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 to evaluate and decide on. Do some producers benefit from designing such products,

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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-á-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 (Célérier and Vallée, 2017) and lower realized returns to investors (Ghent, Torous and Valkanov, 2019).[1] 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' private 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 in particular in the municipal bond markets (Butler, Fauver and Mortal, 2009; Garrett, forthcoming).[2]

Lastly, our methods relate to the literature on the structural analyses of decentralized asset markets (Gavazza, 2016; Allen, Clark and Houde, 2019; Pintér and Uslu, 2022; Coen and Coen, 2022). Our model for over-the-counter (OTC) market is based on Üslü (2019), which incorporates (time-varying) heterogeneity across dealers

[1]See also Bonelli et al. (2021), which studies product differentiation of mutual funds.

[2]There is a large literature on the US municipal bond market, recently reviewed by Cestau et al. (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 Schürhoff, 2007; Bethune, Sultanum and Trachter, 2019; Cestau, Green, Hollifield and Schürhoff, 2019b; Garrett, Ordin, Roberts and Suárez Serrato, 2023).

and investors that hold continuous, unrestricted amounts of assets. These features 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 Piwowar, 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 Piwowar, 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 or tax considerations. Thus, a bond's low liquidity must be compensated by its high yields, leading to high interest costs to its issuer.[3]

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%).[4] This is in part because most municipal

[3]See, for example, Ang et al. (2014) and Schwert (2017) on estimating the impacts of liquidity or transaction costs on municipal bond pricing.

[4]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.

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 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 to match client needs, 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.[5] 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).[6] 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.

[5]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.

[6]Which method of sales is cheaper to issuers has been a long-standing question. See, for example, Cestau et al. (2019b) and the references therein.

We find that for negotiated deals, the underwriting market is fairly concentrated, especially for smaller issuers.[7] Regardless of issue sizes, repeat relationships between an issuer and an underwriter are notoriously common. For example, Chen et al. (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.[8] 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

[7]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, JP Morgan, etc.). When focusing on relatively small deals only (less than $10 million), we find the market becomes more concentrated: mean HHI is 0.24, and top 3 firms covering 64% on average.

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

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 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 that 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.[9]

[9]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

It is notable that regulations of revolving-door practices differ across states, while regulations of gifts and campaign contributions are governed by federal institutions (the MSRB, the FINRA, and the SEC).[10] 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 transaction data from Municipal Securities Rulemaking Board (MSRB). We complement these data with various attributes of the bond-issuing government sourced from multiple databases. We obtain government finances from the Census, demographic and economic attributes of the residents associated with the issuer from the American Community Survey, and political environment measured by the voting records for the recent Presidential elections from CQ Press Voting and Elections Collection. Lastly, based on Ethics and Lobbying State Law and Legislation Database by National Conference of State Legislatures, 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

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.

[10]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.[11]

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.[12] 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 and state regulations, 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).[13] 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 the key variables used in our analyses for the final sample of 13,118 bond

[11]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.

[12]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.

[13]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
Key issue attributes			*Nonstandard, complex features*		
Face value (in million USD)	20.345	53.878	Multiple bonds in an issue	0.972	0.166
Maturity (in years)[a]	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 %)[a]	2.960	1.045	Variable/floating interest rate	0.028	0.306
Revolving-door regulation			Num. of nonstandard features	6.953	5.937
Affecting state officials	0.829	0.376	Complexity index[b]	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.

issues. The average size of capital raised by a bond issue is $20.3 million, and the length of maturity 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.[14] 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."[15] Table 1 shows that

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

[15]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 seminannual), 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

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.[16]

4. Motivating Evidence

This section explores the determinants of bond design. We first show that conflict-of-interest regulations targeting government officials decrease the prevalence of nonstandard provisions in municipal bonds. Building on this suggestive 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 default risk for the issuing government, 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.[17] We construct two dummy variables capturing the scope of the revolving door legislation in place: LocalReg_i indicates there was a

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).

[16]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.

[17]See Appendix B.1 for the five pieces of state legislation on regulating post-government employment.

revolving-door regulation covering local government officials when bond i was issued, while StateReg_i indicates the presence of a regulation covering state officials.

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

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

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, β_1 and β_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%.[18] 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 practices may reduce the degree of collusion between underwriters and government officials, as long as including nonstandard provisions in a bond benefits the underwriter, possibly at

[18]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).

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

	Bond complexity index (log)			
	(1)	(2)	(3)	(4)
Local officials regulated	-0.072***	-0.064***	-0.073***	-0.064***
	(0.012)	(0.013)	(0.012)	(0.013)
State officials regulated			-0.020***	-0.010
			(0.008)	(0.010)
Bond attributes[a]	Yes	Yes	Yes	Yes
Issuer financial health attributes[b]	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 expenditures, the fraction of taxes in government revenue, and the fraction of government revenue sourced from federal and state governments.)

the expense of the issuing government and its taxpayers.[19] In Appendix B.3, we provide additional evidence for this mechanism by showing that the impact of these regulations intensifies with an underwriter's sway over the government officials and with its rent from underwriting more complex bonds.

Exogeneity Assumption as an Instrument. Having shown that revolving-door regulations impact bond design, in Section 4.2 we use changes in these regulations as an instrument to explore the incentives of underwriters at origination and the pros and cons 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

[19]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.

state-wide legislation, such circumstances may not be necessarily relevant for other localities. In addition, we do not find evidence for a pre-trend, as can be seen in 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.[20]

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, although revolving-door regulations may influence the work morale or composition of government officials, we do not find evidence that they impact government officials' behaviors related to the ability to pay back government debts. To see this, 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.[21] We adapt the specification of (1), and present the results in Column (1) of Table 3, showing that revolving-door regulations do not affect the credit ratings of existing bonds.[22]

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

[20]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.

[21]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.

[22]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[b] (1)	Annual issuance amount (log)[c] (2)	Length of maturity (log)[d] (3)	Ratio of negotiation[d] (4)
Local officials regulated	-0.045	-0.322	0.151	-0.080
	(0.031)	(0.264)	(0.094)	(0.062)
State officials regulated	-0.367	0.485	-0.020	-0.027
	(0.012)	(0.455)	(0.052)	(0.026)
Bond attributes[a]	Yes	No	No	No
Issuer financial health[a]	Yes	Yes	Yes	Yes
Year FE, County FE	Yes	Yes	Yes	Yes
Number of observations	286,554	62,588	21,963	21,963
R^2	0.407	0.066	0.358	0.422

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 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).

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 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. We next study whether the underwriter's role as an intermediary can be a driver of these incentives.

Our analysis relies on the following model:

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

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. We instrument these variables using the two revolving-door regulation dummy variables, interacted with county/state-level attributes inspired by the heterogeneity in the effects of revolving-door regulations as documented in Table A4. To control for different time trends depending on these county/state attributes, we include their interaction with year-month fixed effects. In addition, we control for issuer and bond characteristics, as well as 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.[23,24] 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 1.4 percentage points, corresponding to an increase of 11% 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.

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

[23] Appendix A.4 describes the procedure to identify trades by an underwriter of a bond.

[24] 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.

Table 4. Underwriter Incentives in Bond Design

	Underwriter's Market Share[c]		Gross profit[d]	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)
Complexity index (log)	0.082**	0.368**	2.105***	6.162**
	(0.022)	(0.181)	(0.3670)	(2.140)
Coupon rate	Yes	Yes	Yes	Yes
Bond attributes[a]	Yes	Yes	Yes	Yes
Issuer financial health attributes[a]	Yes	Yes	Yes	Yes
Year-month FE, County FE	Yes	Yes	Yes	Yes
Heterogeneous time trend[b]	Yes	Yes	Yes	Yes
Mean of the dependent variable	0.122	0.122	1.752	1.752
SD of the dependent var.	0.240	0.240	5.526	5.526
Number of observations	11,807	11,807	11,420	11,420
First stage F-stat[e]	-	9.7	-	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 originated 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 (executive vs. legislative or two chambers of the state legislature). 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*. 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.

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 extremely rare in this market.[25] In our sample, on average, a bond experiences 0.074 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

[25]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[a]		Intermediation spread[b]	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)
Complexity index (log)	0.034	-0.243**	0.009**	0.046**
	(0.034)	(0.091)	(0.002)	(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	0.074	0.074	0.012	0.012
SD of the dependent variable	0.303	0.303	0.022	0.022
Number of observations	13,008	13,008	11,078	11,078
First stage F-stat[c]	-	16.18	-	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.

risk: a 1% increase in the bond complexity index lowers the number of negative credit incidences by 0.002, which corresponds to a decrease of 3% over the mean, 0.074.

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 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. This is large, compared to the bid-ask spread of corporate bonds in 2010–2013, 30-60 basis points (Figure 13 of Mizrach (2015)). The estimated coefficient for β_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 basis points, corresponding to a 14% increase over the average.[26]

By taking an instrumental variable 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 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 $T \in \mathbb{R}_+$.[27] 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, $s \in \mathbb{R}_+$.[28] In exchange of the payment of F, the underwriter is awarded the entire bond.

[26]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.

[27]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.

[28]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

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 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 ρ_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.[29] 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:

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

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

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

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

and long-term relationships, as discussed in Section 2.2. Appendices C.3 and G.3 show that our counterfactual results are robust to these modeling choices.

[29]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.

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, with a weight representing her collusive relationship with the underwriter, denoted by $\psi \geq 0$.[30] We allow the weight, ψ, 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

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

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 τ 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 δ.

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:

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

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.[31]

[30]As discussed in Appendix D.2, under this specification, the equilibrium bond design depends on ψ, 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.

[31]Since the role of investor substitution across bonds is limited in this market(Appendix G.1), 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.1.2). To ensure that the estimates are robust to this

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 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:

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

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 ρ_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.[32] On the other hand, the rate at which a dealer meets an investor, λ, is chosen by each dealer at costly search efforts.

A dealer's cost of meeting investors at rate λ is:

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

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, $F_{\phi_0|(s,\mathbf{x},\xi)}$.[33] The second component captures how a dealer's client network impacts its search costs. We denote the size

modeling choice, we allow for κ_I to be bond-specific, and for the type of an investor to be flexibly heterogeneous both across investors and bonds. Appendix G.1.3 discusses the implications of this modeling approach for the counterfactual analyses.

[32] As λ_D increases, the inter-dealer market can approximate no search frictions. In estimation, we do not impose an upper bound for λ_D.

[33] In estimation, the realized value of ϕ_0 is allowed to depend on the dealer's prior experience in local bond trades.

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.

Note that both F_{ϕ_0} and ϕ_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 ϕ_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 ϕ_0. An investor's state, $y \equiv (a, \nu)$, consists of her inventory a and taste type ν. We denote the equilibrium price and quantity for a trade between two dealers of states u and u' at τ 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 τ 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:

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

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 λ_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 λ 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 λ in (9), the equilibrium meeting rate is:

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

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

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

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 α; 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

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

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

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

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 θ_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 ψ (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 ψ. 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-a-́vis other dealers through their impact on the network effect parameter ϕ_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 during one year prior to the bond's origination, 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 ($g_{ij} = 2$).

6.2. **Model Primitives.** There are three groups of model primitives that we estimate. First, we recover how search costs, investor preferences, and government costs depend on complexity (s) and exogenous bond attributes $(\mathbf{x}, \xi_M, \xi_G)$. This includes (i) the initial search cost type distribution, $F_{\phi 0|(s,\mathbf{x},\xi_M)}(\cdot|s, \mathbf{x}, \xi_M)$; (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 employing nonstandard provisions in a bond, θ_d.

Second, we estimate the parameters of the trading market that do not depend on bond design. These parameters include the dealers' utility parameters (κ_D, ν_D), the investors' cost of holding inventory κ_I and their liquidity shock α, the inter-dealer meeting rate λ_D, and the dealers' bargaining power against investors ρ. 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 $(\kappa_{D,i}, \nu_{D,i}, \kappa_{I,i}, \alpha_i, \lambda_{D,i}, \rho_i)$.[34]

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 ρ_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.[35] 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).

[34]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 $\rho_i \equiv \rho(\mathbf{x}_i, \xi_{i,M})$.

[35]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.

6.3. **Estimation Strategy.** We estimate the model primitives in three steps, as described below.

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, $F_{\phi_0|(s,\mathbf{x},\xi_M)}(\cdot|s,\mathbf{x},\xi_M)$ and $F_{\nu|(\tau,s,\mathbf{x},\xi_M)}(\cdot|\tau,s,\mathbf{x},\xi_M)$. Specifically, we assume that ν 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 ϕ_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.[36]

To estimate the parameter θ_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

[36]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 $g = 0,1,2$.

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 variation in the dealers' inventory and its correlation with trading prices is useful for identifying the bargaining parameter ρ_i.[37] Given this, we use the observed distribution of trading prices to identify the investor type distribution $(\gamma_{1,i}, \gamma_{2,i})$.[38] Finally, note that the exogenous passage of time, along with the fact that the model is finite-horizon, helps identification; for example, α_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. 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

[37]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.

[38]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.

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 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:

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

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

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

and

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

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, ξ_M, are mean zero conditional on $\mathbf{x}_1$ and revolving-door regulations h:

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

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, ξ_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.[39] 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

[39]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).

the government preference parameters while holding fixed the underwriter's incentives concerning the endogenous bond attributes, (s, r).

We cannot jointly identify the scale of the marginal cost of financing (c_0), the direct marginal benefits from bond complexity (θ_d), and the conflict-of-interest parameter (ψ).[40] 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.[41]

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.

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

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.[42] We denote the vector of these three variables by $\mathbf{x}_\psi \subset \mathbf{x}$, and consider the following specification:

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

[40] 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.

[41] 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.

[42] 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 ψ is not necessary for identification, but reduces the dimension of parameters.

To identify how c_0 changes with bond complexity s, 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 ξ_M if we assume that ξ_M is uncorrelated with ξ_G. Instead of making that assumption, we introduce additional instrument $\mathbf{z}$, and assume that the mean of the unobserved shock to government preferences, ξ_G, is zero conditional on $(\mathbf{x}, h, \mathbf{z})$:

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

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.[43] 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 (time-varying) observed attributes that capture its own circumstances.

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 (ξ_s, ξ_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.[44] We report bootstrap standard errors

[43]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.

[44]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 period of our study (AR, IN, ME, NM, and VA) and the counties at the borders of these states.

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 $\lambda = 1$, ϕ_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.

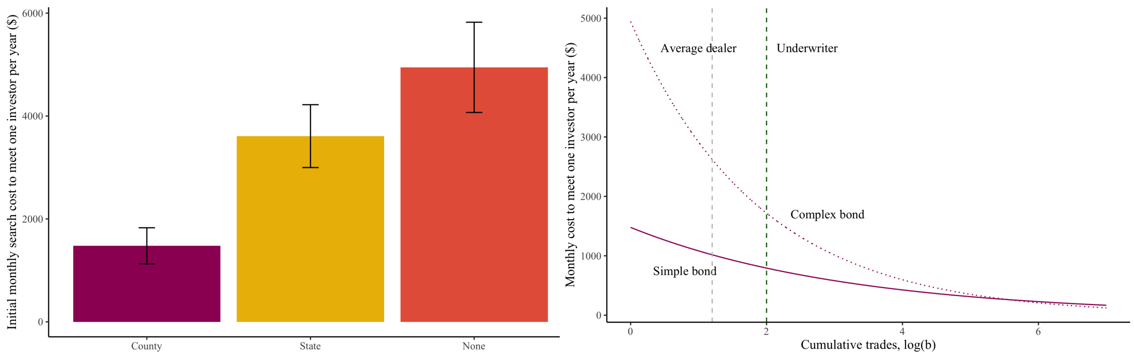
Additionally, we find a dealer's knowledge of the local market is critical in lowering its search costs. Figure 1(A) shows that the initial monthly search cost for a dealer who has experience trading bonds originated from the same county ($\phi_{0,0}$) to meet one investor per year is on average \$1,477, less than a third of the cost for a dealer with no experience of trading bonds from the same state ($\phi_{0,2}$).[45] 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%

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 statics of key bond and issuer attributes of this estimation sample are similar to those of the entire sample.

[45]Given our search cost function (8), the parameter value of ϕ_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



(A) Geographic advantage (B) Bond design and client network

Notes: In panel (A), each bar represents the average estimate of ϕ_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^{th} and 75^{th} 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 $\lambda = 1$ (ϕ_0) and the average value of cost advantage from client network, $\exp(-\phi_1 \log(b+1))$. The underwriter's ϕ_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.[46] Combining these two search cost components (ϕ_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,

[46] 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	Network	Mean	SD
	$\log \hat{\phi}_{0,i}$	$\log \hat{\phi}_{1,i}$	$\log \hat{\gamma}_{1,i}$	$\log \hat{\gamma}_{2,i}$
	(1)	(2)	(3)	(4)
Complexity index (log)	3.791	1.662	-0.0851	4.599
	(2.002)	(0.543)	(0.696)	(1.004)
Bond/issuer attributes[a]	Yes	Yes	Yes	Yes
Year-month FE, County FE	Yes	Yes	Yes	Yes
Heterogeneous time trend[a]	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 ϕ_0, which measures the level of search costs, by 3.79% (Column (1)) as well as the magnitude of the network effect parameter, ϕ_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 ϕ_0 and a 19% increase in ϕ_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.[47] 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 ν follows Gamma distribution with mean γ_1 and standard deviation γ_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 θ_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.[48] 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,

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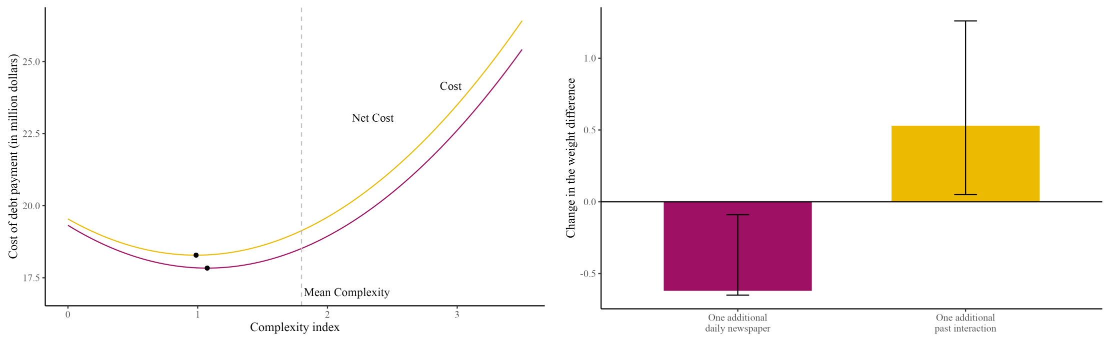
[47]Specifically, we rely on the second-step parameter estimates (θ_{ϕ_0} and θ_{ϕ_1}) and specifications (16) and (17), to compute the search parameters associated to two bonds with the median value of the estimated unobserved search cost factors, $\hat{\xi}_{\phi_0,1}$ and $\hat{\xi}_{\phi_1,i}$ and, respectively, a complexity index of 1 (the 25^{th} percentile in our data) and 2.14 (the 75^{th} percentile).

[48]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



(A) Cost of Debt Payments

(B) Difference in officials' weight ($\hat{\psi}_{0,i} - \hat{\psi}_{1,i}$)

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.[49] 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.[50] Panel (A) in Figure 2 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

[49]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 $\hat{c}_{0,i}$.

[50]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.[51] This amount corresponds to 27% of the median total interest payment per bond and 6.53% of the median par value in the sample.

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.[52] We find that the Fourth Estate can help rein in the influence of underwriters: as shown in Panel (B) of Figure 2, 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 over time; 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.[53] 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 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.

[51] 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 θ_d may reflect a combination of the dynamic incentives of both players.

[52] 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.

[53] 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	Change under Standardization		
	Median	Median	25^{th}	75^{th}
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 equilibrium bond design (complexity and interest rate), the annual rate of meeting with investors, the issuer costs, and investor surplus.

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.[54] 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 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%.[55]

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.

[54]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.

[55]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).

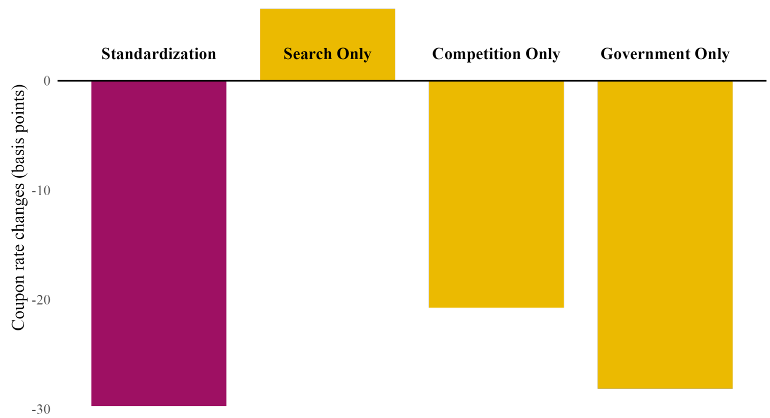
For most bonds, investors would overall benefit from a standardization policy, with the median percentage change in the investor surplus being an increase of 8%. This finding is striking because, as we discuss below, the policy would lower the coupon rate in general, which wouldn't be palatable to investors.

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 ($d_0 s$). 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.

When interpreting these counterfactual results, a few caveats are in order. First, remember that in our model the bond-specific opportunity cost κ_I reflects the desirability of alternative investments. When simulating the impact of standardization, we hold this opportunity cost fixed. In light of this, the analysis we present in this section should be thought of as describing a "partial equilibrium" impact of the standardization mandate, where investors' alternatives do not respond to the policy. Appendix G.1 shows that allowing κ_I to change to capture the impact of standardization on other bonds is likely to have a relatively small impact on the results, reflecting the limited role of investor substitution across bonds. Second, we abstract away from the municipal governments' choice of underwriters. However, under a standardization mandate the issuers might be less tied to a particular underwriter, and they may switch to low-cost underwriters. Appendix G.3 confirms that our results are overall robust in this scenario. Finally, call options can be particularly useful for the issuers. For this reason, in Appendix G.2 we simulate an alternative standardization 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

Figure 3. Effects of Standardization



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.

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, ϕ_0 and ϕ_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 ϕ_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 equilibrium 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 negotiated coupon rate would be higher under standardization than under this scenario by 6.6 basis points ("Search Cost Only" in Figure 3). This result illustrates that 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.[56] We 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 3). This confirms that the declined market power under standardization drives the

[56]To approximate this scenario, we first compute equilibrium trading prices and quantities when ϕ_1 is set to the standardization level while ϕ_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 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.

underwriter to negotiate less aggressively over the coupon rate, strengthening the decline of the coupon rate under standardization. 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.

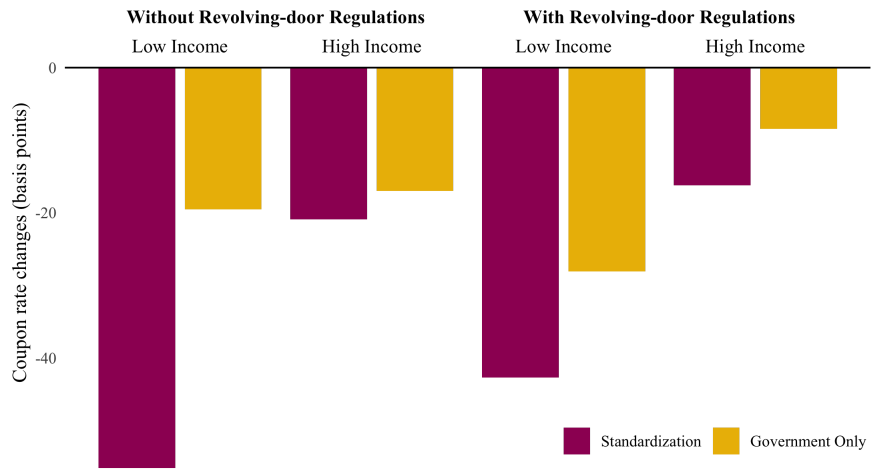
As mentioned earlier, the equilibrium coupon rate also reflects the issuer's marginal cost of interest payments (c_0). The standardization policy would, overall, increase c_0 (Table 8), encouraging the issuer to negotiate more aggressively with the underwriter over the coupon rate and thus driving a 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 3).[57]

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 Mississipi, whose county's median household income is less than one fourth of FairFax, Virginia. These differences will affect the relative importance of the multiple economic forces determining the coupon rate under standardization.

[57]Note that our findings on these multiple channels through which standardization affects the negotiated 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.

To explore the distributional impact of standardization, we focus specifically on low vs high-income counties, since governments located in low-income counties tend to have higher marginal financial cost estimates, and issue more complex bonds. Moreover, we distinguish between bonds issued by governments with or without revolving-door regulations.[58]

The purple bars in Figure 4 show the median predicted coupon rate changes under the standardization policy, for each of the four groups of bonds. Notably, regardless of the income level, bonds issued without revolving-door regulations would experience a larger decline in coupon rate than those with such regulations. 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

[58]Specifically, we divide the 386 bonds into four groups based on the revolving-door regulations at the time of issuance 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).

difference cannot be explained by the difference in the issuing government's incentives, 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 4).

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 ϕ_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.[59] 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-á-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

[59]The median difference between the underwriter's ϕ_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.

low-income counties with fewer regulations to protect government integrity. Having said that, our 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 the incentive to do so depends on the market conditions surrounding search frictions and dealer competition, which should be taken into account when designing policies.

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Online Appendix for

Search Frictions and Product Design in the Municipal Bond Market

Appendix A. Construction of Variables in the Data

This section describes how we construct the variables used in our analysis. The face value, maturity, coupon rates, and various provisions for each bond, as well as the type of assets that will pay the debt and the purpose of the funds raised by the bond, are directly from the Mergent Municipal Bond Securities Database. Below, we discuss how we combine that data with the issuing government attributes at the county or state level, define the method of sale for each bond issue, summarize the underwriter and the financial advisor market at the state level, and identify which trades observed from the MSRB data belong to the underwriter(s) of a bond.

A.1. **Issuing Government Attributes.** We gather demographic and economic attributes of the residents from the American Community Survey at the county level. To merge the county-level attributes with the bond data, we obtain the county of the issuer based on the name of the issuer for each bond and the state, both of which are provided by the Mergent database. Most issuer names indicate the county, but for those that do not, we manually search for the issuer's name online to identify its county. Some local governments serve multiple counties, in which case we randomly select one county.

The Annual Survey of State and Local Government Finances from the Census provides the local government finance information. A census is conducted every five years, and a sample of local governments is used to collect data in the intervening years. We do not always observe the financial information for every year for local governments, but we find that while the data for county governments are consistently provided over time, other local governments, especially for small ones, are not. Therefore, when necessary, we interpolate the finance information over time. In addition, for local governments other than county governments, we use the finance information aggregated over the governments of the same category (city/township, school districts, and other special-purpose governments). As for government revenues and expenditures, we use CPI-adjusted values (where the base year is 2012).

We measure the political environment that each bond issuer faces by the fraction of votes for the Democratic Presidential candidate in the most recent election at the county level, which we gather from CQ Press Voting and Elections Collection. In addition, we record whether the state government was divided, between the legislature and the governor's office, at the time of the origination of a bond, based on the state partisan composition data from the National Conference of State Legislatures.

A.2. **Method of Sale.** The Mergent database provides the method of sale for each bond issue, but when not available, we use the SDC Platinum Financial Securities data. This way, we observe the method of sale for 98% of all tax-exempt general obligation or revenue bonds issued by local governments during the period of study.

A.3. **Primary Market Conditions.** The Mergent database provides the identifiers of the underwriters and the financial advisors (if any) for each bond. Based on these identifiers, we calculate the number of available underwriters and financial advisors at the state level, and the respective Herfindahl-Hirschman index, accordingly. The underwriter identifier, along with the issuer identifier based on the first six digits of a bond's CUSIP, is used to figure out whether an underwriting firm has a history of underwriting another bond of a given issuer. Note that the identifiers for underwriters from the Mergent database do not correspond to the dealer identifiers of the trading data from the MSRB data.

A.4. **Identification of Transactions by an Underwriter.** In our analysis to study the incentives of the underwriters (Section 4.2) and to estimate our model, it is important to identify which transactions for a bond were conducted by the underwriter of the bond, as opposed to other dealers. The transaction data from the Municipal Securities Rulemaking Board (MSRB) provide anonymized dealer identifiers, so we infer whether a transaction of a bond was with its underwriter or not. Our inference procedure is based on the idea that the dealer(s) with the highest net sales given the history of secondary transactions for a given bond issue is likely to be the issue's underwriter(s). The logic behind this strategy is that the underwriter (syndicate) purchases the entirety of the issue and thus is likely to have the largest inventory. Noting that multiple financial institutions may act as an underwriter for an issue as a part of an underwriter syndicate, we look for a dealer whose net sales is the highest for each bond within an issue and when there is a tie, we choose one whose first trade of the bond as in the data precedes the other(s). This way, we designate one

Table A1. Distribution of Underwriters: Our Method vs. Mergent

	Issue-level		Underwriter-level	
	Ours	Mergent	Ours	Mergent
	(1)	(2)	(3)	(4)
Number of observations	13,118	12,202	375	338
5^{th} percentile	1	1	1	1
25^{th} percentile	1	1	2	2
Median	1	1	8	6
75^{th} percentile	2	1	41	35
95^{th} percentile	5	4	313	288

Notes: The first two columns of this table provide the distribution of the number of underwriters for our final sample of 13,118 issues ("Issue-level"), where we identify the underwriters based on the method described in Appendix A.4 ("Ours") or the dataset from Mergent ("Mergent"). Note for 916 issues, our method is not able to identify an underwriter. The last two columns ("Underwriter-level") present the distribution of the number of issues in which an underwriter participated, based on our sample.

underwriter per bond within an issue, but there may be multiple underwriters per issue.

Column (1) of Table A1 provides order statistics regarding the distribution of the number of the underwriters that we assign based on our procedure described earlier. Because most issues include multiple bonds (i.e., are a serial issue) and we consider the highest net sellers at each of the bond given an issue as the underwriters of the issue, it is notable that our methods indicate the median number of underwriters per issue is one. This statistic corresponds to the median value based on the underwriter information in the Mergent database, represented in Column (2).

Looking at our data at the underwriter level, we find the number of financial institutions that underwrote at least one of bonds in our sample, as identified by our method, is 375, which is somewhat larger than the counterpart based on the Mergent dataset, 338 ("Number of observations" for Columns (3) and (4) of Table A1). The market concentration for underwriting business is a bit higher under our method: The 95^{th} percentile underwriter under our methods is indicated to have underwritten 313 issues, while the counterpart based on the Mergent data is 288. However, overall, the two distributions seem remarkably similar.

Appendix B. Revolving-door Regulations

B.1. **State Legislation.** Based on the Ethics and Lobbying State Law and Legislation database by National Conference of State Legislatures, we identify the 14

TABLE A2. State Legislation on Revolving-door Lobbying (2010-2013)

State	Date	Act	Who are newly regulated?
Arkansas	April 4, 2011	H 2202	Certain state regulatory officials
Indiana	March 17, 2010	H 1001	Members of the general assembly
Maine	May 24, 2013	H 144	Members of the general assembly
New Mexico	April 7, 2011	S 432	Public officers or employees
Virginia	March 25, 2011	H 2093	Constitutional officer

enactments of state legislation regarding revolving-door practices during the period of our study, 2010-2013. Among them, five pieces of state legislation introduced revolving-door regulations to state or local government officials. Table A2 provides the list of these five pieces of legislation, which provides variation in regulations, which is important in our empirical strategy. The rest, nine pieces of legislation, is to strengthen the existing revolving-door regulations.

The enacted pieces of legislation in Arkansas, Indiana, and Maine target state officials. Those in Indiana and Maine regulate members of the state legislature. On the other hand, the legislation in Arkansas focuses on certain state officials such as the Insurance Commissioner, the Bank Commissioner, and the Securities Commissioner. The other two pieces of legislation in Table A2 extend the existing revolving-door regulations to local officials. In New Mexico, the enacted legislation extended the provisions of the Governmental Conduct Act, and an important feature is to include public officers and employees of local governments. Section 10-16-8 of the State Code states, "A former public officer or employee shall not represent a person in the person's dealings with the government on a matter in which the former public officer or employee participated personally and substantially while a public officer or employee." In Virginia, H 2093, entitled "State and Local Government Conflict of Interests Act," prohibits a constitutional officer, during the one year after the termination of his public service, from acting in a representative capacity on behalf of any person or group, for compensation, on any matter before the agency of which he was an officer. This resulted in a new section, 2.2-3104.02, to the State Code. In Section 2.2-3101 of the Code, an "officer" is defined as "any person appointed or elected to any governmental or advisory agency including local school boards, whether or not he receives compensation or other emolument of office." Prior to this new section of the State Code, existing provisions regulating revolving-door practices include 2.2-3104 with regards to certain state officers or employees and 30-103 regarding the members of the general assembly.

Table A3. Revolving-door Regulations and Individual Features of Municipal Bond Complexity

	Multiple (1)	Sinking Fund (2)	Call (3)	Irregular Payment (4)	Non-fixed Coupon (5)
Local officials regulated	-0.048***	-0.020***	-0.016	-0.020***	-0.014***
	(0.009)	(0.005)	(0.012)	(0.007)	(0.005)
State officials regulated	0.039	0.038	-0.033*	-0.030***	-0.032***
	(0.046)	(0.051)	(0.017)	(0.007)	(0.007)
Bond attributes[a]	Yes	Yes	Yes	Yes	Yes
Issuer financial health attributes[a]	Yes	Yes	Yes	Yes	Yes
Year-month FE, County FE	Yes	Yes	Yes	Yes	Yes
Number of observations	13,086	13,086	13,086	13,086	13,086
Mean of the dependent variable	0.972	0.004	0.294	0.082	0.006
R^2	0.397	0.486	0.751	0.307	0.262

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; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. The outcome variables represent each of the complexity features as follows: whether or not an issue consists of multiple bonds (Column (1)); the logarithm of the sum of one and the frequency of a particular bond provision (call option, sinking fund, non-standard interest payment schedule, and variable/floating interest rate) across bonds (Columns (2)–(5), respectively). *a*. See the notes in Table 2 for the details on the control variables.

B.2. **Revolving-door Regulations and Bond Design: Further Evidence.** Table 2 shows that the bond complexity, as measured by the index described in Section 3, decreases with revolving-door regulations, especially those regulating local officials. Our complexity index is based on five different features of bond complexity and, to verify the robustness of our results, we consider alternative specifications where each of the components of the index is an outcome variable, respectively.

We present the regression results in Table A3, and find that all components decrease with the regulations. Column (1) shows that revolving-door regulations targeting local officials are associated with a 4.8% decrease in the probability that an issue includes multiple bonds, while Column (2) shows that these regulations reduce the number of provisions introducing a sinking fund. The next column presents the effects of such regulations on call option provisions, which are not statistically significant; however, regulations targeting state officials reduce call provisions. With either type of revolving-door regulations, bonds are more likely to pay interest in a non-standard schedule (Column (4)), or to use variable or floating coupon rates (Column (5)).

B.3. **Heterogeneous Effects.** We argue that revolving-door regulations increase the extent to which officials internalize the payoff of the underwriter when negotiating over bond design at origination. Appendix D.2 shows that, if the underwriter's payoff from trades is increasing in bond complexity, the equilibrium level of complexity is increasing in ψ as well as in the underwriter's rent from underwriting a complex bond. Consistent with this result, Table A4 shows that the effects of the revolving-door regulations on bond complexity vary with bond or issuers' exogenous attributes that can increase the magnitude of ψ or the underwriter's rent from complexity. This analysis serves a validation both for the model and the mechanism behind the main result presented in Table 2. The specifications used here are the same as (1), except that we include an interaction term with revolving-door regulation dummies.

First, we find that the effects of revolving-door regulations vary with the circumstances that the issuer faces in the primary market. When a government issues a bond, it can hire a financial advisor, which is the case for 52% of our sample. Column (1) of Table A4 shows that the impact of regulating local officials' post-government employment is stronger when the local market for financial advisors is more concentrated.[1] When the market for financial advisors is concentrated, local governments may be less likely to hire a financial advisor due to higher fees. In addition, higher market concentration can facilitate collusion between financial advisors and underwriters. Both channels may increase the underwriters' influence on the government officials, which is captured by the officials' weight, ψ, in the model. On a similar vein, Column (2) of Table A4 shows that the effects of revolving-door regulations are slightly muted when the local government has prior experience in issuing bonds. Such experience may help reduce the extent to which underwriters can sway the officials at negotiation, lowering the value of ψ in our model.

Another factor that may affect the officials' weight for underwriters, ψ, is the political situation that they may face in office. Column (3) of Table A4 shows that the effects of revolving-door regulations on bond design is higher in "swing" or electorally competitive counties.[2] One explanation is that local government officials' turnover

[1]We measure the market concentration of financial advisors associated with a bond using data on the identity of the financial advisors for all municipal bonds issued in that bond's state within three calendar years prior to its issuance. In our sample, the average HHI for the state-level financial advisor market is 0.153 with the standard deviation of 0.081.

[2]We label that a county is "swing" if the vote share of the Republican candidate in the most recent Presidential election in a county is between 45% and 55%

Table A4. Heterogeneous Effects of Revolving-door Regulations

	Complexity index (log)					
	(1)	(2)	(3)	(4)	(5)	(6)
Local off. regulated	-0.076***	-0.064***	-0.062***	-0.059***	-0.045***	-0.060***
	(0.011)	(0.013)	(0.013)	(0.012)	(0.015)	(0.013)
State off. regulated	0.019	-0.018*	-0.010	-0.006	-0.032***	-0.010
	(0.023)	(0.010)	(0.011)	(0.012)	(0.010)	(0.009)
Loc. × Fin. advisor HHI[a]	-0.040***					
	(0.009)					
Loc. × Issuer exp.[b]		0.019**				
		(0.009)				
Loc. × Swing[c]			-0.018**			
			(0.008)			
State × Divided gov.[d]				0.067**		
				(0.027)		
Loc. × Any dailies[e]					0.019**	
					(0.008)	
Loc. × Frac. retail investors[f]						-0.014**
						(0.006)
Bond controls[h]	Yes	Yes	Yes	Yes	Yes	Yes
Issuer controls[h]	Yes	Yes	Yes	Yes	No	Yes
Year-month FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes	No	Yes
Num. obs.	13,086	13,086	13,086	13,086	13,118	13,086
R^2	0.648	0.648	0.648	0.648	0.568	0.648

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; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. For ease of interpretation, we interact a revolving-door dummy variable with the standardized value of a bond or issue attribute, by subtracting its mean and then dividing it by the standard deviation, if the attribute is a continuous variable. *a*. The Herfindahl-Hirschman index associated with a given bond using data on the financial advisors for all municipal bonds issued in the bond's state within three calendar years prior to its issuance. *b*. A dummy variable indicating whether the government issued at least one bond within the three calendar years prior to a given bond issue. *c*. A county where the issuing government of a given bond is located is considered as electorally competitive or "swing" at issuance if the vote margin in the most recent Presidential general election outcome prior to the issuance is less than 5%. *d*. The state government is considered as "divided government" if both chambers in the state legislature are controlled by another party than the governor's. *f*. A dummy variable indicating that there was at least one daily newspaper operating in a given county in 2004, based on Gentzkow et al. (2011). *g*. We define transactions of bonds with par value less than $100,000 as individual investors'. For a given bond, we look at the fraction of such transactions among all transactions involving the bonds of the same type of security (revenue, limited or unlimited general obligation) issued by local governments in the same state during the year when the given bond was issued. *h*. The notes in Table 2 describe the control variables.

rate in these counties can be higher than in other counties, increasing the value of post-government job opportunities and consequently the value of ψ. In addition, Column (4) in the same table shows that the effects of revolving-door regulations for state officials are dampened when the state government is divided (i.e., both chambers in the state legislature are controlled by another party than the governor's). This finding may be explained by the idea that state officials may influence local officials' dealings at bond origination, and that such influence may wane with a divided government, as scrutiny on state officials becomes stronger and thus decreasing ψ. Interestingly, Column (5) shows that the effects of revolving-door regulations are lower when the county is covered by at least one daily newspaper, showing that the local media can serve as a watchdog in the local government dealings with the underwriter.[3]

Finally, we argue that the rent from underwriting a complex bond increases when the share of individual retail investors, as opposed to institutional investors, active in the trading market is larger. This, in turn, can intensify the regulations' effects on bond design, which is documented in Column (6) of Table A4.

B.4. **Pre-trend Analysis.** Section 4.1 documents the effects of revolving-door regulations on bond design over time—before and after the regulation—controlling for county and year-month fixed effects. The specification we consider is

$$\log(s_i + 1) = \sum_{\tau_1=1}^{\tau_1=4} \beta_{\tau,1} d\tau_{1,i} + \sum_{\tau_2=1}^{\tau_2=3} \beta_{\tau,2} d\tau_{2,i} + \gamma \mathbf{X}_i + \kappa_{c(i)} + \theta_{t(i)} + \epsilon_i, \qquad \text{(A.1)}$$

where $d\tau_{1,i}$ is a dummy variable indicating that the i^{th} bond issuance occurred within one to three years ($\tau = 1, 2, 3$) or beyond three years ($\tau = 4$) after a revolving-door regulation was implemented and $d\tau_{2,i}$ is similarly defined except that we count the time period prior to the regulation. Note that for this exercise, we do not distinguish regulations by their target (state vs. local officials). As for controls, we employ the same set of controls used for the specification of Column (4) of Table 2.

Figure A1 presents the coefficient estimates for $\beta_{\tau,1}$ (for Year $+1, +2, +3, +4$) and $\beta_{\tau,2}$ (for Year $-1, -2, -3$). There are two notable patterns in the coefficient estimates. First, we do not find evidence that there exists an obvious pre-trend. Second, the effects are higher and statistically significant after the regulations were in place more

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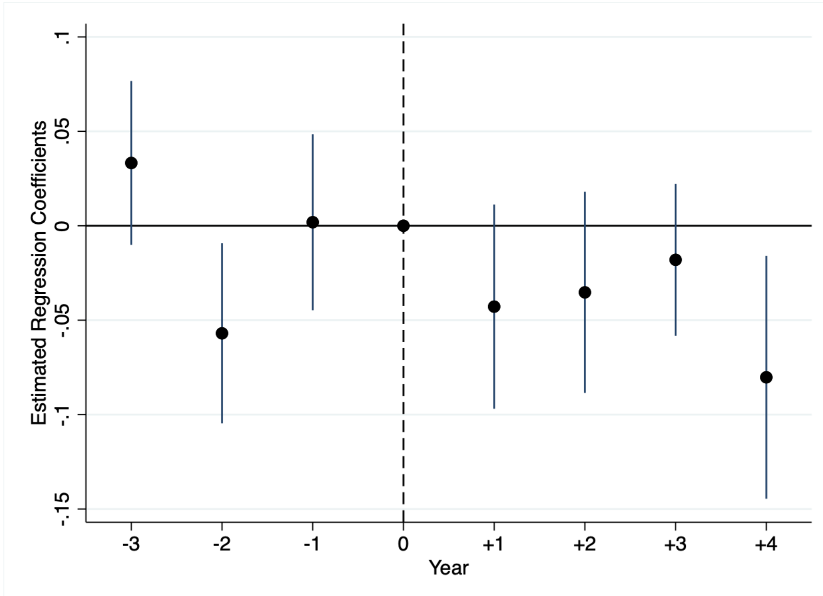
[3]Our period of study is 2010-2013, but the digitized data for local daily newspapers at the county level for this period is not publicly available. For this reason, we use the 2004 data from Gentzkow et al. (2011) to measure the presence of local newspapers in the county.

Figure A1. Effects of Revolving-door Regulations Over Time



Notes: This graph shows the regression coefficient estimates and the 95% confidence intervals for yearly time dummies before and after a revolving-door regulation was implemented. The dependent variable is the logarithm of the bond complexity index plus one. We control for various issue and issuer attributes; see the text for the specification.

than three years. This may reflect that it takes time for local governments to plan on a bond issue, select an underwriter (syndicate), and negotiate over terms of issuance.

Appendix C. Methods of Bond Sale

C.1. **Determinants of the Method of Sale.** To study the local governments' choice of method of sale, we follow all local governments in our main sample: 14,134 governments that issued at least one tax-exempt general obligation or revenue bond during 2010–2013. We also extend the period of study to 2004–2014, during which these governments collectively issued 57,059 tax-exempt bonds. Among them, 52% were negotiated and 46% were auctioned.[4] We then focus on new-money bonds, as opposed to refunding ones, which are often negotiated.[5]

[4]Some of the remainder were sold privately (1.3%), and for the rest (0.8%), we do not identify the method of sale.

[5]Since the benefit of refunding is very sensitive to interest rate movements, issuers tend to consider negotiated sale as more suitable because it allows for the flexibility of market timing (Peng and Brucato, 2003). Consistent with this, the fraction of negotiated bonds among new-money bonds is 38%, much lower than the counterpart among refunding bonds, 66%. Our regression results presented in this section are robust to including refunding bonds.

Using these bonds and focusing on two main methods of sale (negotiated vs. auctioned), we investigate the determinants of the bond sale method, by considering the following specification. For each bond j issued by local government $i(j)$ in county $c(j)$ at semi-annual period $t(j)$ and year $y(j)$,

$$Negotiated_j = \beta \mathbf{x}_j + \pi_{t(j)} + \phi_{c(j),y(j)} + \mu_{i(j)} + \epsilon_j, \tag{A.2}$$

where $Negotiated_j$ is a dummy indicating that bond j was negotiated; $\mathbf{x}_j$ includes various observed attributes such as the source of the security (general obligation vs. revenue bond), in addition to (time-varying) issuer-specific attributes; $\pi_{t(j)}$ summarizes semi-annual period fixed effects; $\phi_{c(j),t(j)}$ represents time-varying county fixed effects, which may capture, among other things, state and local regulations, local primary market conditions, and local investor demand; and $\mu_{i(j)}$ represents issuer fixed effects. Table A5 presents the OLS results of this specification (Column 4) and three modified versions (Columns 1–3).

One notable pattern in Table A5 is that local government attributes, as opposed to bond attributes, explain a large variation in the method of sale. The adjusted R^2 based on the full specification of (A.2), as shown in Column (4), is much higher than the counterpart in Column (1), where bond attributes, state regulations, and time fixed effects are controlled for while issuer attributes are not: 0.769 vs. 0.280. Comparing the (adjusted) R^2 values in Columns (1) and (2) shows that (time-invariant) local conditions captured by county fixed effects, explain a big chunk of the variation in the sale method. We also find that, beyond (time-varying) local factors at the county level, the (time-invariant) circumstances faced by each issuer also matter, by comparing Columns (3) and (4). This pattern is consistent with the fact that among the 5,896 issuers in the sample that issued at least two new-money bonds during 2004–2014, a large majority (83%) of them used a single method only, not both.[6]

The issuer-specific factors may include "*de facto* or *de jure* limitations on the use of negotiated issuance procedures" in local governments (Fruits et al., 2008). They may also include the primary market conditions that an issuer faces. The more there are underwriters available in the market, the larger the benefit from competition becomes, which may reduce the use of negotiation, consistent with the results in

[6]When narrowing down the period to 2010–2013, we identify 1,390 issuers with at least two new-money bonds, and find that a similar fraction of them (89%) used a single method.

Table A5. Determinants of the Method of Sale

	Negotiated sale (as opposed to auctions)			
	(1)	(2)	(3)	(4)
Bond attributes				
Offering amount (log, total)	-0.011	-0.002	0.004	-0.008
	(0.017)	(0.012)	(0.007)	(0.005)
Length of maturity (log, average)	0.035	0.009	0.009	-0.017*
	(0.031)	(0.015)	(0.015)	(0.009)
Limited general obligation bond	-0.042	-0.028	0.010	-0.026
	(0.068)	(0.039)	(0.038)	(0.022)
Revenue bond	0.305***	0.241***	0.299***	0.012
	(0.041)	(0.042)	(0.041)	(0.027)
Issuer attributes				
City government			-0.207***	
			(0.067)	
School district			-0.026	
			(0.091)	
Other district (e.g., water utility)			-0.157	
			(0.100)	
Revenue: Average (log, 2000-14)			-0.062**	
			(0.027)	
Revenue: Standard deviation (log, 2000-14)			0.020	
			(0.024)	
Issued a bond in the past 5 years			0.018	0.014
			(0.026)	(0.018)
Number of bonds issued (log, past 5 years)			0.106***	0.023
			(0.038)	(0.015)
Number of underwriters (log, past 5 years)			-0.146**	-0.027***
			(0.061)	(0.010)
Ratio of taxes in the revenue			-0.134*	0.008
			(0.078)	(0.083)
Ratio of government transfers in the revenue			-0.151	-0.037
			(0.110)	(0.151)
State regulations	Yes	Yes	No	No
Year-month FE	Yes	Yes	Yes	Yes
County FE	No	Yes	No	No
County-year FE	No	No	Yes	Yes
Issuer FE	No	No	No	Yes
Number of observations	26,380	25,997	21,338	17,162
R^2	0.284	0.546	0.629	0.878
Adjusted R^2	0.280	0.513	0.521	0.769

Notes: This table reports OLS estimates, based on all tax-exempt new-money general obligation or revenue bonds issued by local governments in 2004–2014. Standard errors are adjusted for clustering at the state level, and are provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Columns (3) and (4) of Table A5.[7] Column (4) shows that the coefficient for our measure of the availability of underwriters is negative and statistically significant, even when we control for county-time fixed effects and issuer fixed effects. Another relevant variable in this context is the local government's prior experience in bond issuance, which is positively correlated with the probability of negotiation (Column (3) of the table). In addition, city governments and those with a large revenue tend not to rely on negotiation as a method of sale.

C.2. **Effects of Revolving-door Regulations and the Method of Sale.** Having shown that predetermined issuer-specific factors, either observed or not, are key determinants for the method of sale, we investigate how our results presented in Section 4.1 may change when we control for issuer fixed effects. Column (1) of Table A6 reprints the results presented in Column (4) of Table 2, and Column (2) of Table A6 presents the regression results of an alternative specification of (1) where the only difference from the original specification is that issuer fixed effects, instead of county fixed effects, are employed. We find that, despite a steep increase in R^2 in Column (2) compared to that in Column (1), the estimated effects of revolving-door regulations are statistically similar in the sense that the 95% confidence intervals of the precisely estimated coefficients for the revolving-door regulations against local officials, $[-0.088, -0.040]$ and $[-0.066, -0.014]$, largely overlap.[8] In a similar vein, Column (3) shows that the results are robust to using a subsample of negotiated bonds issued by local governments that used negotiation only for all incidences of new-money bond issuance during 2004–2014.[9] This suggests that the issuer-specific factors affecting the method of sale, beyond those captured by county fixed effects, may not be correlated with the error term in (1).

Our study focuses on negotiated bonds because underwriters cannot directly influence bond design at origination for auctioned bonds. We argue that revolving-door regulations reduce conflicts of interest and limit underwriters' pushes for complex bond design in negotiations. As a way to provide additional support for this argument,

[7]The availability of (potential) underwriters, specific to a local government issuer, can be (imperfectly) measured by the number of unique underwriters that the issuer employed in the past five years ("number of underwriters").

[8]Given that our results are robust to controlling for issuer fixed effects and that a large majority (67%) of the issuers in our sample issued only one bond once during the period of study, our analyses include county fixed effects throughout, but not issuer fixed effects.

[9]Here we focus on local governments that issued at least two new-money bonds during 2004–2014. This drastically reduces the sample size because the frequency of bond issuance tends to be low and many local governments issued only one new-money bond during the period.

Table A6. Revolving-door Regulations and Bond Design by Sale Methods

	Complexity index (log)				
	Negotiated			Auctioned	
	(1)	(2)	(3)	(4)	(5)
Local officials regulated	-0.064***	-0.040***	-0.067**	-0.007	-0.005
	(0.012)	(0.013)	(0.029)	(0.009)	(0.010)
State officials regulated	-0.010	0.006	0.016		0.032***
	(0.011)	(0.013)	(0.053)		(0.007)
Bond attributes[a]	Yes	Yes	Yes	Yes	Yes
Issuer financial health attributes[a]	Yes	Yes	Yes	Yes	Yes
Year-month FE	Yes	Yes	Yes	Yes	Yes
County FE	Yes	No	No	Yes	Yes
Issuer FE	No	Yes	Yes	No	No
Number of observations	13,088	13,088	3,828	10,123	10,123
R^2	0.647	0.874	0.798	0.783	0.783

Notes: This table reports OLS estimates, based on the general obligation or revenue bonds issued by local governments in 2010–2013. Standard errors are adjusted for clustering at the state level, and are provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Negotiated bonds are used in the first three columns, and auctioned ones are used for the last two columns. In the third column, we focus on negotiated bonds issued by local governments that used negotiation only for all incidences of new-money bond issuance during 2004–2014. *a*. See the notes in Table 2 for the details on the control variables.

we show that revolving-door regulations do not negatively affect bond design for auctioned bonds. To see this, we run the same specification of (1) using auctioned bonds issued during the same period. Columns (3) and (4) of Table A6 show that revolving-door regulations, if anything, increased complexity, which is the opposite of our findings in Section 4.1.

C.3. **Simulation Exercise on Selection Bias.** The goal of this Monte Carlo exercise is to gauge the extent to which our estimation results and counterfactual analyses are biased due to local governments' selection into negotiation vs. auction as a method of sale. Below we present a simple model to capture a government's choice of the method of sale, where unobserved factors for the choice can be correlated with the government's marginal financial cost and its value of complexity. We then simulate the model, combined with our main model of the equilibrium bond design, and present the results to qualify the interpretation of the main results of the paper.

C.3.1. *Model of the Choice of the Method of Sale.* Consider a municipal government contemplating an issuance of a bond of size $A \in \mathbb{R}_+$ and maturity $T \in \mathbb{R}_+$. Following our main model, the issuer uses F to finance its projects, and bears the cost of paying the principal A and the interest rAT:

$$c_0(s, \mathbf{x}, \xi_s, \xi_r)A(1 + rT),$$

where the coefficient c_0 represents the minimal attainable marginal cost to make the bond payments and (ξ_s, ξ_r) are unobserved government attributes. We consider the same specification for c_0 as in the main model, represented in (19):

$$c_0(s, \mathbf{x}_1, \xi_s, \xi_r) = \theta_{c,s_1} s\mathbf{x}_1 + \theta_{c,s_2} s^2 + \theta_{c,x}\mathbf{x}_1 + s\xi_s + \xi_r.$$

Following the discussion in Appendix C.1, we allow for the issuing government to choose to use negotiation, as opposed to auction, in response to observed issuer-specific observed factors $\mathbf{w}$, such as regulations and conditions in the primary market, as well as unobserved factors captured by a random variable ϵ, possibly correlated with the unobserved government attributes (ξ_s, ξ_r). In particular, the issuer chooses negotiations if

$$\mathbf{w}\delta - \epsilon \leq 0, \tag{A.3}$$

where the vector of $\mathbf{w}$ comprises of the controls used in the specification for Column (3) in Table A5. Note that we control for extra variables that are not used in the estimation of the main model, such as the issuer's past experience of bond issuance and county-year fixed effects, capturing various state and local regulations and market conditions that change over time.[10] Including these extra variables here allows us to take into account some of the correlations between the issuers' preferences in the model and their decision on the method of sale.

C.3.2. *Monte Carlo Simulation: Procedure.* An important factor for the extent of selection bias is the probability that a bond is negotiated, conditional on observed attributes. When the probability is low for a given bond and yet the bond is indeed negotiated, the extent of the role played by ϵ must be big. With that, we first estimate δ (A.3) to match the conditional probability of negotiation for the bonds used for Table A5. Among these bonds, we focus on a bond with a low predicted negotiation probability, to explore a worst-case scenario concerning the role of selection. Specifically, the simulation results presented below are based on a 92-million general obligation bond issued by the city of Chicago, Illinois, in 2010, and the predicted probability of negotiation, given our δ estimates, is 0.244, close to the 25^{th} percentile

[10]These fixed effects are not controlled for in our main analysis because we rely on the panel variation in state-level regulations on revolving-door practices, and instead we use county fixed effects and semester fixed effects, separately.

of the estimated probability of negotiation for bonds in our extended sample, and slightly below the 5^{th} percentile among the negotiated bonds in the sample.

In our simulation exercise, we draw $(\epsilon^{(j)}, \xi_s^{(j)}, \xi_r^{(j)})$ for $j = 1, ..., 1,000$ under the assumption that (ξ_s, ξ_r) are mutually independently distributed and follow a Normal distribution with mean zero, while ϵ follows the standard type I extreme value distribution. We also assume that, conditional on the observed attributes, ϵ is uncorrelated with the unobserved shocks that govern the trading market, ξ_M, so that we can focus on studying selection bias driven by government preferences for bond complexity.

Note that the covariances of ϵ with (ξ_s, ξ_r), denoted by $\sigma_{\epsilon,s}$ and $\sigma_{\epsilon,r}$, are key parameters that govern the extent of selection bias: in the extreme, if ϵ was independent of (ξ_r, ξ_s) issuers choosing negotiation would be indistinguishable from those opting for auctions, conditional on observable attributes. To simplify the analysis, we consider two polar cases, leading to a large extent of selection bias: Case 1, where issuers with the highest value for complexity opt into negotiation $(\sigma_{\epsilon,s} > 0, \sigma_{\epsilon,r} = 0)$ and Case 2, where issuers with the highest marginal cost of financing go for negotiation $(\sigma_{\epsilon,s} = 0, \sigma_{\epsilon,r} > 0)$. Also note that, for a given value of $\sigma_{\epsilon,s}$ $(\sigma_{\epsilon,r})$, the larger the standard deviation of ξ_s (ξ_r) becomes, the larger the selection bias gets. When these standard deviations are large, the unobserved attributes that explain selection become a bigger driver of the issuing government marginal cost of financing and, therefore, of the choice of coupon rate and complexity. Given this observation, for Case 1, which focuses on selection driven by ξ_s, we pick a large value for the standard deviation of ξ_s. Instead, for Case 2, which focuses on selection driven by ξ_r, we pick a large value for the standard deviation of ξ_s.[11]

Given our bond, we use the draws $(\epsilon^{(j)}, \xi_s^{(j)}, \xi_r^{(j)})$, together with the estimates of δ, our model parameter estimates, as well as the estimates for the unobserved attributes of the trading market, $\hat{\xi}_M$ to simulate the chosen method of sale and the equilibrium bond design.[12] In doing so, we use the estimates of δ and our model parameter estimates, as well as the estimates for the unobserved attributes of the trading market, $\hat{\xi}_M$. Note that selection bias does not apply to the estimation of the

[11] Specifically, in Case 1 we set $\sigma_{\epsilon,s} = 0.75$ and $\sigma_{\xi_r} = 0.1$. To pin down the variance of ξ_s in Case 1, we choose the highest variances such that c_0 is positive for at least 97% of the simulated bonds, which correspond to $\sigma_{\xi_s} = 0.581$. By the same token, in Case 2, we set $\sigma_{\epsilon,r} = 0.75$, $\sigma_{\xi_s} = 0.1$, and $\sigma_{\xi_r} = 1.135$.

[12] As described in Section 2.2, the way bonds are designed at issuance differs by method of sale. However, the purpose of this exercise is to study the extent of potential selection bias, not the role of the institutional features that shape bond design under negotiation or auctions. Therefore, we use the same model to simulate equilibrium bond design for bonds, regardless of the method of sale.

trading market parameters and $\hat{\xi}_M$, because the first-step parameter estimation uses within-bond variation across transactions and the moment conditions used for the second-step estimation are valid given our assumption that ξ_M is uncorrelated with ϵ, conditional on observables. The government preference parameters, however, are subject to selection bias, given the nonzero correlation between ϵ and ξ_G.

C.3.3. *Selection Bias in Estimates and Counterfactual Results.* Table A7 presents the simulation results for both Case 1 and Case 2. Allowing for nonzero correlation between ϵ and ξ_s (ξ_r) results in a much larger average value of $\xi_s^{(j)}$ ($\xi_r^{(j)}$) for negotiated bonds, 0.547 (1.043), about one standard deviation of $\xi_s^{(j)}$ ($\xi_r^{(j)}$) away from zero. This translates into a sizeable digression of the marginal financial cost, $c_0^{(j)}$, and its derivative with respect to complexity, $\partial c_0^{(j)}/\partial s$, for the negotiated bonds, compared to all bonds, especially for Case 1 (3.334 vs. 2.212 and 0.633 vs. 0.118). This is by construction, as we choose values for the simulation so that the differences in the resulting $c_0^{(j)}$ (and $\partial c_0^{(j)}/\partial s$) values are as large as possible depending on the method of sale.

However, despite that the governments with high c_0 would choose to use negotiation, the effects of such selection on the equilibrium bond designs are relatively limited. For Case 1, the average complexity index for negotiated bonds is 1.977, lower than that of all bonds by 0.248. This difference is about half of the standard deviation of the complexity index in our negotiated bond sample (Table 1). Similarly, the average coupon rate for negotiated bonds is 295 basis points, lower than that of all bonds by 43 basis points, less than half of the standard deviation in the data.

These patterns are not specific to the bond studied in the simulation exercise, and reflect that, given our trading market parameter estimates, the equilibrium bond design is much more sensitive to the underwriter's value of the bond, than to issuer costs. Therefore, we argue that, even in the scenario when high-cost issuers who value complexity tend to choose negotiation, the predicted trading market outcomes and investor surplus under a counterfactual policy would likely be robust, although the implications on issuer costs would not be.

Appendix D. Modelling Revolving-door Regulations

The empirical findings in Section 4.1 and Appendix B.2 imply that revolving-door regulations reduces the use of nonstandard provisions in bonds. Moreover, Table 3 in Section 4.1 provides suggestive evidence that such regulation does not affect the

Table A7. Simulation Exercise on Selection Bias

	Case 1		Case 2	
Average values (standard error)	All	Negotiated	All	Negotiated
Marginal financial cost for issuers				
$c_0^{(j)}$	2.212	3.334	2.315	3.368
	(0.039)	(0.055)	(0.037)	(0.055)
$\partial c_0^{(j)}/\partial s$	0.118	0.633	0.131	0.127
	(0.018)	(0.025)	(0.003)	(0.006)
Unobserved component for c_0				
$\xi_s^{(j)}$	0.003	0.547	-0.003	-0.006
	(0.018)	(0.026)	(0.003)	(0.006)
$\xi_r^{(j)}$	-0.007	-0.009	-0.018	1.043
	(0.003)	(0.006)	(0.036)	(0.054)
Equilibrium bond design				
Complexity index ($s^{(j)}$)	1.225	0.977	1.399	1.378
	(0.015)	(0.032)	(0.009)	(0.017)
Coupon rate ($r^{(j)}$, basis points)	338.0	295.1	337.9	309.3
	(3.0)	(4.7)	(3.1)	(5.4)
Number of simulated bonds	1,000	266	1,000	266

Notes: This table reports the simulation exercise to study how allowing for a large correlation between unobserved factors for the choice of the method of sale and for the marginal cost of financing to the issuer. Both cases use the estimates from the main analysis and focus on a bond from our sample, with a low predicted probability of negotiation, 0.244. For Case 1, the correlation between ϵ and ξ_s is 0.75 and the standard deviation of ξ_s is high, 0.581, while the standard deviation of ξ_r is low, 0.1. For Case 2, on the other hand, the correlation between ϵ and ξ_r is 0.75 and the variance of ξ_r is high, 1.135, while the variance of ξ_s is low, 0.1.

investor demand or the local government behavior in managing credit risk or issuing bonds. This implies that the government cost of paying debt is not directly influenced by the regulations. To explain these findings, we propose that revolving-door regulations may affect the extent to which officials internalize the payoff of the underwriter from trades, V_U, when negotiating over bond design upon its origination.[13] Under an alternative model, the officials may internalize the net payoff of the underwriter, $V_U - F$, under constraints on bond price F. Below, we show that these two models are observationally equivalent in the sense that they both can rationalize the same

[13]Specifically, our model allows that revolving-door regulations, denoted by an indicator variable h, affects the weight parameter, ψ, and that officials' payoff is the weighted sum of the government cost of paying $A(1 + rT)$ and the underwriter's payoff from trading the bond, V_U.

equilibrium bond design. In addition, we provide comparative statics consistent with our main finding in Section 4.1 and heterogeneous effects in Appendix B.3.

D.1. **Two Models.** Let us consider a simplified version of our model where bond design is one-dimensional, over s. The Nash bargaining problem is

$$\max_{(s,F)} \left[F - c(s) + \psi V_U(s)\} - J_G\right]^{\rho} \left[V_U(s) - F - J_U\right]^{1-\rho}, \tag{A.4}$$

subject to

$$P_G(s, F, \psi, J_G) \equiv F - c(s) + \psi V_U(s) - J_G \geq 0, \tag{A.5}$$

$$P_U(s, F, J_U) \equiv V_U(s) - F - J_U \geq 0. \tag{A.6}$$

The first order conditions, with respect to s and F respectively, are

$$\rho P_G^{\rho-1} P_U^{1-\rho}[-c'(s) + \psi V_U'(s)] + (1-\rho) P_G^{\rho} P_U^{-\rho} V_U'(s) = 0,$$
$$\rho P_G^{\rho-1} P_U^{1-\rho} - (1-\rho) P_G^{\rho} P_U^{-\rho} = 0,$$

where P_G and P_U denote the surpluses relative to the outside options of the officials and the underwriter as defined in (A.5)–(A.6). Rearranging them leads to

$$\frac{(1-\rho)V_U'(s)}{\rho[c'(s) - \psi V_U'(s)]} = \frac{P_U(s, F, J_U)}{P_G(s, F, \psi, J_G)} = \frac{1-\rho}{\rho}, \tag{A.7}$$

where the first equality derives from the first FOC and and the second one from the second FOC. Focusing on the equality of the two ends of (A.7), we have

$$(1+\psi)V_U'(s) = c'(s). \tag{A.8}$$

Note ψ affects the equilibrium level of s. For example, suppose $V_U'(s)$ is decreasing in s and $c'(s)$ is increasing in s. Then a higher $\psi > 0$ leads to a more complex bond.

The alternative model where the officials internalize the underwriter's net payoff with weight ψ where the bond price F is constrained can be written as follows:

$$\max_{(s,F)} \left[F - c(s) + \psi \left\{V_U(s) - F\right\} - J_G\right]^{\rho} \left[V_U(s) - F - J_U\right]^{1-\rho}, \tag{A.9}$$

subject to

$$F \leq \bar{F}, \tag{A.10}$$

$$\tilde{P}_G(s, F, \psi, J_G) \equiv F - c(s) + \psi \left\{V_U(s) - F\right\} - J_G \geq 0, \tag{A.11}$$

$$P_U(s, F, J_U) \geq 0. \tag{A.12}$$

If the constraint on F, (A.10), is not binding, then the first order conditions with respect to (s, F) can be written as

$$\frac{(1-\rho)V_U'(s)}{\rho[c'(s) - \psi V_U'(s)]} = \frac{P_U(s, F, J_U)}{\tilde{P}_G(s, F, \psi, J_G)} = \frac{1-\rho}{\rho(1-\psi)}. \tag{A.13}$$

Rearranging terms in (A.13), we have

$$V_U'(s) = c'(s),$$

where the value of ψ does not affect the bond design.

On the other hand, suppose the constraint on F is binding so that the equilibrium F is $\bar{F}$. Then the following inequality holds

$$\frac{P_U(s, \bar{F}, J_U)}{\tilde{P}_G(s, \bar{F}, \psi, J_G)} \geq \frac{1-\rho}{\rho(1-\psi)}, \tag{A.14}$$

and the FOC with respect to s becomes

$$\frac{(1-\rho)V_U'(s)}{\rho[c'(s) - \psi V_U'(s)]} = \frac{P_U(s, \bar{F}, J_U)}{\tilde{P}_G(s, \bar{F}, \psi, J_G)}.$$

Rearranging terms in the above equation, we have

$$\left(\frac{(1-\rho)\tilde{P}_G(s, \bar{F}, \psi, J_G)}{\rho P_U(s, \bar{F}, J_U)} + \psi \right) V_U'(s) = c'(s). \tag{A.15}$$

Fix the underwriter's payoff from trades, $V_U(\cdot)$, outsides options J_G and J_U, the bond price upper bound $\bar{F}$, and two bargaining parameters, (ρ, ψ). In the prior model, suppose s^* satisfies (A.8) for a given cost function, $c(\cdot)$. Now consider the following alternative financial cost function, denoted by $\tilde{c}(\cdot)$:

$$\tilde{c}(s) = \frac{1}{1+\psi} \left(\frac{(1-\rho)\tilde{P}_G(s^*, \bar{F}, \psi, J_G)}{\rho P_U(s^*, \bar{F}, J_U)} + \psi \right) c(s).$$

If we replace $c'(s)$ with $\tilde{c}'(s)$, then s^* also satisfies (A.15). Given that we observe bond design s (but not F), our observational equivalence claim for the two above models holds. This argument can be extended if we also observe bond price.

D.2. **Comparative Statics.** Using the first model considered in the previous section, we show that the equilibrium level of bond complexity increases with the weight parameter value, ψ, if complexity increases the underwriter's payoff from trading. Using the Implicit Function Theorem, we take the derivative with respect to ψ in both sides of (A.8) to obtain

$$V_U'(s) + (1+\psi)V''(s)\frac{\partial s}{\partial \psi} = c''(s)\frac{\partial s}{\partial \psi}.$$

Rearranging terms we have

$$\{(1+\psi)V''(s) - c''(s)\}\,\frac{\partial s}{\partial \psi} = -V_U'(s).$$

Note the second order condition must hold, thus $(1+\psi)V''(s) - c''(s) < 0$. Therefore, $\frac{\partial s}{\partial \psi} > 0$ if $V_U'(s) > 0$. Put it differently, as the officials' weight for the underwriter increases, the equilibrium bond design is more complex as long as complexity benefits the underwriter's payoff from trades.

In addition, we look at the relationship between bond complexity and the size of its influence on the underwriter's payoff from trades, $V_U'(s)$. To facilitate our discussion, let us parameterize it by $V_U'(s;\alpha)$ where $\frac{\partial}{\partial \alpha}V_U'(s;\alpha) > 0$. Similarly as above, we take the derivative with respect to α in both sides of (A.8) to obtain

$$(1+\psi)\left\{V''(s)\frac{\partial s}{\partial \alpha} + \frac{\partial}{\partial \alpha}V_U'(s;\alpha)\right\} = c''(s)\frac{\partial s}{\partial \alpha}.$$

Rearranging terms we have

$$\{(1+\psi)V''(s) - c''(s)\}\,\frac{\partial s}{\partial \alpha} = -(1+\psi)\frac{\partial}{\partial \alpha}V_U'(s;\alpha).$$

Because $(1+\psi)V''(s) - c''(s) < 0$, $\frac{\partial}{\partial \alpha}V_U'(s;\alpha) > 0$ by assumption, and $\psi > 0$, we conclude that $\frac{\partial s}{\partial \alpha} > 0$, implying that as the benefit of complexity as perceived by the underwriter increases, the equilibrium bond design gets more complex.

Appendix E. Characterizing Equilibrium in the Trading Market

Given the value function of dealers and investors, as well as the optimal meeting rate that dealers choose (Section 5.2), we write the equilibrium quantity for trades with an investor, q_I, and the equilibrium quantity for inter-dealer trades, q_D:

$$q_I(\tau;u,y') = \arg\max_q \left\{W(\tau;a'+q,\nu') - W(\tau;y) + V\left(\tau;a-q,b+1,\phi_0\right) - V\left(\tau;u\right)\right\}, \tag{A.16}$$

$$q_D(\tau;u,u') = \arg\max_q \left\{V(\tau;a+q,b,\phi_0) - V(\tau;u) + V\left(\tau;a'-q,b',\phi_0'\right) - V\left(\tau;u'\right)\right\}, \tag{A.17}$$

The total—not unit—price in a transaction implements a division of the gain:

$$p_I(\tau; u, y') = \rho \max_q \Big\{ W(\tau; a' + q, \nu') - W(\tau; y') - V(\tau; a - q, b + 1, \phi_0) + V(\tau; u) \Big\}, \tag{A.18}$$

$$p_D(\tau; u, u') = (1-\rho_D) \max_q \Big\{ V(\tau; a+q, b, \phi_0) - V(\tau; u) - V(\tau; a' - q, b, \phi_0) + V(\tau; u') \Big\}. \tag{A.19}$$

Given the equilibrium meeting rates and trading quantities, the equilibrium path of the investor state distribution satisfies:

$$\begin{aligned} -\dot{\Phi}_I(\tau; u) \quad &= \quad -\alpha \Phi_I(\tau; a, \nu) \left[1 - F(\nu|\tau)\right] + \alpha \int_{-\infty}^{a} \int_{\nu}^{\infty} \Phi_I(\tau; da, d\nu') F(\nu'|\tau) \\ &- \quad \int_{-\infty}^{\nu} \int_{-\infty}^{a} \int_{u} \lambda(\tau; u) \mathbb{I}_{\{\tilde{a} + q_I(\tau; u, \tilde{a}, \tilde{\nu}) > a\}} \Phi_D(\tau; du) \Phi_I(\tau; d\tilde{a}, d\tilde{\nu}) \\ &+ \quad \int_{-\infty}^{\nu} \int_{a}^{\infty} \int_{u} \lambda(\tau; u) \mathbb{I}_{\{\tilde{a} + q_I(\tau; u, \tilde{a}, \tilde{\nu}) \leq a\}} \Phi_D(\tau; du) \Phi(\tau; d\tilde{a}, d\tilde{\nu}). \end{aligned} \tag{A.20}$$

The term $-\dot{\Phi}_I(\tau; a, \nu)$ captures the net inflows of investors from $t = T - \tau$ to $t' = t + \epsilon$ for a small $\epsilon > 0$. The first two terms in the right hand side of (A.20) capture the flow of investors due to the idiosyncratic taste shock; and the last two terms are associated with trades. Specifically, the first term represents the outflow of investors who draw a new taste type greater than ν, which occurs with probability $\alpha [1 - F(\nu|\tau)]$. The second term shows the inflow of investors who draw a new taste type less than ν and have inventory less than a. The third term presents the outflow of investors whose asset holding after a trade becomes greater than a; and the fourth term reflects the inflow of investors whose post-trade inventory becomes less than a.

To define the equilibrium path of the dealer state distribution, it is useful to make a change of variable. In particular, we denote by $\varphi(b)$ the dealer's cost advantage associated with trading experience b: $\varphi(b) = \exp(-\phi_1 \log(b+1))$. With this notation, each dealer' state is summarized by the vector $u = (a, \varphi, \phi_0)$. Moreover, after a trade with an investor the dealers' state evolves to $\varphi(b)' = \exp(-\phi_1 \log(b + 1))$. Then the dealers' state distribution must satisfy the following law of motion:

$$
\begin{aligned}
&-\dot{\Phi}_D(\tau;u) && \text{(A.21)}\\
=\;& -\int_0^{\varphi}\int_{-\infty}^{a}\int_y \lambda(\tau;\tilde{u})\max\left[\mathbb{I}_{\{\tilde{a}-q_I(\tau;y,\tilde{u})>a\}},\mathbb{I}_{\{\tilde{\varphi}'>\varphi\}}\right]\Phi_I(\tau;dy)\Phi_D(\tau;d\tilde{u})\\
+\;& \int_0^{\varphi}\int_{a}^{\infty}\int_y \lambda(\tau;\tilde{u})\min\left[\mathbb{I}_{\{\tilde{a}-q_I(\tau;y,\tilde{u})\le a\}},\mathbb{I}_{\{\tilde{\varphi}'\le\varphi\}}\right]\Phi_I(\tau;dy)\Phi_D(\tau;d\tilde{u})\\
+\;& \int_{\varphi}^{\infty}\int_{\tilde{a}}\int_y \lambda(\tau;\tilde{u})\min\left[\mathbb{I}_{\{\tilde{a}-q_I(\tau;y,\tilde{u})\le a\}},\mathbb{I}_{\{\tilde{\varphi}'\le\varphi\}}\right]\Phi_I(\tau;dy)\Phi_D(\tau;d\tilde{u})\\
-\;& \lambda_D\int_0^{\varphi}\int_{-\infty}^{a}\int_{u'} \mathbb{I}_{\{\tilde{a}+q_D(\tau;\tilde{u},u')>a\}}\Phi_D(\tau;du')\Phi_D(\tau;d\tilde{u})\\
+\;& \lambda_D\int_0^{\varphi}\int_{a}^{\infty}\int_{u'} \mathbb{I}_{\{\tilde{a}+q_D(\tau;\tilde{u},u')\le a\}}\Phi_D(\tau;du')\Phi_D(\tau;d\tilde{u}).
\end{aligned}
$$

The initial conditions for the investors' distribution is that investors do not hold the asset at the beginning of the trading game:

$$
\Phi_I(T;a,\nu)=\mathbb{I}_{\{a\ge 0\}}F_{\nu|\tau}(\nu|T). \tag{A.22}
$$

The initial condition for Φ_D requires that the underwriter, whose search cost parameter is denoted by $\phi_{0,U}$, holds all bonds in the beginning of the trades. To approximate this condition, we denote by m_U the (small) mass of the underwriter and write the initial condition:

$$
\Phi_D(T;a,b,\phi_0)=\begin{cases}\mathbb{I}_{\{a\ge 0,b\ge 0\}}F_{\phi_0}(\phi_0), & \text{if } \phi_0\neq\phi_{0,U}\\ (1-m_U)\mathbb{I}_{\{a\ge 0,b\ge 0\}}F_{\phi_0}(\phi_0)+m_U\mathbb{I}_{\{a\ge A,b\ge 0\}}F_{\phi_0}(\phi_0), & \text{if } \phi_0=\phi_{0,U}\end{cases} \tag{A.23}
$$

Now, an equilibrium in the trading market is defined as follows.

Definition E.1. *An equilibrium in the trading market is (i) a path for the distribution of investors' state, $\Phi_I(\tau;y)$, and a path for the distribution of dealers' state, $\Phi_D(\tau;u)$, (ii) value functions for investors and dealers, $W(\tau;y)$ and $V(\tau;u)$, (iii) dealer-to-investor meeting rates $\lambda(\tau;u)$, (iv) dealer-to-investor trade prices and quantities, $p_I(\tau;y,u)$ and $q_I(\tau;y,u)$ and dealer-to-dealer trade prices and quantities, $p_D(\tau;u,u')$ and $q_D(\tau;u,u')$, such that*

1. *(i) follows (A.20)–(A.21) subject to (A.22)–(A.23), given (ii)–(iv);*
2. *(ii) satisfies (9), (11), and the terminal values in Section 5, given (i);*
3. *(iii) satisfies (10), given (i)–(ii);*

4. (iv) satisfies (A.16)–(A.19), given (ii).

Appendix F. The Estimator

This section provides a more detailed discussion of the first and third steps of the estimation.

F.1. **Step 1.** We provide the moment conditions and the likelihood function used in estimating the first-step parameters for each bond, $\hat{\theta}_i$, present the distribution of the first-step estimates across bonds, and describe the model fit.

F.1.1. *First-step Estimator.* We first estimate the dealer state distribution, denoted by $\hat{\Phi}_D(\tau; u)$ using a Kernel estimator. We then estimate θ_i by minimizing the weighted average of three sets of components. The first group of components relates to the joint distribution of price, quantity, and dealer inventory for transactions between dealers ($d_{ij} = 0$). Let $p_D(\tau; u, u'|\theta)$ and $q_D(\tau; u, u'|\theta)$ denote the inter-dealer trading prices and quantities defined in (A.17) and (A.19), and let $\Phi_D(\tau; u)$ denote the distribution of dealer states $u = (a, b, g)$ defined in (A.21). The moment conditions are based on the average inter-dealer trading price and the covariance of trading price (quantity) with a dealer's inventory, over the period that we observe trades, denoted by $\bar{t}_i$, which is often less than the bond's maturity, T_i, given our data. Denoting the inventory of a dealer participating in transaction j by a_{ij}, we have the following conditions:

$$\begin{aligned}
\mathbb{E}\left(\left[p_{ij} - \int_{T_i-\bar{t}_i}^{T_i}\int_{u'}\int_{u} p_D(\tau; u, u'|\theta_i) d\hat{\Phi}_D(\tau; du) d\hat{\Phi}_D(\tau; du') d\tau\right](1-d_{ij})\right) &= 0,\\
\mathbb{E}\left(\left[p_{ij}a_{ij} - \int_{T_i-\bar{t}_i}^{T_i}\int_{u'}\int_{u} p_D(\tau; u, u'|\theta_i) a d\hat{\Phi}_D(\tau; du) d\hat{\Phi}_D(\tau; du') d\tau\right](1-d_{ij})\right) &= 0,\\
\mathbb{E}\left(\left[q_{ij}a_{ij} - \int_{T_i-\bar{t}_i}^{T_i}\int_{u'}\int_{u} q_D(\tau; u, u'|\theta_i) a d\hat{\Phi}_D(\tau; du) d\hat{\Phi}_D(\tau; du') d\tau\right](1-d_{ij})\right) &= 0,
\end{aligned}$$

The second group of components concerns the joint distribution of price, quantity, inventory, and trading network for dealer-to-investor trades ($d_{ij} = 1$). Let $p_I(\tau; u, y|\theta)$ and $q_I(\tau; u, y|\theta)$ denote the trading prices and quantities defined in (A.16) and (A.18), and let $\Phi_I(\tau; y|\theta)$ be the distribution of investors' states $y = (\nu, a)$ defined in (A.20). We define the distribution of dealer state, conditional on meeting and trading with an investor, by $\tilde{\Phi}_D$:

$$\tilde{\Phi}_D(\tau; u|\theta) = \frac{\lambda(\tau; u|\theta)\hat{\Phi}_D(\tau; u)}{\int \lambda(\tau; u|\theta) d\hat{\Phi}_D(\tau; u)}.$$

We rely on moment conditions related to the first two moments of trading price and quantity:

$$\begin{aligned}
\mathbb{E}\left(\left[p_{ij} - \int_{T_i-\bar{t}_i}^{T_i}\int_y\int_u p_I(\tau;u,y|\theta_i)d\tilde{\Phi}_D(\tau;du|\theta_i)d\Phi_I(\tau;dy|\theta_i)d\tau\right]d_{ij}\right) &= 0,\\
\mathbb{E}\left(\left[q_{ij} - \int_{T_i-\bar{t}_i}^{T_i}\int_y\int_u q_I(\tau;u,y|\theta_i)d\tilde{\Phi}_D(\tau;du|\theta_i)d\Phi_I(\tau;dy|\theta_i)d\tau\right]d_{ij}\right) &= 0.
\end{aligned}$$

$$\begin{aligned}
\mathbb{E}\left(\left[p_{ij}^2 - \int_{T_i-\bar{t}_i}^{T_i}\int_y\int_u p_I(\tau;u,y|\theta_i)^2 d\tilde{\Phi}_D(\tau;du|\theta_i)d\Phi_I(\tau;dy|\theta_i)d\tau\right]d_{ij}\right) &= 0,\\
\mathbb{E}\left(\left[q_{ij}^2 - \int_{T_i-\bar{t}_i}^{T_i}\int_y\int_u q_I(\tau;u,y|\theta_i)^2 d\tilde{\Phi}_D(\tau;du|\theta_i)d\Phi_I(\tau;dy|\theta_i)d\tau\right]d_{ij}\right) &= 0.
\end{aligned}$$

Moreover, we match the covariance of trading prices and quantities with the dealer's inventory a and trading network b. Denoting the inventory and network of the dealer participating in trade j by (a_{ij}, b_{ij}), we present the moment conditions as follows:

$$\begin{aligned}
\mathbb{E}\left(\left[p_{ij}a_{ij} - \int_{T_i-\bar{t}_i}^{T_i}\int_y\int_u p_I(\tau;u,y|\theta_i)a d\tilde{\Phi}_D(\tau;du|\theta_i)d\Phi_I(\tau;dy|\theta_i)\right]d_{ij}\right) &= 0,\\
\mathbb{E}\left(\left[q_{ij}a_{ij} - \int_{T_i-\bar{t}_i}^{T_i}\int_y\int_u q_I(\tau;u,y|\theta_i)a d\tilde{\Phi}_D(\tau;du|\theta_i)d\Phi_I(\tau;dy|\theta_i)\right]d_{ij}\right) &= 0,\\
\mathbb{E}\left(\left[p_{ij}b_{ij} - \int_{T_i-\bar{t}_i}^{T_i}\int_y\int_u p_I(\tau;u,y|\theta_i)b d\tilde{\Phi}_D(\tau;du|\theta_i)d\Phi_I(\tau;dy|\theta_i)\right]d_{ij}\right) &= 0,\\
\mathbb{E}\left(\left[q_{ij}b_{ij} - \int_{T_i-\bar{t}_i}^{T_i}\int_y\int_u q_I(\tau;u,y|\theta_i)b d\tilde{\Phi}_D(\tau;du|\theta_i)d\Phi_I(\tau;dy|\theta_i)\right]d_{ij}\right) &= 0.
\end{aligned}$$

The last component of our objective function is the negative value of the log likelihood of the timing of each observed transaction. Let $\tau_{i,-1}$ denote the time at which the most recent trade by the dealer of trade j prior to that trade, and let us denote the dealer's state for trade j by $u_{ij} \equiv (a_j, b_j, g_j)$, which is observed from the data. We denote the equilibrium dealer-to-investor meeting rate at time τ_{ij}, as characterized by (10), by $\lambda(\tau_{ij}; u_{ij}|\theta_i)$, and recall that the inter-dealer meeting rate, denoted by $\lambda_{D,i}$, is a part of trading market parameters, θ_i. The log-likelihood of τ_{ij} conditional on $(\tau_{ij,-1}, u_{ij}, d_{ij})$ is

$$\begin{aligned}
\log\mathcal{L}(\tau_{ij}|\tau_{ij,-1}, u_{ij}, d_{ij}, \theta_i) &= d_{ij}\left[\log\{\lambda(\tau_{ij}; u_{ij}|\theta_i)\} - \int_{\tau_{ij,-1}}^{\tau_{ij}}\lambda(s, u_{ij}|\theta_i)ds\right]\\
&+ (1-d_{ij})\{\log\lambda_{D,i} - (\tau_{ij} - \tau_{ij,-1})\lambda_{D,i}\}. \qquad \text{(A.24)}
\end{aligned}$$

Table A8. The Distribution of First-Step Parameter Estimates

	Mean	SD		Mean	SD
Search cost			*Investor demand*		
$\hat{\phi}_{1,i}$	0.436	0.188	$\hat{\gamma}_{1,i}$	0.047	0.047
	(0.007)	(0.005)		(0.0006)	(0.001)
$\hat{\phi}_{0,0,i}$	838	1,759	$\hat{\gamma}_{2,i}$	0.026	0.023
	(91)	(101)		(0.0006)	(0.001)
$\hat{\phi}_{0,1,i}$	1,374	2,134	$\hat{\kappa}_{I,i}$	0.001	0.003
	(109)	(100)		(0.0002)	(0.0004)
$\hat{\phi}_{0,2,i}$	1,647	2,227	$\hat{\alpha}_i$	1.42	1.05
	(75)	(65)		(0.021)	(0.013)
Dealer preferences			*Bargaining parameter*		
$\hat{v}_D$	0.029	0.036	$\hat{\rho}_i$	0.597	0.203
	(0.0004)	(0.0002)		(0.007)	(0.003)
$\hat{\kappa}_{D,i}$	0.0006	0.002			
	(0.0001)	(0.0004)			

Notes: This table presents the mean and the standard deviation of the first-step parameter estimates, over the bonds used in the estimation. The bootstrapped standard errors are in parentheses.

F.1.2. *First Step Estimates and Fit.* Table A8 reports the average and standard deviation of the first stage estimates across bonds, along with the bootstrapped standard errors for each statistic.

Figure A2 depicts the fit of the model in terms of the average dealers' meeting rate and trading quantity across estimated bonds. The model does a good job of fitting the data. Indeed, the average trading quantity across estimated bonds is \$-69,000, and the simulated one is \$-71,000. Similarly, the average meeting rate over 24 months is 3.3, and the simulated one is 3.05.

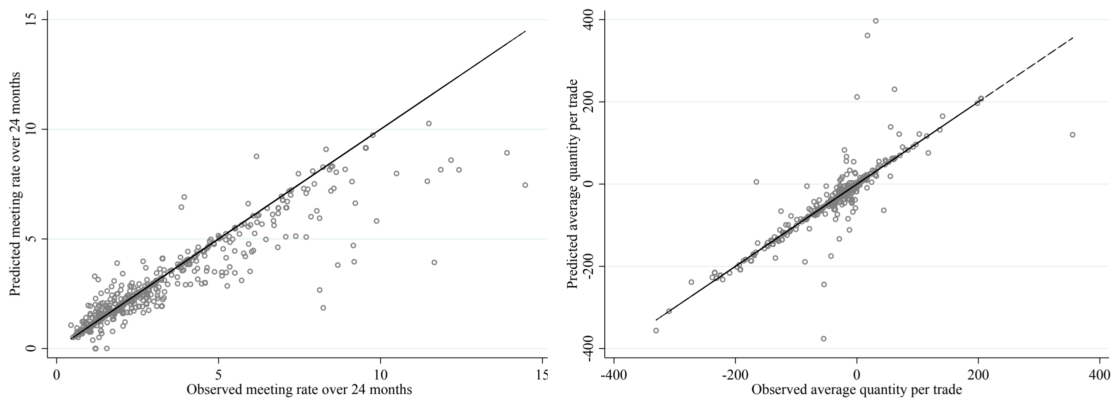
F.2. **Step 3.** We derive the GMM estimator for the government preference parameters, and discuss the implications of our normalization that the officials' weight for their underwriter when revolving-door regulations are in place, $\psi(\mathbf{x}_\psi, 1) = 0$ for all $\mathbf{x}_\psi$.

F.2.1. *Third-step estimator.* This step relies on the first order conditions on (s, r) determined at the negotiation between the issuer and the underwriter, (12) and (13):

$$-\frac{\partial}{\partial s} c_0(s, \mathbf{x}_G, \xi_G) A(1 + rT) + \theta_d + \{1 + \psi(\mathbf{x}_\psi, h)\} \frac{\partial}{\partial s} V_U(s, r, \mathbf{x}_M, \xi_M) = 0,$$

$$-c_0(s, \mathbf{x}_G, \xi_G) AT + \{1 + \psi(\mathbf{x}_\psi, h)\} \frac{\partial}{\partial r} V_U(s, r, \mathbf{x}_M, \xi_M) = 0.$$

FIGURE A2. Goodness of fit



(A) Meeting Rate

(B) Trading Quantity

Notes: In Panel (A), each dot represents the average observed and predicted meeting rates for each bond used in the estimation. In Panel (B), each dot shows the average observed and predicted trading quantities for each bond. For both graphs, the 45-degree line is presented to facilitate the comparison.

We plug our specifications of c_0 and $\psi(\mathbf{x}_\psi, 0)$, (19) and (20) in the above equations, and replace V_U with its estimate based on the previous steps, $\hat{V}_U(s, r, \mathbf{x}_M, \hat{\xi}_M) \equiv V_U(s, r, \mathbf{x}_M, \hat{\theta}, \theta_\gamma, \hat{\theta}_{\phi_0}, \hat{\theta}_{\phi_M}, \hat{\xi}_M)$. Then solving for ξ_s from (12) gives us

$$\begin{aligned} & \xi_s(s, r, \mathbf{x}, h, \hat{\xi}_M; \theta_c, \theta_d, \theta_\psi) \\ = \quad & -(\theta_{c,s_1}\mathbf{x}_G + 2\theta_{c,s_2}s) + \frac{\theta_d}{A(1+rT)} + \frac{1 + (1-h)\exp(\mathbf{x}_\psi\theta_\psi)}{A(1+rT)} \frac{\partial}{\partial s}\hat{V}_s(s, r, \mathbf{x}_M, \hat{\xi}_M). \end{aligned} \tag{A.25}$$

Then, solving for ξ_r from (12) and plugging in $\xi_s(s, r, \mathbf{x}, h, \hat{\xi}_M; \theta_c, \theta_d, \theta_\psi)$ for ξ_s gets

$$\begin{aligned} & \xi_r(s, r, \mathbf{x}, h, \hat{\xi}_M; \theta_c, \theta_d, \theta_\psi) \\ = \quad & -\Big(\theta_{c,s_1}s\mathbf{x}_G + \theta_{c,s_2}s^2 + \theta_{c,x}\mathbf{x}_G + s\xi_s(s, r, \mathbf{x}, h, \hat{\xi}_M; \theta_c, \theta_d, \theta_\psi)\Big) \\ + \quad & \frac{1 + (1-h)\exp(\mathbf{x}_\psi\theta_\psi)}{AT} \frac{\partial}{\partial r}\hat{V}_s(s, r, \mathbf{x}_M, \hat{\xi}_M). \end{aligned} \tag{A.26}$$

We then employ (21) and derive the following moment conditions:

$$\mathbb{E}\left(\xi_s(s, r, \mathbf{x}, h, \hat{\xi}_M; \theta_c, \theta_d, \theta_\psi)\,[\mathbf{x}_G, \mathbf{z}, h, h\mathbf{x}_\psi]\right) = 0, \tag{A.27}$$

$$\mathbb{E}\left(\xi_r(s, r, \mathbf{x}, h, \hat{\xi}_M; \theta_c, \theta_d, \theta_\psi)\,[\mathbf{x}_G, \mathbf{z}, h, h\mathbf{x}_\psi]\right) = 0, \tag{A.28}$$

where $\xi_s(\cdot)$ and $\xi_r(\cdot)$ are defined in (A.25) and (A.26). Note that, for these conditions to hold, we assume that the estimation error from the previous steps is uncorrelated with $(\mathbf{x}_G, \mathbf{z}, h)$. Our GMM estimator for $(\theta_c, \theta_d, \psi)$ is based on (A.27) and (A.28).

F.2.2. *Normalization of the Officials' Weight Parameter.* To simplify our discussion, let us fix $\mathbf{x}$ and ξ_M, where the latter is estimated in previous steps. Suppose there is a variation in revolving-door regulations, h, conditional on $(\mathbf{x}, \xi_M)$. With that, we have the following first order conditions, based on (12) and (13), where we suppress the dependence of the objects on $(\mathbf{x}, \xi_M)$ and (s^*, r^*) and (s^{**}, r^{**}) denote the negotiated bond terms with or without the revolving-door regulation:

$$\begin{gathered}
-c_0'(s^*)A(1+rT) + \theta_d + \{1+\psi(1)\}\frac{\partial}{\partial s}V_U(s^*, r^*) = 0, \\
-c_0(s^*)AT + \{1+\psi(1)\}\frac{\partial}{\partial r}V_U(s^*, r^*) = 0, \\
-c_0'(s^{**})A(1+r^{**}T) + \theta_d + \{1+\psi(0)\}\frac{\partial}{\partial s}V_U(s^{**}, r^{**}) = 0, \\
-c_0(s^{**})AT + \{1+\psi(0)\}\frac{\partial}{\partial r}V_U(s^{**}, r^{**}) = 0.
\end{gathered}$$

Noting that the derivatives of V_U are identified in the previous steps, the above becomes a system of four equations and six unknowns, for given $(s^*, r^*, s^{**}, r^{**}, A, T)$:

$$\frac{c_0(s^*)}{1+\psi(1)}, \frac{c_0'(s^*)}{1+\psi(1)}, \frac{c_0(s^{**})}{1+\psi(1)}, \frac{c_0'(s^{**})}{1+\psi(1)}, \frac{\theta_d}{1+\psi(1)}, \frac{1+\psi(0)}{1+\psi(1)}.$$

Thus, combined with parametric assumptions on $c_0(\cdot)$, variation in the derivatives of V_U conditional on $(h, \mathbf{x}, \xi_M)$, that comes from bond supply of neighboring counties $\mathbf{z}$, helps us identify

$$\frac{c_0(\cdot)}{1+\psi(1)}, \frac{\theta_d}{1+\psi(1)}, \frac{1+\psi(1)}{1+\psi(1)}.$$

Therefore, we normalize $\psi(\mathbf{x}_\psi, 1) = 0$ all $\mathbf{x}_\psi$.

Suppose we, instead, set $\psi(\mathbf{x}_\psi, 1) = \psi_1$ for some $\psi_1 > 0$. Under this alternative normalization, the resulting government preferences satisfy

$$\begin{gathered}
\tilde{c}_0(s, \mathbf{x}_G, \xi_G; \theta_c, \psi_1) = (1+\psi_1)c_0(s, \mathbf{x}_G, \xi_G; \theta_c), \\
\tilde{\theta}_d(\theta_d, \psi_1) = (1+\psi_1)\theta_d, \\
\tilde{\psi}(\mathbf{x}_\psi, 0) = \psi_1 + (1+\psi_1)\psi(\mathbf{x}_\psi, 0; \theta_\psi),
\end{gathered}$$

where $c_0(s, \mathbf{x}_G, \xi_G; \theta_c)$, θ_d, and $\psi(\mathbf{x}_\psi, 0; \theta_\psi)$ are the identified preferences under the normalization of $\psi_1 = 0$.

Given this, we explore how our results related to the impact of a standardization policy may be affected by this normalization. Note that the negotiated coupon rate under the standardization policy would be invariant to the normalization by construction: the first order condition for r doesn't depend on ψ_1. This implies that the welfare implications of standardization for underwriters and investors are unaltered. However, the changes to government costs would be scaled up by $(1+\psi_1)$, suggesting that our normalization of $\psi_1 = 0$ leads to the most conservative estimate of government costs. Also note that although the level change in government costs depends on ψ_1, the percentage change doesn't.

F.3. **Bootstrapped Standard Error.** For statistical inference, we employ a bootstrapping method. For the first-step, bond-specific parameter estimates, we draw 200 bootstrap samples where resampling is at the dealer level, with replacement. Let us denote the first-step parameter estimates for bond i based on the m^{th} sample by $\hat{\theta}_i^m$ for $m = 1, ..., 200$. Noting that the second and third steps rely on the first-step estimates $\hat{\theta}_i$ for all bonds, we estimate the remaining parameters by resampling 927 bonds and their accompanying first-step parameter estimates from the m^{th} sample, with replacement.

While the second-step estimation procedure is straightforward as it involves running IV regressions, the third-step GMM estimation procedure requires solving for the derivatives of the underwriter's value function, $\partial V_U(s_i, r_i, \mathbf{x}_{M,i}, \hat{\xi}_{M,i}^m; \hat{\theta}_i^m)/\partial s$ and $\partial V_U(s_i, r_i, \mathbf{x}_{M,i}, \hat{\xi}_{M,i}^m; \hat{\theta}_i^m)/\partial r$, for all bonds i and each the bootstrap sample m. To do this, we need to compute the value function $V_U(s_i, r_i, \mathbf{x}_{M,i}, \hat{\xi}_{M,i}^m; \hat{\theta}_i^m)$ for a few values of (s, r) around the observed (s_i, r_i). With that, the calculation of the bootstrapped standard errors becomes computationally prohibitive.

In order to make progress, we assume that the first-step, bond-level parameter vector, $\hat{\theta}_i$, is asymptotically normally distributed with the variance-covariance matrix, Σ_i, for each bond i:

$$\sqrt{n_i}(\hat{\theta}_i - \theta_{0,i}) \to^d N(0, \Sigma_i),$$

where n_i is the number of transactions for bond i and $\theta_{0,i}$ denotes the true parameter vector. Using the bootstrapped first-step estimates, $\hat{\theta}_i^m$ for $m = 1, ..., 200$, we estimate Σ by employing a maximum likelihood estimator and denote it by $\hat{\Sigma}$.[14]

[14]Given the modest size of the bootstrapped sample, we further impose that the variance-covariance matrix for $\hat{\theta}_i$ is not bond specific.

This asymptotic normality assumption for $\hat{\theta}_i$ allows us to obtain the asymptotic distribution of the derivatives of the underwriter's value function, noting that the derivatives are a continuously differentiable function of θ_i. Employing the Delta method, the derivatives of the underwriter's value function, $\partial V_U(s, r, \mathbf{x}_{M,i}, \hat{\xi}_{M,i}; \hat{\theta}_i)/\partial s$ and $\partial V_U(s, r, \mathbf{x}_{M,i}, \hat{\xi}_{M,i}; \hat{\theta}_i)/\partial r$, for each bond i are asymptotically normally distributed with the variance-covariance matrix $\Sigma_i^V(s, r)$ for each (s, r) point. We estimate this matrix by numerically computing the derivative of $\partial V_U(s, r, \mathbf{x}_{M,i}, \hat{\xi}_{M,i}; \hat{\theta}_i)/\partial s$ and $\partial V_U(s, r, \mathbf{x}_{M,i}, \hat{\xi}_{M,i}; \hat{\theta}_i)/\partial r$ with respect to each element of $\hat{\theta}_i$.[15]

With this asymptotic distribution of the derivatives of the underwriter's value function, we draw them from the distribution for each point (s, r) and for each bond of the m^{th} bootstrapped sample, instead of computing them. This dramatically reduces the computational burden and allows us to estimate the third-step parameters for each m^{th} bootstrapped sample and accordingly the bootstrapped standard errors and confidence intervals.

F.4. **Estimation Sample .** Given that the first-step estimation is conducted at the bond level, we focus on a sub-sample of bonds that we can exploit the panel variation in the revolving-door regulations and also reduce computational burdens. Specifically, we use all bonds from the five states that introduced revolving-door regulations during the period of our study (AR, IN, ME, NM, and VA) and the counties at the borders of these states, resulting in 927 bonds out of the original sample of 13,118. This estimation sample covers 20 states.

Table A9 presents the summary statics of key bond and issuer attributes of this estimation sample as well as the entire sample, respectively. It can be seen that the distributions of these variables within each of the two samples are similar, across almost all dimensions.

For the counterfactual analysis, we draw a stratified subsample from the estimation sample and focus on that sample to understand the overall distribution of the effects of a standardization policy. Although the estimation sample is comparable to the entire sample, we draw the stratified sample to further mimic the latter. To this end, the stratification relies on the distribution of three key bond attributes: coupon rate, complexity index, and transaction frequency. Specifically, we create four bins

[15]Note that $\hat{\xi}_{M,i}$ is determined by the second-step parameters, which are determined by some of the first-step parameters across all bonds, namely $\{\gamma_{1,i}, \gamma_{2,i}, (\phi_{0,g,i})_{g=0,1,2}, \phi_{1,i}\}_{i=1}^N$. When we perturb $\partial V_U/\partial s$ and $\partial V_U/\partial r$ with respect to one of these first-step parameters for bond i (say $\hat{\phi}_{1,i}$), we allow for the second-step parameters and subsequently $\hat{\xi}_{M,i}$ to reflect the change in $\hat{\phi}_{1,i}$.

TABLE A9. Comparison between the Estimation and the Entire Sample

	All			Estimation			Stratified		
	25^{th}	50^{th}	75^{th}	25^{th}	50^{th}	75^{th}	25^{th}	50^{th}	75^{th}
Bond attributes									
Face value (in \$M)	2.91	6.53	14.3	2.93	6.40	17.3	3.02	6.40	13.3
Maturity (in years)[a]	5.55	7.74	10.28	5.64	8.17	10.9	5.53	7.56	10.1
Coupon rate (in pp)[a]	2.32	2.94	3.63	2.53	3.19	3.92	2.39	3.00	3.67
Complexity index[b]	1.00	1.44	1.69	1.00	1.45	1.76	1.00	1.44	1.69
Secondary transactions with investors									
Frequency (for 4 years)	3	10	45	2	10	50	3	9	43
Volume (for 4 years, \$M)	0.30	1.37	5.2	0.30	1.30	6.34	3.55	1.25	5.09
Issuer attributes									
Government revenue (in \$B)	0.10	0.48	1.86	0.09	0.53	10.4	0.08	0.40	3.01
Median household income (in \$K)[c]	45.4	52.7	61.1	43.2	53.3	54.6	41.4	50.4	54.6
Unemployment rate (percent)[c]	6.5	7.8	9.4	7.4	9.5	10.4	7.4	9.2	9.9
Number of observations		13,118			927			386	

Notes: This table presents the 25th, 50th, and 75th percentile of each variable's distribution among the entire sample of bonds, the estimation sample, and the stratified sample used for the counterfactual analysis. *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), plus a dummy indicating that the issue includes multiple bonds. c. The demographic information is at the county level.

for each attribute, using the 25th, 50th, and 75th percentiles of the entire sample as cutoffs, and then obtain the probability that a bond in the sample falls into one of the 4×3 bins. Then, based on these probabilities, we randomly draw a subsample from the estimation sample. As a result, Table A9 shows that the 25th, 50th, and 75th percentiles of the three bond attributes used for the stratification are almost identical between the entire sample and the stratified sample. Remarkably, the distribution of the other variables for which the stratification procedure does not target among the stratified sample resembles the counterpart distribution among the entire sample, more so than the estimation sample.

Appendix G. The Effects of Standardization: Sensitivity Analyses

This section looks at the sensitivity of or results to the investors' substitution across different bonds (Section G.1), the role of call options (Section G.2), and the choice of underwriter.

G.1. **Investor Substitution.** We estimate the demand for each bond separately, holding fixed the value of alternative investment opportunities that an investor may choose from. This does not bias our estimates, but it may warrant some important caveats for the interpretation of the counterfactual policies that we study. Specifically, when we estimate the impact of standardization policy, our approach only allows us to simulate a "partial equilibrium" impact of the policy, where we hold the opportunity cost constant, thus assuming that an investor's alternatives do not respond to the policy. This section explores how our findings may change if we allow all bonds to be simultaneously subject to the policy. Section G.1.1 describes a few institutional features of the municipal bonds market that shape investors' substitution across bonds. Taken together, these features suggest that investors' substitution across bonds is limited. Section G.1.2 then discusses how our model reflects these features related to investors' substitution behavior in a parsimonious way, allowing the opportunity cost of holding a bond $\kappa_{I,i}$ to depend flexibly on the desirability of alternative investment opportunities. If standardization were imposed on all bonds simultaneously, it would change such a bond-specific opportunity cost; therefore, Section G.1.3 studies how sensitive our counterfactual results are to that parameter.

G.1.1. *Investor Behavior in the Municipal Bond Market.* One of the key features of the municipal bond market is the dominance of individual retail investors, largely due to income tax exemption based on residence: municipal bond interest income is exempt from federal and, for in-state residents, state taxes. The local nature of these tax advantages restricts the extent of investors' substitution across bonds; for example, investors looking for federal/state tax savings would primarily look for their home-state bonds. Another limitation in investors' substitution behavior relates to their tendency to "buy-and-hold" municipal bonds; they typically buy new bonds at issuance and hold them until maturity, unless they are in (unexpected) need of liquidity.[16]

To confirm this characterization of investor behavior using our data, we study how municipal bond trading in the secondary market responds to an increase in the availability of alternative municipal bonds, i.e., new bonds issued by local governments in the same state. Specifically, we consider the following specification at the state (s) and month (t) level:

$$\log(\text{Secondary sales}_{s,t}) = \beta \log(\text{Primary offering}_{s,t}) + \gamma \mathbf{x}_{s,t} + \phi_s + \mu_t + \epsilon_{s,t},$$

where Secondary sales$_{s,t}$ represents the volume of sales to investors (net of purchases from investors) in month t of existing bonds issued in state s; Primary offering$_{s,t}$ measures the total face value of the new bonds issued in the state during the month;

[16] U.S. Securities Exchange Commission (2012).

TABLE A10. Do Investors Buy and Hold Their Municipal Bonds?

	Secondary market sales volume (log)			
	Total		Net	
	(1)	(2)	(3)	(4)
Issuance volume (log)	0.021***	0.023***	0.005	0.004
	(0.005)	(0.004)	(0.003)	(0.003)
State attributes†	No	Yes	No	Yes
Year-month FE, State FE	Yes	Yes	Yes	Yes
Number of observations	2,544	2,544	2,544	2,544
R^2	0.649	0.804	0.257	0.234

Notes: This table reports OLS estimates at the state-month level, for the period of 2010-2013. The dependent variables are the logarithm of the total volume of sales of existing bonds to investors in the secondary market (Columns (1) and (2)) and the net volume of sales (Columns (3) and (4)). The key independent variable is the logarithm of the volume of new bond issues. Standard errors are adjusted for clustering at the state level, and are provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. † Time-varying state attributes include demographic and economic variables at the state level (median household income, senior population, poverty rate, population growth rate, unemployment rate).

and $\mathbf{x}_{s,t}$ includes various state-level, time-varying attributes that capture the state's economy and financial health, such as the state's median income, population size, and growth rates.

Table A10 shows that the elasticity of the sales volume in the secondary market to the influx of new bonds from the same state is low (0.02 in Columns (1) and (2)), and the elasticity of the net sales volume is even lower and statistically insignificant (0.004-0.005 in Columns (3) and (4)). Note that a state's secondary trading activity and influx of municipal debt can potentially co-move in response to macroeconomic factors. For example, large and rich states tend to have a more active secondary market, and they also issue more municipal bonds. However, it is important to emphasize that these factors tend to create a spurious positive correlation. In that sense, the estimated elasticity could be interpreted as an upper bound to the extent of substitution between existing bonds and new issuance, suggesting that the extent of investors' substitution across bonds is limited.

G.1.2. *Modelling Investors' Substitution.* The features of the municipal bonds market described above suggest a model where investors explore newly issued bonds in their home state, and once they buy a bond at issuance, they trade it in the secondary market to adjust their holdings in response to their liquidity shocks. Note that the main model captures that an investor's holding of a given bond i in her portfolio

Table A11. Does $\kappa_{I,i}$ Represent Bond-specific Opportunity Cost?

	$\hat{\kappa}_{I,i}$ (1)	$\log(\hat{\kappa}_{I,i})$ (2)
Average value of substitutes (log)	0.7062**	0.0280*
	(0.0960)	(0.0116)
Year-month FE	Yes	Yes
Year-state FE	Yes	Yes
Number of observations	763	763
R^2	0.232	0.264

Notes: This table reports OLS results at the bond level, using the bonds used in estimation. The number of observations is smaller than the total number of bonds used in estimation because those issued in the first semester of our period of study are omitted, given our definition of $\hat{W}_{-i,t}$. The dependent variable is the (logarithm of) bond-specific $\kappa_{I,i}$ estimate, and the key explanatory variable is the logarithm of the average investor surplus across all bonds that are deemed as close substitutes, specifically those issued in the six months before its issuance, in the same state, by the same government type (county, city, school district, or other special district). Standard errors are adjusted for clustering at the state level, and are provided in parenthesis; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

depends on alternative investment opportunities. In particular, the investors' flow utility for holding quantity a_i of bond i includes a bond-specific quadratic cost $-\frac{1}{2}\kappa_i a_i^2$, which reflects the opportunity cost of tying up amount a_i in bond i rather than in alternative investment opportunities. In other words, more desirable alternatives in the market at the issuance of bond i can be reflected by a larger κ_i.

Our estimates of $\kappa_{I,i}$ for each bond i are consistent with this interpretation. Table A11 presents the regression results based on the following specification:

$$\hat{\kappa}_{I,i} = \beta \log(\hat{W}_{-i,t}) + \mu_{sy(i)} + \rho_{t(i)} + \epsilon_i,$$

where $\hat{W}_{-i,t}$ is the value function for the investors, based on our estimates, averaged across investor types, for bond i's close substitutes when they are issued.[17] The state-year fixed effects, $\mu_{sy(i)}$, and the monthly period fixed effects, $\rho_{t(i)}$, reflect the opportunity costs associated with other potential alternatives specific to the state during the year and all alternatives, regardless of location, available during the month of bond issuance, respectively. As for the bond's substitutes, we include all bonds that were issued in the six months before its issuance, in the same state, by the same government type (county, city, school district, or other special district). We find that the estimate of β is positive and statistically significant, implying that our

[17] Given that we use an estimate for the investor value, the β coefficient can be subject to attenuation bias. Despite that, we find that the β estimates are statistically significant.

bond-specific parameter of $\kappa_{I,i}$ is positively correlated with the average value of close substitutes.

An alternative, full-blown approach to explicitly capture the impact of investors' substitution would be to consider a model that allows investors to choose from heterogeneous assets while facing search frictions in the decentralized market. As mentioned by Weill (2020), it is difficult to study how asset demand is shaped by both diversification and liquidity concerns in search-based models. Most existing search-theoretic multi-asset models of over-the-counter markets impose restrictions on portfolio holdings, and the only exceptions are Uslu and Velioglu (2019) and Li (2023), to our knowledge. Gavazza (2016) structurally estimates this type of model, but restricts investors to have binary, stochastic preference, and only hold up to one unit of a single asset. Our model, on the other hand, allows investors to hold and buy/sell any quantity of an asset, based on their continuously distributed valuations. This is not only a close representation of the data, where the variation in transaction quantities is large, but also essential for understanding how bond attributes, including bond complexity, affect investor valuation and search costs. Additionally, empirically measuring such a model would require data on investors' asset holdings, which are unavailable.

G.1.3. *Robustness.* If the standardization policy were to be implemented for all bonds, their values to investors would be accordingly adjusted, and the opportunity cost of holding bond i, $\kappa_{I,i}$ would also be affected. Under this scenario, all alternative bonds would be plain vanilla, but they would compete in coupon rate, liquidity, and (exogenous) default risk. Note that here $\kappa_{I,i}$ becomes an equilibrium object, along with the equilibrium coupon rates and liquidity levels of all bonds.

Instead of computing the general equilibrium under this policy scenario, we conduct a sensitivity analysis by simulating the effects of the policy when $\kappa_{I,i}$, as an equilibrium response, increases by 1% compared to the estimated value. Note that given the elasticity estimate for $\kappa_{I,i}$ with respect to the average value of substitutes to investors (0.0208, from Column (2) in Table A11), a 1% increase in $\kappa_{I,i}$ would require a 50% increase in the investor surplus from other bonds in equilibrium.

Table A12 presents the results for the bond studied in Section 8.2 of the paper, a general obligation bond issued in 2012 by a school district in Michigan, as an example.[18] We find that our overall results are robust to a 1% change in the equilibrium opportunity cost of holding a bond. When $\kappa_{I,i}$ increases, reflecting the additional

[18]The results for other bonds in the sample are similar to this bond.

Table A12. What If Standardization is Required for All Bonds?

	Current	Change under standardization	
		$\kappa_{I,i}$ constant	$\kappa_{I,i}$ increase
	(1)	(2)	(3)
Interest rate (basis points)	269.7	−29.7	−26.0
Average dealer's meeting rate (yearly)	0.950	+0.591	+0.581
Interest payment ($ thousand)	2,104.0	−222.0	−198.2
Total issuer cost ($ million)	8,833.3	+750.7	+773.9

Notes: This table reports the model predictions under a standardization policy where nonstandard provisions are allowed at a minimum level and the coupon rates are negotiated, focusing on a representative bond discussed in Section 8.2 of the paper. The table shows the negotiated coupon rate, the annual rate of meeting with investors, the interest payment size, and the total issuer cost under the current policy and the model-predicted changes under the standardization policy holding the opportunity cost ($\hat{\kappa}_{I,i}$) fixed or increasing it by 1%.

competitive pressure, the decrease in the coupon rate as described in Section 8.2 (or in Column (2) of Table A12) would be slightly offset (−29.7 vs. −26.0 basis points), and so would the increase in liquidity.

Finally, note that the paper's focus is on competition among dealers for a given bond, and how this competition shapes market outcomes. Competition among bonds for investors, on the other hand, seems to have a relatively small impact on the results, reflecting the investor behavior documented in Section G.1.1.

G.2. **The Role of Call Options: An Alternative Standardization Policy.** Among the various nonstandard provisions considered in this study, call options are frequently used: for our sample of 13,118 tax-exempt bonds that are negotiated in 2010-2013, having a call option in a bond issue is common (74%). We find that the revolving-door regulations decrease the extent to which call options are embedded in the bond contract (Table A8, Column 3), suggesting that call options may be "over"-used. However, these options can be particularly useful for the issuers, allowing them to lower the interest costs when the market interest rate is falling. For this reason, we explore the role of call options, specifically in driving the counterfactual results in Section 8.

To this end, we simulate the market outcomes under an alternative standardization policy that would restrict the use of all nonstandard provisions except for call options. In implementing this policy, we set the complexity level of a bond issue equal to the observed complexity level determined by the call options in the issue only, so that the counterfactual bond would include the same call option provisions but would

Table A13. What If Standardization Allows Call Options?

	Current	Median Change	
		Standardization	Robustness
Interest rate (basis point)		−46.88	−38.97
Average dealer's meeting rate (yearly)		+24.8%	+18.67%
Investor surplus		+5.48%	+7.20%
Issuer costs			
Interest payment ($K)		−16.0%	−12.0%
Marginal financial cost (c_0)		+6.07%	+2.94%
Total issuer cost ($c_0 A(1 + rT) - d_0 s$, $K)		+15.08%	+9.35%

Notes: The numbers are based on the 386 stratified sample bonds that have a call option. In the first column, we consider a standardization policy where nonstandard provisions are allowed at a minimal level. In the second column, we consider a standardization policy where only call options are allowed. The table presents the median percentage changes, relative to the market current outcomes.

not include any other nonstandard provisions. We present the equilibrium outcomes under this counterfactual policy in the last column of Table A13, presenting the median percentage change in these outcomes, compared to those of the baseline scenario (as represented in the "Current" column). Here we focus on the 386 stratified sample bonds that have a call option, as the effect of this alternative standardization policy would be the same as that of the standardization policy considered in the main text.

Table 8 shows that mandating a full-fledged standardization would increase the marginal financial cost c_0 by 6.97%, but allowing for call options would only increase the marginal cost by 2.94%, which is consistent with the fact that call options are often embedded in municipal bond contracts. With that, the impact of this alternative approach to standardization is more muted, compared to the policy we study in the main text, but the overall results are similar. First, the key trade-off associated with non-standard bond provisions is present: standardization would increase the rate at which transactions occur for all the bonds, with a median percentage equal to +16.8%, but reduce the flexibility in the payment schedule for governments, increasing the marginal financial cost (c_0) and decreasing the long-term benefits of such flexibility on government finances ($d_0 s$). Second, the coupon rate would fall, with the median change in coupon rate by -39 basis points, and thanks to the higher liquidity investors would, in general, benefit from standardization despite the overall decrease in coupon rate, with the median percentage change in the investor surplus +7%.

TABLE A14. What if the Issuer Chooses the Low-cost Underwriter under Standardization?

	Median Change	
	Standardization	Robustness
Interest rate (basis point)	−22.7	−26.93
Average dealer's meeting rate (yearly)	+33%	+33.74%
Investor surplus	+8.01%	+9.48%

Notes: The numbers are based on the 386 stratified sample bonds that have a call option. In the first column, we consider the baseline standardization mandate. In the second column, we consider a standardization policy where only call options are allowed. The table presents the median percentage changes, relative to the market's current outcomes.

G.3. **The Choice of Underwriter.** Municipal governments choose their underwriter and can switch underwriters. However, the underwriter-issuer relationship is notoriously persistent (Section 2.2). Moreover, the underwriting market tends to be fairly concentrated. These facts indicate that although the issuers do choose their underwriter, the scope of their choice is often limited. This motivates us to abstract away from the choice of underwriters in our model.[19] Yet, this decision may have implications for our results. In particular, under a standardization mandate, the government might be less tied to a particular underwriter, and it may switch to low-cost underwriters. As a robustness check, we simulate our counterfactual policy and assume that, when switching to standardization, issuers switch underwriters in favor of a dealer with the lowest search cost. The results, summarized in Table A14, confirm that our results are overall robust although, perhaps unsurprisingly, the improvement in investors' welfare and market liquidity are magnified, and drive a a bigger decline in the coupon rate.

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[19]Note the estimates of the trading market parameters wouldn't be affected by this modeling choice, but the government preference parameters can be. Specifically, the underwriter's effort to attract and retain issuers as clients on the primary market can create dynamic incentives that affect their incentives to issue complex bonds in a way that is not captured by the marginal benefit $\partial V/\partial s$. Our estimated model would capture these dynamic incentives jointly with the government's in the parameter θ_d.

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