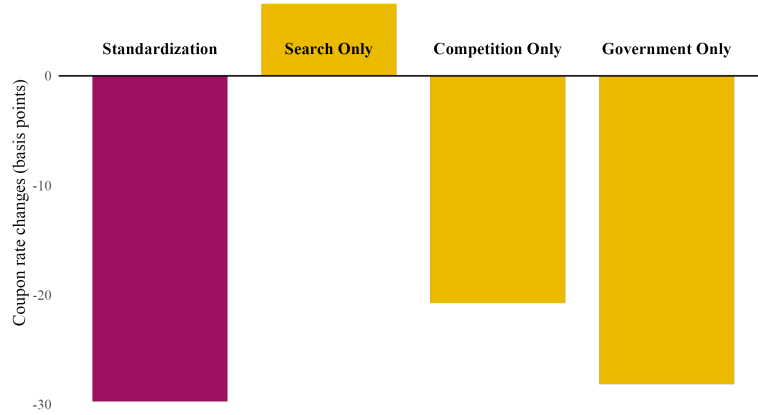
This increase in liquidity benefits investors, who can quickly offload their inventory in case of a liquidity shock, reducing misallocation. Specifically, we find that the correlation between investors' valuations and their asset holdings would increase under standardization, with a median percentage change equal to +19%. In addition, when bargaining with dealers, investors find themselves in a stronger position since their outside option improves as they can easily find another dealer to trade with. For most bonds, investors would overall benefit from a standardization policy, with the median percentage change in the investor surplus being an increase of 8%. This finding is striking because, as we discuss below, the policy would lower the coupon rate in general, which wouldn't be palatable to investors.

From the point of view of the issuing government, the impact of the policy highlights a fundamental trade-off. Our results suggest that the policy tends to lower the coupon rate, with a median change of -22.7 basis points. As a result, interest payments decline by 9% (median). To gauge the magnitude of the coupon rate change, it is useful to compare it to the impact of bond downgrading, which, according to Ingram et al. (1983), increases a bond's yield by 11.3 basis points. However, the lower interest payments come at the cost of a loss in flexibility in the payment schedule for governments, which increases their marginal financial cost ( $c_0$ ) and decreases the long-term benefits of such flexibility on government finances ( $d_0s$ ). Interestingly, we find a large heterogeneity in the impact of standardization on the coupon rate, with an interquartile range going from -99.6 to +8.8 basis points. In the next sections, we explore this heterogeneity and show how the underwriter's incentives affect the changes in the negotiated coupon rate.

There are a few caveats in interpreting these results. First, the bond-specific opportunity cost  $\kappa_I$  is held fixed. Thus the analysis here should be thought of as describing a "partial equilibrium" impact of standardization, where the desirability of alternative investments does not respond to the policy. Appendix G.1 shows that allowing  $\kappa_I$  to change in response to standardization is likely to have a small impact on the results, reflecting the limited role of investor substitution. Second, we abstract away from the issuers' choice of the method of sale and underwriters. Appendix G.2

<sup>63</sup>Consistent with the results in Section 4, underwriters' surplus from trades after issuance would decrease under this policy. The median change in an underwriter's surplus, relative to its bond's face value, amounts to 0.65%. This is large, given that the average underwriting fee during the period of study for negotiated bonds ranges from 0.50% to 0.58% of the bond's face value (Braun, 2015).

FIGURE 3. Effects of Standardization on the Coupon Rate



*Notes:* This plot presents the predicted coupon rate changes, measured in basis points, for the example bond under four different scenarios. The first scenario is the standardization policy, described in Section 8.1. The rest are hypothetical scenarios to evaluate two channels related to the underwriter's incentives, associated with fewer search frictions and more competition in the market due to standardization, and the role of government cost changes, respectively. See the text in Section 8.2 for the description of each scenario.

and G.3 confirm that our results are overall robust to allowing for some issuers to switch to auctions or to change their underwriter. Finally, Appendix G.4 considers an alternative mandate that allows for call options.

**8.2. Mechanism: Determination of Coupon Rate.** Whether standardization reduces the cost of capital for an issuer depends on the extent to which the coupon rate adjusts to reflect the increase in both liquidity and marginal financial cost, translating these factors into interest cost savings. To better understand the implications of standardization for the cost of capital for the issuing government and investors, we explore the economic forces that shape the equilibrium coupon rate, focusing on the role played by the underwriter's incentives. Here, we look at a specific bond, a general obligation bond issued in 2012 by a school district in Michigan. Both the coupon rate (269.7 basis points) and its expected change under the standardization policy (-29.7 basis points) are close to the average values in the sample (323.3 and -27.1 basis points, respectively). The insights from this bond generalize to the overall sample.

As shown in Equation (13), the negotiated coupon rate balances the marginal cost of the interest payments for the issuer, and the marginal value of a higher coupon rate

for the underwriter. As standardization decreases the search cost parameters,  $\phi_0$  and  $\phi_1$ , it changes the trading market for the bond and, thus, the underwriter’s incentives when negotiating the coupon rate. To understand the underwriter’s incentives with regard to the coupon rate, and how they change with standardization, note that the underwriter’s value function reflects the investors’ total benefits from holding the bond, to the extent that the underwriter can extract a fraction of these benefits when trading. As the coupon rate increases, the investor’s benefits also increase, and so does the underwriter value function.

Standardization affects the underwriter’s marginal value for the coupon rate through multiple channels. One channel stems from the reduction in overall search costs. As meeting investors becomes cheaper and more frequent, the extent to which the underwriter can extract the benefits of a higher coupon rate for investors increases. This incentivizes the underwriter to negotiate more aggressively at origination for a higher coupon rate, partially limiting the benefits of standardization on interest payments for the issuing government.

Another channel has to do with the decrease of  $\phi_1$ , which reduces the underwriter’s competitive advantage against other dealers. A stiffer competition from other dealers implies that the underwriter can extract a lower share of the benefits that the investor enjoys from holding a bond. This force may decrease the underwriter’s marginal value for the coupon rate, leading it to negotiate less aggressively at origination and creating downward pressure on the coupon rate.

We separately quantify these counteracting effects of standardization on the coupon rate. Regarding the first channel, which we call the *search cost effect*, we compute the coupon rate that the underwriter would negotiate if it faced the same trading outcomes (and the issuer with the same financial cost) as under standardization, but its cost parameters were fixed at the baseline. We find that the coupon rate would be higher under standardization than under this scenario by 6.6 basis points (“Search Cost Only” in Figure 1). Therefore, the lower search costs under standardization motivate the underwriter to negotiate for a higher coupon rate.

To isolate the second channel, or *market power effect*, we compute the coupon rate that the underwriter would negotiate if they faced the same competitive pressure as under standardization, holding the other aspects of the market fixed.<sup>64</sup> We

<sup>64</sup>To approximate this scenario, we first compute equilibrium trading prices and quantities when  $\phi_1$  is set to the standardization level while  $\phi_0$  and investor taste distribution parameters are set to the baseline level. We then simulate the underwriter’s value function when facing these more competitive prices and yet dealing with the same search cost parameters at the baseline level. To

find that under this scenario, the negotiated coupon rate would be lower by 20.7 basis points compared to that under standardization for our bond ("Market Power Only" in Figure 1). This confirms that the declined market power under standardization drives the underwriter to negotiate less aggressively over the coupon rate, strengthening the decline of the coupon rate. The implication of this observation goes beyond standardization, suggesting that limiting the underwriter's market power in the trading market can reduce the interest payments for local governments in the US.

The equilibrium coupon rate also reflects the issuer's marginal cost of interest payments ( $c_0$ ). The standardization policy would, overall, increase  $c_0$  (Table 8), encouraging the issuer to negotiate more aggressively with the underwriter over the coupon rate and thus driving a decline in the coupon rate. As a way to illustrate this channel, we consider a hypothetical scenario where the government costs are at the standardization level, but all market parameters are fixed at the baseline level. We find that the negotiated coupon rate under this scenario would decrease by 28.1 basis points, compared to the baseline coupon rate ("Government Only" case in Figure 1).<sup>65</sup>

**8.3. One Size Fits All?** The previous section illustrates that the impact of standardization can potentially vary substantially, depending on the market conditions surrounding search frictions and dealer competition, as well as the government's financial cost structure and incentives shaped by regulations. This section studies how the nature of these market conditions would affect the distributional impact of a standardization mandate.

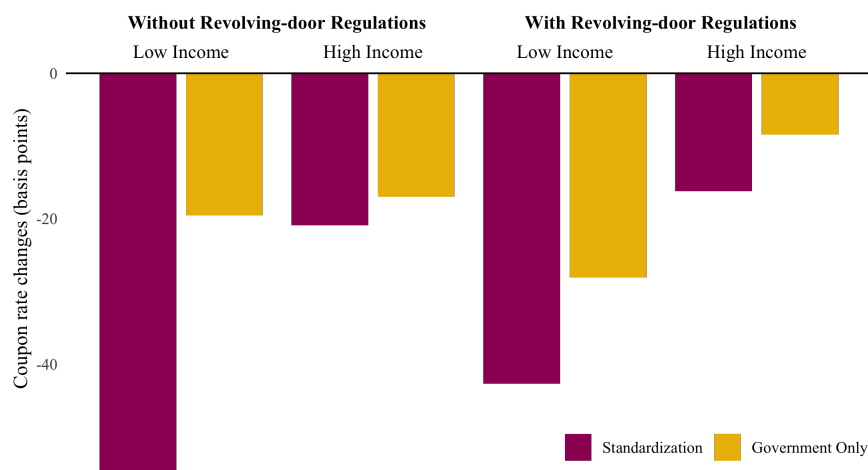
The municipal bonds market is known for the huge variety of issuing governments. Municipal bond issuers differ in many dimensions, including their purpose (general vs. special, e.g., school districts, transportation authorities, etc.), financial health, and experience in bond issuance, in addition to the regulations and rules that affect the incentives of their officials. For example, our 386 bond sample spans from a 192.3-million bond by the county government of Fairfax in Virginia, whose median household income is one of the highest in the country, to a 1.4-million bond by a small school district in Mississippi, whose county's median household income is less than one

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quantify how this channel mediates the effect of standardization, we solve for the equilibrium coupon rate given this value function of the underwriter and the government costs under standardization.

<sup>65</sup>Our findings on the channels through which standardization affects the coupon rate are not specific to the bond that we chose as an example, and are quantitatively similar to the average effects in the 386 sample used in the counterfactual analysis. The average search cost effect increases the rate by 2.4 bp; the average competitive effect lowers the coupon rate by 10.5 bp; and the average effect of the change in the government costs decreases the rate by 34.9 bp.

FIGURE 4. Who Benefits Most from Standardization in Coupon Rates?



*Notes:* This plot presents the median predicted coupon rate changes, measured in basis points, among four groups of bonds—based on (i) revolving-door regulations and (ii) the median household income (low or high) in the county—under two different scenarios: the standardization policy and a hypothetical case where the government cost changes due to standardization while the market parameters stay at the baseline level.

fourth of Fairfax, Virginia. These differences will affect the relative importance of the multiple economic forces determining the coupon rate under standardization.

To explore the distributional impact of standardization, we focus specifically on low (as opposed to high) -income counties, where governments tend to have higher marginal financial costs and issue more complex bonds. Moreover, we distinguish between bonds issued by governments with or without revolving-door regulations.<sup>66</sup> The purple bars in Figure 2 show the median predicted coupon rate changes under the standardization policy for each group of bonds. Bonds issued without revolving-door regulations would experience a larger decline in coupon rate. This may not be surprising, since in the absence of these regulations, the standardization policy can further counteract the distortion in bond design from the underwriter's influence.

Moreover, we find that the standardization policy would reduce the coupon rate more for those from low-income counties than for high-income ones. This overall difference cannot be explained by the difference in the issuing government's incentives,

<sup>66</sup>Specifically, we divide the 386 bonds into four groups based on the revolving-door regulations and the county-level median household income, where the cutoff is at the median value in the sample, \$50,433 (CPI-adjusted, with 2012 as the base year).



encapsulated in the marginal cost of paying the debt  $c_0$ , alone. As an example, focusing on bonds issued without revolving-door regulations, changing  $c_0$  only (as simulated in the Government Only case in Section 8.2), would decrease the equilibrium coupon rate by a similar amount for high-income governments than low-income ones (with the median being -19.5 basis points vs. -17.0, Figure 2).

The underwriter’s incentives are a key factor driving the coupon rate differences. For example, we find that underwriters for low-income governments tend to have a geographic advantage in the baseline scenario, which is not the case for high-income governments. Specifically, the underwriter’s initial search cost, represented by  $\phi_0$  in the model, is smaller than that of an average dealer for low-income governments, while the reverse is true for high-income governments. Under standardization, less complex bonds are more easily traded by any dealer, smoothing out the differences in initial search costs among dealers. Thus, the advantage of the underwriters for low-income governments would shrink.<sup>67</sup> Combined with the loss of network effects, the loss of the initial search advantage means that underwriters would face fiercer competition from other dealers. The resulting decline in their market power would lead these underwriters to negotiate less aggressively over the coupon rate. These results suggest that considering underwriters’ incentives is important when designing a policy that imposes a particular bond design.

## 9. CONCLUSION

This paper presents new empirical evidence, along with market institutions, suggesting that underwriters have an incentive to increase the prevalence of complex bonds. This incentive stems from an underwriter’s dual role as a dealer because complexity amplifies its advantage in locating investors and trade the bond with them, *via-à-vis* other dealers.

One salient policy discussion centers on the standardization mandate, which is relevant not only for this market, but also for insurance, annuity, and mortgage markets. Using our estimated model of bond origination and trading, we find that under such a policy, the market would become more liquid, investors’ overall surplus would increase, and the issuers would benefit from interest savings, especially those in low-income counties with fewer regulations on government integrity. With that, our

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<sup>67</sup>The median difference between the underwriter’s  $\phi_0$  and an average dealer’s is -0.52 for low-income governments and 1.17 for high-income ones, which would change to -0.03 (0.07) for low-income (high-income) governments under standardization.

results present two caveats. First, the interest savings come at the cost of a decrease in flexibility for the government, and the discretion for local governments to customize their bonds can be valuable. Second, we find that standardization might drive the underwriter to negotiate less aggressively for a higher coupon rate. The strength of such incentives depends on the market conditions surrounding search frictions and dealer competition, which should be taken into account when designing policies.

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