# SEARCH FRICTIONS AND PRODUCT DESIGN IN THE MUNICIPAL BOND MARKET

GIULIA BRANCACCIO AND KARAM KANG

WORKING DRAFT—NOT FOR QUOTATION—SUBJECT TO CHANGE

Abstract. This paper shows that product attributes shape search frictions, and studies the incentives of intermediaries to leverage this channel to increase their rents in the context of the US municipal bond market. About half of municipal bonds are designed via negotiations between a local government and its underwriter, and they are traded in an over-the-counter market, where the underwriter is often a dealer. Exploiting variations in state regulations to limit government officials' conflict of interests, we provide suggestive evidence that including special provisions to a bond decreases its liquidity and yields, while it increases the market share of underwriters in the secondary market trades. Motivated by these findings, we build and estimate a model of bond issuance and trades to quantify market inefficiency driven by underwriters' dual role in both primary and secondary markets, as well as government officials' conflict of interest, and discuss policy implications.

## 1. Introduction

Search frictions are present in many markets, ranging from real estate and used goods to over-the-counter (OTC) financial markets. Understanding the nature and source of these frictions is a key to designing policies and improving market efficiency. In this paper, we study product attributes as a driver of search frictions. As consumers have access to a large number of highly customized product varieties, they benefit from the wealth of options, but they may find it difficult to evaluate and compare alternatives. As we demonstrate, this observation has two important implications. First, it introduces a trade-off that can limit the benefits of product variety. Second, it exposes search frictions as endogenous objects, affected by market participants' incentives to exploit this channel.

We focus on the US municipal bond market, a $4 trillion financial market on which state and local governments rely to finance infrastructure projects. At its simplest, a bond contract specifies its maturity and fixed interest rate paid on a semiannual base. Many bonds in this market, however, have a variety of special provisions, such as flexible maturities, variable interest rates, and unique redemption clauses contingent on elaborate circumstances. We show

*Date*: October 22, 2021.
Brancaccio (email: giulia.brancaccio@cornell.edu), New York University, CEPR, and NBER.
Kang (email: kangk@andrew.cmu.edu): Tepper School of Business, Carnegie Mellon University.

that while these bond provisions may be designed to accommodate investors' or issuing government's financial needs, they may not necessarily be beneficial to the government because they may also decrease the bond's liquidity. Moreover, we find suggestive evidence that an underwriter may benefit from including various special provisions in the bond, which tends to increase her market share in trades. After issuance, an underwriter competes with other financial institutions to intermediate trades in the secondary market, and special provisions can make it harder for the underwriter's competitors to trade the bond.

The goal of this paper is two-fold. First, we aim to capture how the underwriters' incentives affect bond variety in the municipal bond market and shape the search frictions in the market. In this respect, our study offers an important perspective for several other financial markets such as insurance, fixed-income asset, annuity, and mortgage markets, where the proliferation of highly customized and increasingly complex products has recently provoked a policy debate concerning whether reining in product complexity might be beneficial (Aguilar, 2015; Bernard, 2016). Second, we measure he impact of nonstandard bond attributes on overall welfare and the cost of capital for state and local governments. Our findings can provide an important input into the policy discussion on how to lower the cost of investment in infrastructure, much needed to update the overstretched US infrastructure that was built decades ago.

We combine rich issuance-level data with proprietary transaction-level data on bond trades to document key empirical patterns regarding the factors that affect how bond attributes are designed. Our results show that state regulations to limit lobbying activities of former public officers or employees reduces the number of special provisions in newly issued bonds. These regulations are intended to reduce conflict of interests by setting a "cool-off" period during which a former official is not allowed to be employed by certain firms related to their work at the government. They may reduce the underwriter's influence over the choice of bond attributes at issuance, while they may not directly affect the demand for the municipal bonds. With that, we leverage them to build an instrument that exogenously changes the bond attributes of newly issued bonds. Using this instrument, we find that when a bond includes several special provisions, the underwriter intermediates a larger share of the bond's secondary market trades. This pattern suggests why an underwriter might want to include special provisions when originating a bond. In particular, the underwriter's exclusive right to sell the bond at issuance provides her with the unique advantage of learning about investors' interests in the bond before other dealers. This knowledge becomes more valuable for highly customized bonds, explaining her larger market share.

We also find that as the number of special provisions in a bond increases, both default risk and market liquidity fall. In addition, the offering price of a bond decreases with more special provisions in the bond. This finding implies that the welfare consequences of mandating simple, standardized bonds are not necessarily clear. Special provisions can be suited to the issuing government's specific revenue and cost stream, reducing its default risk. However, they make the pricing of the bond more difficult, increasing search frictions.

Motivated by the aforementioned empirical findings, we build and estimate a model of bond issuance 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 (issuer, hereafter), negotiate over the bond's price and its attributes including the interest rate and special provisions. The underwriter then buys the entirety of the bond from the issuer at the agreed price and can resell it to investors and other dealers. Then, investors and dealers trade the bond in continuous time until its maturity. During the negotiations, the underwriter's payoff is the sum of the resale value of the bond and the profit from brokering trades. The payoff of the government official reflects the cost of paying bond's principal and the interests, which possibly varies with the bond's special provisions, as perceived by the official. In addition to the government cost, the official may partially internalize the underwriter's payoff depending on conflict-of-interest regulations. During trading, dealers choose the rate at which to meet investors, given a convex search cost. Search costs also vary with dealers' cumulative trade volume with investors, reflecting differences among dealers in their client network. In this model, search costs as well as investors' and dealers' valuations are allowed to depend on bond attributes, observed by all participants in the market, although some may not be observed by the researcher.

In estimating the model, we take a multi-step strategy. First, we use trading prices, quantities, and meeting rates to estimate bond-specific dealer costs and investor valuations. Second, we estimate how these model primitives depend on the bond attributes that are endogenously determined—i.e., the interest rate and the number of nonstandard attributes—using the conflict-of-interest regulations as instruments. This approach accounts for rich heterogeneity in the factors that affects the choice of bond attributes: investor demand, dealer costs, and issuer preferences. Third, we look at the bond attributes determined at issuance to estimate the preferences of government officials involved in the negotiations: the cost of paying debt and the extent to which they internalize the underwriter's payoff in negotiations. Given the estimates for the trading stage from the previous steps provide the underwriter's payoffs, we isolate and recover the government officials' preferences.

Employing the estimated model, we study how the selection of bond attributes affects search frictions and welfare. First, we quantify how special provisions in a bond affects the key primitives of the model: investor demand, dealer costs to search for investors, and government officials' perceived cost of debt payment. Second, given the estimated parameters of the model, we contribute to the debate on standardization in financial markets by evaluating policies that restrict the choice of bond attributes by the issuer to "plain vanilla" bonds. Third, we study the impact of policies to reduce underwriters' incentives to distort the choice of bond attributes to gain a competitive advantage via-à-vis other dealers. One such policy is to ban underwriters' participation in the trading market, and the other policy is to ban other dealers' participation in the trading market, thus granting monopoly to the underwriter.

This paper contributes to multiple strands of the literature. First, there is a large literature that studies the consequences of search frictions, which are often taken as an exogenous object. In this paper, we study search frictions as an endogenous object, partially determined by the intermediaries' incentives. In this regard, our approach is close to Ellison and Ellison (2009). Second, our paper discusses how financial institutions' dual role as underwriters and dealers distorts product design in favor of highly customized and complex products. In this respect, we contribute to the literature on how vertical relations affect product selection (Asker and Bar-Isaac, 2014; Ho and Lee, 2019; Hristakeva, 2019). Third, we emphasize how the distortion in product selection may be amplified by government officials' private interests, exploiting time-varying state-level regulations on revolving-door practices. Our 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). Finally, this study belongs to the literature on the structural analyses of decentralized asset markets (Gavazza, 2011, 2016; Allen, Clark and Houde, 2019).

## 2. US Municipal Bond Market

2.1. **Overview.** Municipal bonds are securities issued by US state and local governments to finance public infrastructure projects including schools, hospitals, and highways. During 2003–2012 municipal bonds financed more than $1.65 trillion of infrastructure investment. Most municipal bond interest payments are exempt from federal and state income taxes (for in-state residents), as well as local income taxes in some cases. This feature provides advantages to investors who fall into high tax brackets. Out of $3.7 trillion municipal bond 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%). The rest is owned by banks and insurance companies (10% and 12% each).[1]

A municipal bond may be issued via either a competitive bidding or a negotiated sale.[2] In the former, competing dealers submit bids and the bidder specifying the lowest cost to

[1]These statistics are based on the quarterly documents on the "Financial Accounts of the United States" by the Board of Governors of the Federal Reserve System (`https://www.federalreserve.gov/releases/z1/`).
[2]There has been an increase in negotiated sales: in 1975, only 40% of the $29.3 billion newly issued bonds were negotiated; in 2005, 81% of the $408 billion new issues were negotiated (Feldstein and Fabozzi, 2008).

the issuer wins, becoming the underwriter of the bond. In the latter process, the issuing government selects an underwriter, and these two parties negotiate in designing and originating the bond.[3] When designing the bond, the issuer has various options from employing a simple bond with a fixed semiannual coupon rate and a maturity date to a more complex version with several special provisions, such as flexible maturity dates, the right to retire a specified portion of debt, alternative interest payment frequency, variable or floating interest rate, to name a few. In addition, issuers may employ serial bonds, consisting of a number of different bonds that mature in consecutive years in one issue.

One important difference between these two processes is whether or not the underwriter plays a role in determining the bond's attributes and timing of the sale, prior to its pricing. In a negotiated sale, the underwriter has usually several months before the issuance, and can affect these features depending on the specific demand profile of investors, overall investor demand, and the interest rate environment, amongst others. This contrasts to a competitive sale, where the underwriter typically has about a week between the posting of the notice of sale and the final sale date, and the bond features are already set before submitting bids.

Once the issuing government awards the bond to the underwriter, the latter sells it to investors and other financial institutions in the *primary market*. After these initial sales, investors and financial institutions may trade the bond before its maturity in an over-the-counter market, which we refer to as the *secondary market*. In this market, the underwriter is a key player, competing with other financial institutions to attract order flow.

2.2. **Why Municipal Bonds Market?** The market for municipal bonds has a few distinctive features that motivate us to study bond attributes and search frictions. First, this market is known for the large number and variety of bonds. In 2019, there are about one million bonds outstanding; as a comparison, in the market for corporate bonds, with \$9.6 trillion outstanding, there are 40,000 different bonds. This relatively high level of variety partly reflects the fact that the number of outstanding bonds per issuer is large: the average issuer has 20 different bonds outstanding, which contrasts to 6 in the corporate bond market.

Second, municipal bond trades are relatively infrequent. The average daily trading volume in 2019 is \$11.5 billion, about 0.3 percent of the market size. When a bond is not liquid, investors will find it difficult or costly to resell the bond before maturity, which in turn can increase the capital cost for the issuing government (Wang et al., 2008). The lack of

[3]In a negotiated sale, the government issuer often employ a formal request for proposals (RFPs) to pick an underwriter. However, without a formal proposal process, an underwriter may be selected possibly based on its previous experience with a particular underwriter. Even in a proposal process, the criteria for selecting an underwriter can be more subjective than that in the competitive bidding process; since the interest rate is not known at the time of RFP, the selection of the underwriter will be based on a host of factors, such as the underwriter's previous experience with similar projects, the experience of the major personnel involved, the quality of proposal, and the anticipated financing cost. See Chapter 4 of Feldstein and Fabozzi (2008) for a further discussion on the process of the municipal bond sales.

standardization of bond attributes has been identified as one of the culprits driving the market illiquidity. As an example, from a 2014 speech of SEC Commissioner:

> "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."

Third, underwriters participate both in the issuance 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 issuance volume in 2010–11, and these top 10 broker-dealer firms executed about 55% of secondary market trades during the same period. The revenues from the secondary market are not negligible compared to the underwriter fee: the average underwriter's fee on negotiated bonds in 2012 is 0.54% of the face value of a bond (Braun, 2015), and the average dealer markups on round-trip transactions as estimated by Li and Schürhoff (2019) based on data from 1998–2012 is 2%. 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.

2.3. **Conflict of Interest between Underwriter and Issuer.** When designing bond attributes, underwriters and bond-issuing governments may consider various factors. Certain bond provisions may lower the government's borrowing costs by tailoring the debt payment schedule to its revenue and cost streams; however, to the extent that such provisions increase trading costs in the secondary market (Harris and Piwowar, 2006), they may increase the government costs. A part of trading costs is associated with time and efforts to educate and find investor (Feldstein and Fabozzi, 2008); in this regard, both investors and governments may value simple bonds (Harris and Piwowar, 2006). The underwriter, on the other hand, may find it beneficial to include special provisions in a bond, because it may improve its competitive advantage vis-á-vis other dealers in the secondary market. For example, some provisions may be particularly appreciated by its clientele, helping the underwriter solidify its client network and locate trading partners faster than other dealers.

This discussion suggests that underwriter's and issuer's interest might not be aligned, and in fact bond origination is often preceded by months of negotiations to determine the bond attributes. An important aspect of these negotiations is the potential for conflict of interest between issuer and underwriter. Indeed, there are regulations to limit such behaviors.[4]

[4]There may be conflicts of interest between underwriters and financial advisors; see, for example, Liu (2015). A financial advisor may help an issuer select an underwriter in the issuance process, and monitor the underwriter's activities in terms of bond structuring and pricing for a negotiated sale. In this regard, conflicts of interest in this dimension may be relevant in our context, but we focus on the conflicts of interest between

First, in 1994, the MSRB adopted Rule G-37 ("pay-to-play" rule), which prohibits municipal securities dealers from engaging in business with a municipality if they have made political contributions to an official of the municipality for two years from the date of the triggering contribution. This rule expanded the coverage of existing Rule G-29, the commercial bribery prohibition, and provided disclosure requirements on political contributions by municipal securities dealers.

Second, gifts to state and local officials are in general prohibited by state and local regulations. In addition to such regulations, the Financial Industry Regulatory Authority (FINRA), a self-regulatory organization regulating member brokerage firms and exchange markets, bans its member firm from "giving anything of value in excess of $100 per year to any person where such payment is in relation to the business of the recipient's employer" by Rule 3220. This rule was first introduced in 1969, with the most recent amendment in 2008. For example, in September 2013, the FINRA fined a Missouri municipal underwriting firm $200,000 for providing improper gifts to its local government clients, including over $183,500 worth of professional sports tickets (Schweich, 2013).

Third, 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 (so-called "revolving-door" practices). The restrictions are often in the form of mandatory "cooling-off" periods, where public officials are not allowed to lobby or be hired by certain employers for a period of time, typically one or two years, after leaving public service. They aim to reduce a conflict of interest that may arise through the following two channels; first, public officials may be influenced when making decisions by the implicit or explicit promise of a lucrative job in the private sector; second, firms may have special access and inside information or connections to sitting government officials by the former officials hired by them.

It is notable that regulations of revolving-door practices concerning underwriters differ across states, while regulations of other "quid-pro-quo" practices, specifically campaign contributions and gifts, are governed by the MSRB and the FINRA, both of which govern financial institutions across all states. Given this, we exploit the variations of state-level revolving-door regulations across states and time and study how these affect the negotiations between underwriters and public officials when issuing a municipal bond.

State revolving-door regulations primarily target state officials, such as members of state legislatures or officials in the executive branch. However, some states extend their regulations to local government officers and employees. For example, New Mexico and Virginia expanded the targets of their revolving door regulations to include local officials in 2011.

underwriters and government officials, because the latter parties choose a financial advisor. In addition, a financial advisor could serve as an underwriter prior to the MSRB Rule G-23, adopted in November 2011. Garrett (2020) finds that this regulation increased competition and lowered borrowing costs. In our data, the issuances where the advisor is also the underwriter is very rare (13 out of our final sample of 6,550 issuances).

2.4. **Data and Scope of Study.** We draw issuance data for all municipal bonds issued in 2010–2013 from Mergent, and secondary-market transaction data for these bonds during 2010–2015 from Municipal Securities Rulemaking Board (MSRB). We complement these data with various attributes of the government issuer of a bond, 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 state governor's party and 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.

We focus on tax-exempt general obligation or revenue bonds that were sold via a negotiation process. By focusing on negotiated bonds, we study the role of underwriters in the determination of bond attributes and search frictions in the secondary market. Out of 26,623 originations 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 a competitive bidding, 1% (320) via other methods such as a private placement, and the sale method for the rest (2%, 514) is not specified. In our sample, revenue bonds are more likely to be negotiated than to be auctioned, and negotiations are more likely for the bonds issued by school districts or other special-purpose governments like water utilities, than for the bonds issued by county or city governments. However, the correlation between the method of sale and other bond attributes, such as bond size and the length of bond maturity, is not statistically significant.

We further narrow down our sample by focusing on issuances with at least one trade in the secondary market, leading to the final sample of 13,120 bond originations, with the total maturity amount \$255.5 billion, in nominal USD.

## 3. Motivating Evidence

3.1. **Bond Attributes and Complexity.** Table 1 presents summary statistics of the key variables used in our analyses for the final sample of 13,120 issuances. The average size of capital raised by an issuance is \$19.5 million, and the length of maturity is on average 8.4 years. An issuance may comprise of multiple different bonds, and on average there are 12.1 bonds with different maturities and attributes in the same issuance. Following Harris and Piwowar (2006), we focus on five different bond attributes that may affect the level of difficulty for investors to evaluate a given issue: (1) multiple or serial bonds (as opposed to a single bond) per issue, (2) provisions that allow the government to redeem or "call" the bond, (3) the existence of a sinking fund, (4) interest payment frequencies other than every six months, and (5) a variable interest rate. We construct a measure of "complexity" based

Table 1. Summary Statistics

| | Mean | SD | Median | Min | Max |
|---|---|---|---|---|---|
| *Issuance attributes* | | | | | |
| Face value (in million USD) | 19.474 | 51,791 | 6.352 | 0 | 1,192 |
| Maturity (in years) | 8.366 | 4.335 | 7.739 | 0.042 | 30.936 |
| Type of assets to pay the debt | | | | | |
| General obligation (unlimited) | 0.634 | 0.482 | 1 | 0 | 1 |
| General obligation (limited) | 0.158 | 0.364 | 0 | 0 | 1 |
| Revenue | 0.208 | 0.406 | 0 | 0 | 1 |
| Number of bonds per issue | 12.125 | 6.568 | 12 | 1 | 86 |
| With call provisions | 4.700 | 5.204 | 3 | 0 | 63 |
| With sinking fund | 0.897 | 1.668 | 0 | 0 | 26 |
| Without semi-annual interest payment | 0.015 | 0.159 | 0 | 0 | 6 |
| Without fixed interest rate | 0.045 | 0.360 | 0 | 0 | 10 |
| Average complexity† | 0.885 | 0.181 | 0.894 | 0.000 | 1.609 |
| Weighted average complexity† | 0.943 | 0.221 | 0.945 | 0.000 | 1.609 |
| *Issuer attributes* | | | | | |
| Issuer type | | | | | |
| County government | 0.070 | 0.255 | 0 | 0 | 1 |
| City government | 0.295 | 0.465 | 0 | 0 | 1 |
| School districts | 0.388 | 0.487 | 0 | 0 | 1 |
| Other special purpose government | 0.247 | 0.431 | 0 | 0 | 1 |
| Issuer finances | | | | | |
| Interest expenditures/Total expenditures | 0.043 | 0.029 | 0.036 | 0 | 0.751 |
| Tax revenue/Total expenditures | 0.362 | 0.147 | 0.361 | 0 | 1.008 |
| Intergovernmental revenue/Total expenditures | 0.379 | 0.190 | 0.356 | 0 | 1.090 |
| Revolving-door regulation affecting | | | | | |
| State officials | 0.812 | 0.390 | 1 | 0 | 1 |
| Local officials | 0.292 | 0.455 | 0 | 0 | 1 |

*Notes*: Based on the 13,120 negotiated general obligation or revenue bonds with any secondary market trades issued by local governments in 2010–2013. † : The "average complexity" is the sum of a dummy indicating that the issue includes multiple bonds (serial) and the simple average number of special attributes (in terms of call and sinking fund provision, interest payment frequency, and interest rate). The "weighted average complexity" is the sum of the serial bond dummy and the average number of special attributes, weighted by each bond's face value for a given issue.

these five attributes: the average complexity is the sum of a dummy indicating that the issue includes multiple bonds and the simple average number of the latter four attributes across the bonds within the issue; the weighted average complexity is the sum of the serial bond dummy and the average number of the four special attributes, weighted by each bond's face value for a given issue.

3.2. **Revolving-door Regulations as Instruments.** To identify the causal impacts of including special bond provisions to a bond issuance on various market outcomes, we rely on an instrumental variable framework based on across-state and across-time variation in revolving-door regulations. Between 2010 and 2013, three states, Arkansas (2011), Indiana (2010), and Maine (2013), enacted legislation, which started regulating state government officials in the executive branch and/or the state legislature. During the same period, two states, New Mexico (2011) and Virginia (2011), expanded their existing revolving door regulations to restrict post-government employment of local officials, in addition to state officials.

We argue that revolving-door regulations may affect the bond issuance negotiations and accordingly the bond design. We construct two dummy variables regarding the regulations, depending on the scope of the revolving door legislation. Local $\text{Reg}_i$ indicates that, when bond $i$ was issued, there was a revolving-door regulation in place covering local government officials. Instead, State $\text{Reg}_i$ takes 1 if the officials covered by the regulation are state government officials only. Using these variables, we estimate the following regression model:

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

where $\mathbf{X}_i$ includes issuer and bond characteristics and 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 variables, as denoted by $s_i$, we employ the average complexity measure as described earlier. Our coefficients of interest, $\beta_1$ and $\beta_2$, represent the average change in the complexity of newly issued bonds following a regulation change, controlling observed issuer and bond attributes, county fixed effects, and semi-annual fixed effects.

The results, shown in Table 2, show that revolving-door regulations substantially decrease the average number of special provisions in newly issued bonds. Regulating local officials led to a 8-9% decrease in the average number of special bond provisions, which is consistent with an idea that revolving-door practices may reduce the degree of collusion between underwriters and local government officials who are in charge of originating municipal bonds, if including special bond provisions in a bond benefits an underwriter, possibly at the expense of the issuing government and its taxpayers.

We also find that revolving-door regulations targeting state government officials only also decreased the average number of special provisions. Although the extent of the estimated decrease is smaller than the counterpart associated with regulations extended to local officials (2% vs. 8-9%), the estimate is statistically significant. This is interesting because state officials are not, at least officially, involved in the bond origination negotiations. However, state officials may have capacity to indirectly influence the negotiations, because for example, they help determine the current and future allocations of the state budget to local

Table 2. Do Revolving-door Regulations Affect Municipal Bonds Attributes?

| | Num. of Special Bond Provisions (log) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Local revolving-door regulation | -0.077*** | -0.094*** | -0.077*** | -0.0937*** |
| | (0.014) | (0.016) | (0.014) | (0.015) |
| State revolving-door regulation | | | -0.022*** | -0.023*** |
| | | | (0.007) | (0.006) |
| Issuance attributes† | Yes | Yes | Yes | Yes |
| Issuer type† | Yes | Yes | Yes | Yes |
| Other issuer attributes† | No | Yes | No | Yes |
| Year-month FE | Yes | Yes | Yes | Yes |
| County FE | Yes | Yes | Yes | Yes |
| Number of observations | 13,103 | 12,974 | 13,103 | 12,974 |
| $R^2$ | 0.638 | 0.644 | 0.638 | 0.644 |

*Notes*: This table reports OLS estimates. Standard errors are adjusted for clustering at the state level, and are provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. † : Issuance attributes include the logarithm of the total face value and the average maturity length, two dummy variables on the type of assets to pay the debt (limited general obligation and revenue, respectively). We include three dummy variables on the issuer type (city, school districts, and other special-purpose governments, respectively). As for other issuer attributes, we include the three issuer finance variables in Table 1, as well as various demographic, economic, and political variables aggregated at the state-level for state government issuers and at the county-level for other issuers: median household income, senior population, poverty rate, population growth rate, whether there is a high concentration of a single NAICS 2-digit industry, party of the governor, as well as the county-level vote share for a Republican candidate and the vote margin of the preferred candidate in the most recent Presidential election.

governments. However, it is beyond our scope of study to elucidate the mechanism through which state officials may influence local officials.

An important assumption underlying our instrumental variable approach is that the changes in revolving-door regulations only affect the choice of bond attributes through its impact on the negotiations between government officials and underwriters at issuance. This assumption would be violated, for example, if these regulations directly affected factors such as the type of investments financed by municipal bonds or the financial health of the issuing government. Here, we provide suggestive evidence that this assumption is not violated in our context. Table 3 show regression results based on models similar to (1) except that the dependent variables are the logarithm of the face value of a bond for Columns (1) and (2) and the credit ratings of existing bonds for Columns (3) and (4). The first two columns of Table 3 show that changes in revolving-door regulations do not affect the amount of capital raised through municipal bonds. The last two columns show that these regulations do not change the rating of existing bonds for the issuers, suggesting that the regulations do not directly alter the financial health or the solvability of the issuing governments. In addition, Columns (5) and (6) indicate that there is no statistically significant relationship between

Table 3. Do Revolving-door Regulations Directly Affect Municipal Bond Market?

| | Face Value (log) | | Rating of Existing Bonds | | $\mathbb{I}${Negotiated Bonds} | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Local revolving-door regulation | 0.178 | 0.178 | -0.044 | -0.045 | -0.0187 | -0.0190 |
| | (0.145) | (0.145) | (0.031) | (0.031) | (0.0366) | (0.0368) |
| State revolving-door regulation | | -0.0255 | | 0.003 | | -0.0190 |
| | | (0.134) | | (0.012) | | (0.0197) |
| Issuance attributes | Yes | Yes | Yes | Yes | No | No |
| Issuer type | Yes | Yes | Yes | Yes | Yes | Yes |
| Other issuer attributes | Yes | Yes | No | No | Yes | Yes |
| Year-month FE | Yes | Yes | Yes | Yes | Yes | Yes |
| County FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of observations | 6,272 | 6,272 | 286,554 | 286,554 | 26,087 | 26,087 |
| $R^2$ | 0.522 | 0.522 | 0.407 | 0.407 | 0.416 | 0.416 |

*Notes*: This table reports OLS estimates. Standard errors are adjusted for clustering at the state level, and are provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

revolving-door regulations and the propensity to employ a negotiated sale as opposed to a competitive bidding.

Table 4 shows the effects of the revolving-door regulations on bond complexity vary with bond or issuing government's exogenous attributes. Column (1) shows that the magnitude of the effects on bond complexity increase with the length of the bond maturity, which we interpret as a proxy for the size of the rent from intermediating in the secondary markets.

Column (3) indicates that the tighter the Presidential election is for a given county, the larger the magnitude of the effects of revolving-door regulations is. Measuring the political climate of a county by the vote share of the Republican candidate in a Presidential election, we measure the extent to which state and local elections are likely to be a toss-up, labeled as "electoral vulnerability" by one minus the absolute value of the difference between the county's Republican vote share of the most recent Presidential election and 0.5, normalized by 0.5, so that it takes a value between 0 and 1. This may be due to the possibility that local government officials' turnover in the electorally vulnerable counties is higher, and we expect revolving-door regulations to have more bite, in so far the effects of revolving-door regulations on municipal bonds are channeled through government officials' career incentives. Finally, Columns (3)-(4) explore whether the impact of the revolving-door regulations varies depending on whether the government is divided.

3.3. **Effects of Special Bond Provisions.** Table 2 shows that regulations that restrict the scope for conflict of interest in the issuance negotiations reduces the number of special provisions included in newly issued bonds. This finding suggests that the underwriter might derive a rent from issuing complex bonds. To explore the nature of this rent, we estimate

Table 4. Heterogeneous Effects of Revolving-door Regulations

| | Num. of Special Bond Provisions (log) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| State revolving-door regulation | -0.023*** | -0.023*** | -0.023*** | -0.094*** |
| | (0.006) | (0.006) | (0.06) | (0.015) |
| Local revolving-door regulation | 0.863*** | 0.119*** | -0.106*** | -0.045*** |
| | (0.22) | (0.033) | (0.015) | (0.006) |
| Local revolving × Log (maturity) | -0.206*** | | | |
| | (0.06) | | | |
| Local revolving × Electoral vulnerability† | | -0.286*** | | |
| | | (0.045) | | |
| Local revolving × Divided government† | | | -0.020 | |
| | | | (0.045) | |
| State revolving × Divided government† | | | | 0.0551*** |
| | | | | (0.013) |
| Issuance attributes | Yes | Yes | Yes | Yes |
| Issuer type | Yes | Yes | Yes | Yes |
| Other issuer attributes | No | Yes | No | Yes |
| Year-month FE | Yes | Yes | Yes | Yes |
| County FE | Yes | Yes | Yes | Yes s |
| Number of observations | 12,974 | 12,974 | 12,974 | 12,974 |
| $R^2$ | 0.624 | 0.633 | 0.624 | 0.632 |

*Notes*: This table reports OLS estimates. Standard errors are adjusted for clustering at the state level, and are provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. †: The "electoral vulnerability" variable is one minus the absolute value of the difference between the county's Republican vote share of the most recent Presidential election and 0.5, normalized by 0.5, so that it takes a value between 0 and 1. The closer this measure is to 1, the tighter the election was, predicting that state and local elections are likely to be a toss-up.

the following equation:

$$\text{Markt Share}_i = \beta \log(s_i) + \gamma \mathbf{X}_i + \kappa_{st(i)} + \theta_{t(i)} + \epsilon_i, \tag{2}$$

where Market Share$_i$ is the underwriter's share in the secondary market of bond $i$. We instrument the bond's complexity using (1). Column (1) of Table 5 shows that increasing the number of special attributes by 1% raises the underwriter's share in the bonds' secondary market by 0.006pp, corresponding to a 2% increase over the base level. During 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 in Column (1) of Table 5 suggest that this knowledge can give him a sizable edge in the case of highly customized bonds, enabling him to quickly locate potential buyers and sellers and increase its market size vis-a'-vis other dealers.

Next, we use the exogenous change in bond attributes caused by changes revolving-door laws to showcase the welfare trade-offs involved in designing the level of complexity in bonds. On the other hand, special provisions can help tailor the debt payment schedule to the issuer's

TABLE 5. Effects of Special Bond Provisions

| | Underwriter's Market Share (1) | Intermediation Spread (2) | Risk of Downgrading (3) | Offering Price (log) |
|---|---|---|---|---|
| Num. of special bond provisions (log) | 0.667*** | 0.064*** | -0.629** | -1.229*** |
| | (0.309) | (0.012) | (0.249) | (0.476) |
| Issuance attributes | Yes | Yes | Yes | Yes |
| Issuer type | Yes | Yes | Yes | Yes |
| Coupon rate | Yes | Yes | Yes | Yes |
| Year-month FE | Yes | Yes | Yes | Yes |
| County FE | Yes | Yes | Yes | |
| Number of observations | 10,693 | 10,693 | 12,910 | 10,323 |
| First stage F-stat | 203.421 | 203.421 | 169.754 | 20.849 |

*Notes*: This table reports 2SLS estimates, where we use a dummy variable for state revolving-door regulations (see Table 2 for the first stage estimates) as an instrument. The regression only includes bonds that are traded at least once after issuance. Moreover, we only observe credit rating for only 3,645 bonds. Standard errors are adjusted for clustering at the state level, and are provided in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Controls are identical to those in Table 2.

specific revenue and cost structure. In particular, matching the maturity structure to the timing of the issuer's revenue flow, or introducing contingencies in timing and size of interest payments, can ensure that the bond's payments are aligned with the times when the issuer has most liquidity and, as an example, reduce the risk of default. On the one hand, as the issuing government and underwriter enrich a bond with special attributes and contingencies the process of trading the bond becomes more involved, as it is more time consuming for dealers to explain to investors the risks and flow payments associated with the purchase of the bond. To capture this trade off we estimate the baseline specification:

$$y_i = \beta \log(s_i) + \gamma \mathbf{X}_i + \kappa_{st(i)} + \theta_{t(i)} + \epsilon_i, \tag{3}$$

where $y_i$ is either bond $i$'s intermediation spread, a proxy for search frictions associated with the bond, or a variable indicating whether a bond is downgraded within the first five years after its issuance, a proxy for the default risk. Column (2) of Table 5 suggest that special provisions tend to decrease search frictions: a 1% increase in the number of special provisions in a bond increases the bond's intermediation spread by 6 basis point, which corresponds to an increase of 5% over the base level. As shown in Column (3) of Table 5 this, in turn, can have a substantial impact on the bond's default probability: it shows that a 1% increase in the number of special bond provisions can decrease the number of downgrades by 0.006pp, which corresponds to a decrease of 5% over the base level. Finally, in Column (4) of Table 5 we use the specification above to measure the impact of the number of special attributes on the government's direct cost of capital, which we proxy with the offering price, the unit price at which the underwriter buys the bond from the government. The estimate shows that a 1% increase in the number of special provisions in a bond decreases the offering price that the government pays by 1.2%.

In summary, taken together the results in Table 5 show that socially optimal level of bond complexity solves a complex trade-off between the issuing government's need for customization, its cost of capital, and the search frictions that dealers and investors face. Moreover, the results point to a potential distortion in how this trade-off is solved at origination by the issuing government and the underwriter.

## 4. Model

To better understand how the underwriters' participation in the secondary market affects the choice of bond attributes and consider welfare implications of policies to affect bond attributes in the market, we build and estimate a structural model of bond issuance and trading. The model reflects several key features of the municipal bonds market as highlighted in Sections 2 and 3. First, while the bond amount and maturity are exogenously determined by the municipal government's financial circumstances and the nature of the infrastructure project, the bond attributes including the interest rates and various special provisions in the bond contract are negotiated between the issuing government and its underwriter. Second, as the underwriting firm participates in the trading of the bonds after its initial sales, the firm's payoff depends on the profits from subsequent trades as an intermediary as well as the resale value of the bond and the underwriting fee. Third, to account for government officials to maintain collusive relationship with the underwriting firm, we allow them to weigh in the underwriter's payoff when negotiating the issuance, where the weight may depend on revolving-door regulations. Lastly, bond attributes may affect investor's flow payoff and government costs of paying the interests, as well as search frictions in the trading market. Thus, the demand and the cost of bonds are affected by bond attributes, both directly and indirectly through search frictions. Here, we allow that the effects of bond attributes on search frictions faced by the underwriter and the other dealers in the trading market may be heterogenous, which can be exploited by the underwriter.

Our model for over-the-counter (OTC) market for a given bond, where initial sales by the underwriter and subsequent trades among investors and dealers take place, is based on Üslü (2019). We modify the model of Üslü (2019) in two dimensions. First, to account for the fact that bonds are traded until their maturity, we consider a finite-horizon model. Second, we assume that dealers choose their meeting rates by exerting costly efforts, as opposed to treating them as exogenously given. This feature allows us to consider the relationship between bond attributes and search frictions in equilibrium.

4.1. **Setup.** Consider a municipal government contemplating an issuance of a bond of size $A \in \mathbb{R}_+$, maturity $T \in \mathbb{R}_+$, and other exogenous attributes like the type of assets to pay the debt and the government's financial health. All bond attributes are observed by market participants. We allow that some of them are not observed by the researcher; we denote those observed by the researcher, such as $(A, T)$, as $\mathbf{x} \in \mathcal{X} \subset \mathbb{R}^{dim(\mathbf{x})}$ and those not observed as $\xi \in \Xi \subset \mathbb{R}^{dim(\xi)}$.

An exogenously chosen underwriter and an official acting on behalf of the government negotiates to determine 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 special provisions, summarized by an one-dimensional index, $s \in \mathbb{R}_+$. In exchange of the payment, the underwriter is awarded the entire face value of the debt from the government and can resell it to investors and other dealers. We assume that the negotiation process can be represented by Nash bargaining, and that the cost of underwriting is zero for simplicity. We denote the outside options for the government and the underwriter by $J_G(\mathbf{x}, \xi, h)$ and $J_U(\mathbf{x}, \xi, h)$ respectively, and assume that these are common knowledge.

The underwriter's payoff is the present value from the initial sales of the bond and the subsequent secondary-market transactions, denoted by $V_U(s, r; \mathbf{x}, \xi)$, minus the price paid to the government:

$$V_U(s, r, \mathbf{x}, \xi) - F. \tag{4}$$

In exchange for the payment of $F$ from the underwriter to finance its projects, the issuer bears the cost of paying the principal and the interests, which may vary with the bond attributes and the total payment size as follows:

$$c_0(s, \mathbf{x})A(1 + rT). \tag{5}$$

We interpret $c_0$ as capturing two factors. First it captures the indirect utility of making the future payments associated with the bond. In fact, when evaluating the cost of making future payments from the point of view of the issuing government, it is important to account for the covariance of the bond payments with the government marginal cost of those payments and hence with their covariance with the government revenues. In other words, the cost of making a payment in the future is larger in "bad states" where a dollar is more valuable and small in "good states" where a dollar is less valuable. For this reason, the cash flow of the issuing government affects the cost of debt payment and thus $c_0(s, \mathbf{x})$ is not necessarily one. Note that we allow $c_0$ to depend on the number of special attributes $s$, since they allow the issuing government to postpone or anticipate the future payments depending on their reserves. For example, the option of calling back (a part of) the debt allows the government to exploit an (unexpected) increase in its cash holdings as well as lower market interest rate than the bond's rate. Second, it captures how much a politician internalizes future payments owed to investors.

We allow that the government official may partially internalize the underwriter's payoff. Specifically, we assume that the official's payoff is a weighted sum of the payoffs of the government and the underwriter, with a weight representing her collusive relationship with the underwriter, denoted by $\psi \geq 0$. We allow that the weight, $\psi$, may vary with revolving-door regulations, denoted by $h$, and bond attributes, $\mathbf{x}$. We write the official's payoff as:

$$F - c_0(s, \mathbf{x})A(1 + rT) + \psi(\mathbf{x}, h) \left\{ V_U(s, r, \mathbf{x}, \xi) - F \right\}. \tag{6}$$

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 $m_D > 0$. Once the bond is issued, investors meet dealers and trade in continuous time with finite horizon $[0, T]$. Let $\tau$ denote the time remaining until the maturity of the bond, that is $\tau = T - t$. Note that in $\tau = T$ (or $t = 0$), the underwriter owns the entirety of the bond. All agents discount payoffs at rate $\delta$. Dealers and investors receive flow utility from holding the bond before maturity. The flow payoff of a dealer from holding $a \in \mathbb{R}$ unit of the bond before the maturity, denoted by $u_D(a, s, r, \mathbf{x}, \xi)$, is:

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

where $\nu_D$ reflects the payoff from receiving interests, and $\kappa_D$ captures factors constraining dealers' ability to expand their asset holdings. Investors' flow payoff from holding the bond depends on their taste type, $\nu \in \mathbb{R}_+$, and is specified as:

$$u_I(a, \nu, s, r, \mathbf{x}, \xi) = \nu r a + \kappa_I(\mathbf{x}, \xi) a^2. \tag{8}$$

For investors, taste types are not persistent, and the investor's new type is drawn with probability $\alpha(\mathbf{x}, \xi)$ according to a distribution which varies with $(\tau, s, \mathbf{x}, \xi)$, denoted by $F_{\nu|(\tau,s,\mathbf{x},\xi)}$. The payoff at the end of the maturity is $\omega_j(\mathbf{x}, \xi)a$, with $\omega_j(\mathbf{x}, \xi) > 0$ for $j = I, D$.

Dealers meet investors and other dealer to trade. 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. On the other hand, the rate at which a dealer meets an investor, $\lambda$, is chosen by each dealer at costly search efforts. We assume that such costs depend on the dealer's initial cost, $\phi_0$, the dealer's cumulative trade volume with investors, $b$, and the bond attributes except the expected interest rate, $(s, \mathbf{x}, \xi)$, and that the costs are increasing and convex in $\lambda$:

$$\phi_0 \exp[-\phi_1(s, \mathbf{x}, \xi) b] \exp(\lambda). \tag{9}$$

Each dealer draws their initial cost parameter $\phi_0$ from a distribution that varies with bond attributes, $F_{\phi_0|(s,\mathbf{x},\xi)}$, whose support is $\mathbb{R}_+$. Note that if $\phi_1$ is strictly positive, then the search cost decreases with the dealer's experience of trading the bond with investors. With that, $\phi_0$ reflects the dealer-specific clientele network in the beginning, and $\phi_1$ measures the degree to which a dealer may benefit from further building up their network through transactions with in- or out-of-network clients. These parameters depend on bond attributes, including the special provision index, $s$: for example, the more extra provisions are included, the harder it is for the dealer to reach out to an investor.

When a dealer and investor meet, they determine the price and quantity to trade via Nash bargaining with dealer's bargaining parameter $\rho(\mathbf{x}, \xi) \in [0, 1]$. Similarly, when two dealers meet, they determine the price and quantity to trade via Nash bargaining with bargaining power $\rho_D = 0.5$. We assume that upon a meeting, each party's state is revealed.

In Section 4.2, we characterize the equilibrium in the trading market for any given bond with $(s, r, \mathbf{x}, \xi)$, and then characterize $(s, r)$ as determined at issuance as a result of bargaining between the issuing government and the underwriter in Section 4.3. To ease notational easiness, the dependence of all primitives and equilibrium objects on $(s, r, \mathbf{x}, \xi)$ is not explicitly stated in the remainder of this section unless it is necessary for our discussion, especially for the endogenous determination of $(s, r)$ in Section 4.3.

4.2. **Equilibrium in the Trading Market.** The state of a dealer at every point in time is summarized by their inventory of the bond, $a \in \mathbb{R}$, their cumulative trade with investors $b \in \mathbb{R}_+$ and their initial search type $\phi_0 \in \mathbb{R}_+$. An investor's state is summarized by her inventory $a \in \mathbb{R}$ and her taste type $\nu \in \mathbb{R}_+$. We use $z \equiv (a, b, \phi_0)$ to denote the state of a dealer and $y \equiv (a, \nu)$ to denote the state of an investor. We denote the equilibrium (total) price and quantity for a trade between two dealers of states $z$ and $z'$ at $\tau$ by $p_D(\tau; z, z')$ and $q_D(\tau; z, z')$; and similarly, those for a trade between a dealer of state $z$ and an investor of state $y$ by $p_I(\tau; z, y)$ and $q_I(\tau; z, y)$. The equilibrium distributions of dealers' and investors' state at time $\tau$ are denoted by $\Phi_D(\tau; z)$ and $\Phi_I(\tau; y)$.

The value function of a dealer of initial search type $\phi_0$ who holds $a$ units of the bond and has transacted $q$ amount of the bond at $\tau > 0$, denoted as $V(\tau; a, b, \phi_0) \equiv V(\tau; z)$, evolves according to

$$\begin{aligned}\dot{V}(\tau; z) = -\delta V(\tau; z) + u_D(a) + \lambda_D \int_{z'} \Big\{ V\left(\tau; a + q_D(\tau; z, z'), b, \phi_0\right) - V\left(\tau, z\right) \\ - p_D(\tau; z, z') \Big\} \phi_D(\tau; dz') + \max_{\lambda} \Big[ \lambda \int_{y} \Big\{ V\left(\tau; a - q_I(\tau; z, y), b + |q_I(\tau; z, y)|, \phi_0\right) \\ - V\left(\tau; z\right) + p_I(\tau; z, y) \Big\} d\Phi_I(\tau; dy) - \phi_0 \exp(-\phi_1 b) \exp(\lambda) \Big],\end{aligned} \tag{10}$$

The first term on the right hand side of (10) captures the dealer's discounting; the second term is their flow utility; and the third term is the expected change in the continuation utility associated with a trade with a dealer, which occurs with Poisson intensity $\lambda_D$. The potential trading party's state, $z'$, is randomly drawn from the equilibrium distribution $\phi_D(\tau; z)$. The fourth term represents the expected change in the continuation utility associated with a trade with an investor. The dealer chooses meeting rate $\lambda$ subject to a deterministic search cost, and the trading partner's state is drawn at random from the equilibrium distribution

$\phi_I(\tau; y)$. At maturity, or equivalently when $\tau = 0$, the dealer receives the face value of their inventory and the after-tax payoff is:

$$V(0; z) = \omega_D a. \tag{11}$$

Noting that the dealer chooses the optimal meeting rate with investors as indicated in (10), we characterize the equilibrium meeting rate by taking the first order condition:

$$\begin{aligned} \lambda(\tau; z) &= \log\Bigg(\frac{1}{\phi_0 \exp(-\phi_1 b)} \int_y \Big\{V(\tau; a - q_I(\tau; z, y), b + |q_I(\tau; z, y)|, \phi_0) \\ &- V(\tau; z) + p_I(\tau; z, y)\Big\} d\Phi_I(\tau; dy)\Bigg). \end{aligned} \tag{12}$$

Let $W(\tau; a, \nu) \equiv W(\tau; y)$ denote the maximum attainable payoff for an investor holding $a$ units of the bond, given her taste type $\nu$, when the time until the maturity of bond is $\tau$:

$$\begin{aligned} \dot{W}(\tau; y) &= -\delta W(\tau; y) + u_I(y) + \alpha \int [W(\tau; a, \nu') - W(\tau; y)] f(\nu'|\tau) d\nu' \\ &+ \frac{m_D}{m_I} \int_z \lambda(\tau; z) \Big\{W(\tau; a + q_I(\tau; z, y)) - W(\tau; y) - p_I(\tau; z, y)\Big\} \Phi_D(\tau; dz). \end{aligned} \tag{13}$$

The first term on the right hand side of (13) represents the investor' 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 Poisson intensity $\alpha$; and the fourth term is the expected change in the continuation utility associated with trade. The potential trading partner is randomly drawn, and the likelihood of drawing a dealer with state $z$ is $\frac{m_D}{m_I} \lambda(\tau; z) \Phi_D(\tau; dz)$. When $\tau = 0$, the investor receives the face value of the bond:

$$W(0; a, \nu) = \omega_I a. \tag{14}$$

The Nash framework bargaining ensures the trading quantity maximizes the joint gain:

$$q_I(\tau; z, y') = \arg\max_q \Big\{W(\tau; a' + q, \nu') - W(\tau; y) + V(\tau; a - q, b + |q|, \phi_0) - V(\tau; z)\Big\}, \tag{15}$$

$$q_D(\tau; z, z') = \arg\max_q \Big\{V(\tau; a + q, b, \phi_0) - V(\tau; z) + V(\tau; a' - q, b', \phi_0') - V(\tau; z')\Big\}, \tag{16}$$

The total price in a transaction implements a division of the gain from the trade:

$$p_I(\tau; z, y') = (1 - \rho) \max_q \Big\{W(\tau; a' + q, \nu') - W(\tau; y') - V(\tau; a - q, b + |q|, \phi_0) + V(\tau; z)\Big\}, \tag{17}$$

$$p_D(\tau; z, z') = (1 - \rho_D) \max_q \Big\{V(\tau; a + q, b, \phi_0) - V(\tau; z) - V(\tau; a' - q, b, \phi_0) + V(\tau; z')\Big\}. \tag{18}$$

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

$$\begin{aligned} -\dot{\Phi}_I(\tau; z) &= -\alpha \Phi_I(\tau; a, \nu)\left[1 - F(\nu|\tau)\right] + \alpha \int_{-\infty}^{a}\int_{\nu}^{\infty} \Phi_I(\tau; da, d\nu')F(\nu'|\tau) \qquad (19) \\ &- \int_{-\infty}^{\nu}\int_{-\infty}^{a}\int_{z} \lambda(\tau; z)\mathbb{I}_{\{\tilde{a}+q_I(\tau;z,\tilde{a},\tilde{\nu})>a\}}\Phi_D(\tau; dz)\Phi_I(\tau; d\tilde{a}, d\tilde{\nu}) \\ &+ \int_{-\infty}^{\nu}\int_{a}^{\infty}\int_{z} \lambda(\tau; z)\mathbb{I}_{\{\tilde{a}+q_I(\tau;z,\tilde{a},\tilde{\nu})\le a\}}\Phi_D(\tau; dz)\Phi(\tau; d\tilde{a}, d\tilde{\nu}). \end{aligned}$$

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 (19) 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 $\nu$, which occurs with probability $\alpha\left[1 - F(\nu|\tau)\right]$. The second term shows the inflow of investors who draw a new taste type less than $\nu$ 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 $a$.

Similarly, the equilibrium path of the dealer state distribution satisfies:

$$\begin{aligned} &-\dot{\Phi}^D(\tau; a, \varphi) \qquad (20) \\ = &- \int_{0}^{\varphi}\int_{-\infty}^{a}\int_{y} \lambda(\tau; \tilde{a}, \tilde{\varphi}) \max\left[\mathbb{I}_{\{\tilde{a}-q_I(\tau;y,\tilde{a},\tilde{\varphi})>a\}}, \mathbb{I}_{\{\tilde{\varphi}e^{-\phi_1|q_I(\tau;y,\tilde{a},\tilde{\varphi})|}>\varphi\}}\right]\Phi_I(\tau; dy)\Phi_D(\tau; d\tilde{a}, d\tilde{\varphi}) \\ &+ \int_{0}^{\varphi}\int_{a}^{\infty}\int_{y} \lambda(\tau; \tilde{a}, \tilde{\varphi}) \min\left[\mathbb{I}_{\{\tilde{a}-q_I(\tau;y,\tilde{a},d\tilde{\varphi})\le a\}}, \mathbb{I}_{\{\tilde{\varphi}e^{-\phi_1|q_I(\tau;y,\tilde{a},d\tilde{\varphi})|}\le\varphi\}}\right]\Phi_I(\tau; dy)\Phi_D(\tau; d\tilde{a}, d\tilde{\varphi}) \\ &+ \int_{\varphi}^{\infty}\int_{\tilde{a}}\int_{y} \lambda(\tau; \tilde{a}, \tilde{\varphi}) \min\left[\mathbb{I}_{\{\tilde{a}-q_I(\tau;y,\tilde{a},\tilde{\varphi})\le a\}}, \mathbb{I}_{\{\tilde{\varphi}e^{-\phi_1|q_I(\tau;y,\tilde{a},\tilde{\varphi})|}\le\varphi\}}\right]\Phi_I(\tau; dy)\Phi_D(\tau; d\tilde{a}, d\tilde{\varphi}) \\ &- \lambda_D \int_{0}^{\varphi}\int_{-\infty}^{a}\int_{z'} \mathbb{I}_{\{\tilde{a}+q_D(\tau;\tilde{a},\tilde{\varphi},z')>a\}}\Phi_D(\tau; dz')\Phi_D(\tau; d\tilde{a}, d\tilde{\varphi}) \\ &+ \lambda_D \int_{0}^{\varphi}\int_{a}^{\infty}\int_{z'} \mathbb{I}_{\{\tilde{a}+q_D(\tau;\tilde{a},\tilde{\varphi},z')\le a\}}\Phi_D(\tau; dz')\Phi_D(\tau; d\tilde{a}, d\tilde{\varphi}). \end{aligned}$$

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

$$\Phi_I(T; a, \nu) = \mathbb{I}_{\{a\ge 0\}}F_{\nu|\tau}(\nu|T). \qquad (21)$$

Instead, the initial condition for $\Phi_D$ 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 as

$$\Phi_D(T;a,b,\phi_0)=\begin{cases}\mathbb{I}_{\{a\geq 0,b\geq 0\}}F_{\phi_0}(\phi_0), & \text{if } \phi_0\neq\phi_{0,U}\\ (1-m_U)\mathbb{I}_{\{a\geq 0,b\geq 0\}}F_{\phi_0}(\phi_0)+m_U\mathbb{I}_{\{a\geq A,b\geq 0\}}F_{\phi_0}(\phi_0), & \text{if } \phi_0=\phi_{0,U}\end{cases} \tag{22}$$

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

**Definition 4.1.** *An equilibrium in the trading market for a bond is (i) a path for the distribution of investors' state, $\Phi_I(\tau;a,\nu)$ and a path for the distribution of dealers' state, $\Phi_D(\tau;a,\varphi)$, (ii) value functions for investors and dealers, $W(\tau;a,\nu)$ and $V(\tau;a,\varphi)$, (iii) dealer-to-investor meeting rates $\lambda(\tau;a,\varphi)$, (iv) dealer-to-investor trade prices and quantities, $p_I(\tau;a,\nu,a',\varphi')$ and $q_I(\tau;a,\nu,a',\varphi')$ and dealer-to-dealer trade prices and quantities, $p_D(\tau;a,\varphi,a',\varphi')$ and $q_D(\tau;a,\varphi,a',\varphi')$, such that*

1. *(i) evolves according to (19) and (20) subject to (21) and (22), given (ii)–(iv);*
2. *(ii) satisfies (10), (11), (13), and (14) ,given (i);*
3. *(iii) satisfies (12), given (i)–(ii);*
4. *(iv) satisfies (15), (16), (17), and (18), given (ii).*

4.3. **Equilibrium Bond Design.** Note the underwriter's payoff from the trading market, $V_U(s,r,\mathbf{x},\xi)$, is equal to $V(T;A,0,\phi_{0,U}|s,r,\mathbf{x},\xi)$, where we make the dependence of the value function on the bond attributes explicit. Given this, we write the Nash bargaining problem between the government official and the underwriter as follows:

$$\max_{(s,r,F)} \quad \Big[F-c_0(s,\mathbf{x})A(1+rT)+\psi(\mathbf{x},h)\left\{V(T;A,0,\phi_{0,U}|s,r,\mathbf{x},\xi)-F\right\}-J_G(\mathbf{x},\xi,h)\Big]^{\rho}$$
$$\times\Big[V(T;A,0,\phi_{0,U}|s,r,\mathbf{x},\xi)-F-J_U(\mathbf{x},\xi,h)\Big]^{1-\rho},$$

subject to

$$F-c_0(s,\mathbf{x})A(1+rT)+\psi(\mathbf{x},h)\left\{V(T;A,0,\phi_{0,U}|s,r,\mathbf{x},\xi)-F\right\}-J_G(\mathbf{x},\xi,h)\geq 0,$$
$$V(T;A,0,\phi_{0,U}|s,r,\mathbf{x},\xi)-F-J_U(\mathbf{x},\xi,h)\geq 0.$$

The solution, $(s^*,r^*,F^*)$, satisfies

$$\frac{\rho}{1-\rho}=\frac{F-c_0(s,\mathbf{x})A(1+rT)+\psi(\mathbf{x},h)\left\{V_U(s,r,\mathbf{x},\xi)-F\right\}-J_G(\mathbf{x},\xi,h)}{V(T;A,0,\phi_{0,U}|s,r,\mathbf{x},\xi)-F-J_U(\mathbf{x},\xi,h)}, \tag{23}$$

$$0=-\frac{\partial}{\partial s}c_0(s,\mathbf{x})A(1+rT)+\left\{1+\psi(\mathbf{x},h)\right\}\frac{\partial}{\partial s}V(T;A,0,\phi_{0,U}|s,r,\mathbf{x},\xi), \tag{24}$$

$$0=-c_0(s,\mathbf{x})AT+\left\{1+\psi(\mathbf{x},h)\right\}\frac{\partial}{\partial r}V(T;A,0,\phi_{0,U}|s,r,\mathbf{x},\xi). \tag{25}$$

The negotiated bond attributes, $(s^*,r^*)$, maximize the sum of the government official's and the underwriter's payoffs, as represented by (24) and (25). The purchase price, $F^*$, divides the surplus of the negotiation by (23).

In summary, bond special provisions, as summarized by $s$, enter the model in three dimensions: they affect the distribution of the investor taste type, the issuer cost, and the search frictions. As for the search frictions, they affect the initial search cost parameters, $\phi_0$, and the prevalence of network effects, as captured by $\phi_1$. These multiple roles that bond provisions play shape the welfare impact of special bond provisions.

Our model provides multiple channels through which $s^*$ may differ from the level of $s$ that maximizes total surplus. First, to the extent that $\psi \neq 0$, the underwriter's payoff is over-represented. Second, given the bargaining framework, the underwriter's payoff from trades, $V(T; A, 0, \phi_{0,U}|s, r, \mathbf{x}, \xi)$, doesn't fully internalize the total expected surplus from all trades of the bond. A direct consequence is that this payoff does not fully reflect search costs borne by other dealers and ultimately investors, whose resale values of the bond are affected by search frictions. Finally, the underwriter is a vertically integrated entity, who is in charge both of selling the bond to investors immediately after issuance, and then competes with other dealers to intermediate trades in the secondary market of the bonds. Due to her dual role, the underwriter may benefit from manipulating the bond provisions so that search frictions faced by her are lower than those by other dealers. One way to achieve such competitive advantage is to exploit the initial sales experience, and employing complex bond provisions may amplify the value of initial experience through $\phi_1$. We next quantify the effects of these channels on the market outcomes and the welfare using the estimated model.

## 5. Estimation

5.1. **Observables and Model Primitives.** To estimate our model, we employ bond issuance and transaction data. For each bond issuance $i$, we observe special provisions attached to the bond contract, with which we construct an index corresponding to $s$ in the model, and denote the index by $s_i$. We also observe various bond attributes, including the interest rate ($r_i$), the face value ($A_i$), the time to maturity ($T_i$), and multi-dimensional bond and government attributes ($\mathbf{x}_{oi}$). The latter includes measures of the issuer's financial health, the issuer's type (city/county vs. special-purpose governments like water utilities) and the state where it is located, and various demographic and economic attributes of the county where the issuer is located. We denote all exogenous bond attributes that are observed in the data by $\mathbf{x}_i \equiv (A_i, T_i, \mathbf{x}_{oi})$. We also observe whether there was a state revolving-door regulation in place at the time of the issuance, represented by a dummy variable, $h_i$. As for transactions, we observe the occurrence of all transactions for a given issuance until its maturity or the end period of our data, whichever is earlier. 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 ($t_{ij}$ and accordingly, the 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.

The model primitives are government preferences, $c_0(s, \mathbf{x})$ and $\psi(\mathbf{x})$; investor preferences, $F_{\nu|(\tau,s,\mathbf{x},\xi)}(\cdot|\tau, s, \mathbf{x}, \xi)$, $\kappa_I(\mathbf{x}, \xi)$, $\alpha(\mathbf{x}, \xi)$, and $\omega_I(\mathbf{x}, \xi)$; dealer preferences, $\nu_D(\mathbf{x}, \xi)$, $\kappa_D(\mathbf{x}, \xi)$, and $\omega_D(\mathbf{x}, \xi)$; search cost parameters, $F_{\phi 0|(s,\mathbf{x},\xi)}(\cdot|s, \mathbf{x}, \xi)$, and $\phi_1(s, \mathbf{x}, \xi)$; inter-dealer meeting rates, $\lambda_D(\mathbf{x}, \xi)$; the ratio of the dealer measure to the investor counterpart, $m_D/m_I(\mathbf{x})$; dealer-to-investor bargaining parameter $\rho(\mathbf{x}, \xi)$; and discount rate, $\delta$.

Given our moderate sample size, we make several parametric assumptions. First, we assume that the support of $F_{\phi 0|(s,\mathbf{x},\xi)}(\cdot|s, \mathbf{x}, \xi)$ is discrete, consisting of at most three points. Specifically, we assume that for a given bond there are up to three different $\phi_0$ values depending on the geographic specialization of a dealer.[5]

Second, we assume that $F_{\nu|(\tau,s,\mathbf{x},\xi)}$ is a Gamma distribution with parameters $\gamma_1(s, \mathbf{x}, \xi)$ and $\gamma_2(s, \mathbf{x}, \xi)$ for all $\tau \in [0, T]$. In addition, we set the discount rate $\delta = 0.05$. We assume that $m_I/m_D$ 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 issuance of a given bond, divided by the total number of dealers in that state. Under these assumptions, we define the *trading market parameters* by:

$$\tilde{\theta}(s, \mathbf{x}, \xi) \equiv \Big\{\gamma_1(s, \mathbf{x}, \xi), \gamma_2(s, \mathbf{x}, \xi), \nu_D(\mathbf{x}, \xi), \kappa_I(\mathbf{x}, \xi), \kappa_D(\mathbf{x}, \xi), \alpha(\mathbf{x}, \xi), \omega_I(\mathbf{x}, \xi), \omega_D(\mathbf{x}, \xi),$$
$$\phi_{0,L}(s, \mathbf{x}, \xi), \phi_{0,M}(\mathbf{x}, \xi), \phi_{0,H}(\mathbf{x}, \xi), \phi_1(s, \mathbf{x}, \xi), \phi_2(\mathbf{x}, \xi), \phi_3(s, \mathbf{x}, \xi), \lambda_D(\mathbf{x}, \xi), \rho(\mathbf{x}, \xi)\Big\}.$$

Third, we assume that $\xi$ is a multi-dimensional random vector of mean zero, and the logarithm of the trading market parameters are additively separable in $\xi$:

$$\log\left[\tilde{\theta}(s, \mathbf{x}, \xi)\right] = \theta(s, \mathbf{x}) + \xi, \tag{26}$$

where $\theta(s, \mathbf{x})$ are functions of observed bond attributes. This specification accounts for rich heterogeneity at the bond level, and given our model, the endogenous bond attribute, $s$, depends on $\xi$. As discussed in Section 4.3, the forward-looking negotiating parties anticipate the underwriter's payoff from trading the bond as a function of both observed and unobserved bond attributes that are predetermined, $(\mathbf{x}, \xi)$. Therefore, these attributes must be factored into when negotiating over $(s, r)$, which complicates identification and estimation of the objects in (26).

[5]Specifically, we define $g_{ij}$ as a categorical variable that takes three values, indicating the group to which a dealer in the $j^{th}$ transaction for bond $i$ belongs: $g_{ij} = 0$ if the dealer has experience of trading any bond from the same county and multiple bonds from the same state; $g_{ij} = 1$ if she has experience of trading the same-county bonds, but not much experience of trading the same-state bonds; and no experience of the same-county bond trading implies $g_{ij} = 2$.

Fourth, we make parametric assumption on $\theta(s,\mathbf{x})$, $c_0(s,\mathbf{x})$ and $\psi(\mathbf{x})$ as follows:

$$\begin{aligned}
\theta(s,\mathbf{x}) &= \theta_{\theta 0}+\theta_{\theta s}s+\theta_{\theta x}\mathbf{x}, && (27)\\
c_0(s,\mathbf{x}) &= \theta_{c0}+\theta_{c1}s+\theta_{c2}s^2+\theta_{cx}s\mathbf{x}+\theta_{cx2}s^2\mathbf{x}, && (28)\\
\psi(\mathbf{x}) &= \theta_{\psi 0}+\theta_{\psi x}\mathbf{x}. && (29)
\end{aligned}$$

Lastly, we assume that the unobserved bond attributes are orthogonal to the state-level revolving door regulations:

$$\mathbb{E}(\xi h)=0. \qquad (30)$$

5.2. **Estimation Strategy: Overview.** We estimate the model primitives described in Section 5.1 by employing a multi-step estimator. This approach addresses two main challenges in (i) recovering investor demand and dealer search costs as a function of both observed and unobserved bond attributes, and (ii) disentangling government officials' preferences and underwriter's payoff, which jointly determine the observed endogenous bond attributes. In the first step, we use bond transaction data to recover the parameters of the trading market, separately for each bond. We denote the trading market parameters of bond $i$ by $\theta_i \equiv \tilde{\theta}(s_i,\mathbf{x}_i,\xi_i)$, and its estimates from the first step by $\hat{\theta}_i$. In the second step, using $\hat{\theta}_i$ from the previous step, we estimate the parameters of $\theta(s,\mathbf{x})$ and the unobserved heterogeneity vector $\xi_i$ for each bond, by employing an instrumental variable approach based on the exogeniety assumption of (30). In the last step, we exploit the optimality of the endogenous bond attributes to recover the issuing government's cost function, $c_0(s,\mathbf{x})$, and the extent to which the government officials weigh in the underwriter's payoff absent revolving-door regulations, $\psi(\mathbf{x})$.

5.3. **Step 1: Trading Market Parameters for Each Bond.** We estimate the trading market parameters for each bond separately, using the observed transaction price, quantity, and timing. Recall that if trade $j$ of bond $i$ is between two dealers ($d_{ij}=0$), we observe the state of both dealers, denoted by $z_{ij}\equiv(a_{ij},b_{ij},g_{ij})$ and $z'_{ij}\equiv(a'_{ij},b'_{ij},g'_{ij})$; otherwise ($d_{ij}=1$), we observe $z_{ij}$ but we do not observe the investor's state.

We estimate the inter-dealer meeting rate, $\lambda_{D,i}$, directly from the timing of the dealer-to-dealer transactions for bond $i$ using a maximum likelihood estimator. Let us denote the estimate by $\hat{\lambda}_{D,i}$ and the sub-vector of $\theta_i$ excluding $\lambda_{D,i}$ by $\theta_{r,i}$. To estimate $\theta_{r,i}$, we use equilibrium conditions regarding the dealer-to-investor meeting rates, $\lambda(\tau,z|\theta)$, and the trade outcomes in terms of price and quantity, $p_I(\tau,z,y|\theta)$, $q_I(\tau,z,y|\theta)$, $p_D(\tau,z,z'|\theta)$ and $q_D(\tau,z,z'|\theta)$, as characterized by (12) and (15)–(18).

First, letting $\tau_{ij,-1}$ denote the time of the most recent trade by the dealer of trade $j$ for bond $i$ prior to that trade, we can show that the log-likelihood of timing of the transaction,

$\tau_{ij}$, conditional on $(\tau_{ij,-1}, z_{ij}, d_{ij})$, denoted by $\log \mathcal{L}(\tau_{ij}|\tau_{ij,-1}, z_{ij}, d_{ij}, \theta_i)$, satisfies:

$$\log \mathcal{L}(\tau_{ij}|\tau_{ij,-1}, z_{ij}, d_{ij}, \theta_i) = d_{ij} \log\left[\lambda(\tau_{jj}; z_{ij}|\theta_i)\right] - \int_{\tau_{ij,-1}}^{\tau_{ij}} \lambda(s, z_{ij}|\theta_i) ds. \tag{31}$$

Second, from the inter-dealer trades, we have the following moment conditions:

$$\mathbb{E}\Big[q_{ij} - q_D\left(\tau_{ij}; z_{ij}, z'_{ij}|\theta_{r,i}, \hat{\lambda}_{D,i}\right) \Big|\tau_{ij}, z_{ij}, z'_{ij}, d_{ij} = 0\Big] = 0, \tag{32}$$

$$\mathbb{E}\Big[p_{ij} - p_D\left(\tau_{ij}; z_{ij}, z'_{ij}|\theta_{r,i}, \hat{\lambda}_{D,i}\right) \Big|\tau_{ij}, z_{ij}, z'_{ij}, d_{ij} = 0\Big] = 0. \tag{33}$$

Third, based on the investor-to-dealer trades, we construct the following moment conditions, noting that we do not observe the investors' state:

$$\mathbb{E}\Big[q_{ij} - \int_y q_I\left(\tau_{ij}; z_{ij}, y|\theta_{r,i}, \hat{\lambda}_{D,i}\right) \Phi_{I,i}\left(\tau_{ij}; dy|\theta_i\right) \Big|\tau_{ij}, z_{ij}, d_{ij} = 1\Big] = 0, \tag{34}$$

$$\mathbb{E}\Big[p_{ij} - \int_y p_I\left(\tau_{ij}; z_{ij}, y|\theta_{r,i}, \hat{\lambda}_{D,i}\right) \Phi_{I,i}\left(\tau_{ij}; dy|\theta_i\right) \Big|\tau_{ij}, z_{ij}, d_{ij} = 1\Big] = 0, \tag{35}$$

where $\Phi_{I,i}\left(\tau_{ij}; dy|\theta_i\right)$ is the simulated distribution of the investors' state given parameter $\theta_i$.

Based on (31)–(35), we build a minimum distance estimator for $\theta_{r,i}$:

$$\begin{aligned}
\hat{\theta}_{r,i} = \arg\min_{\theta_r} \sum_j -w_t \Big\{ d_{ij} \log\left[\lambda(\tau_{jj}; z_{ij}|\theta_r, \hat{\lambda}_{D,i})\right] - \int_{\tau_{ij,-1}}^{\tau_{ij}} \lambda(s, z_{ij}|\theta_r, \hat{\lambda}_{D,i}) ds \Big\} \\
+ w_q \Big\{ q_{ij} - (1 - d_{ij}) q_D(\tau_{ij}; z_{ij}, z'_{ij}|\theta_r, \hat{\lambda}_{D,i}) - d_{ij} \int_y q_I(\tau_{ij}; z_{ij}, y|\theta_i) \Phi_{I,i}(\tau_{ij}; dy|\theta_r, \hat{\lambda}_{D,i}) \Big\}^2 \\
+ \Big\{ p_{ij} - (1 - d_{ij}) p_D(\tau_{ij}; z_{ij}, z'_{ij}|\theta_r, \hat{\lambda}_{D,i}) - d_{ij} \int_y p_I(\tau_{ij}; z_{ij}, y|\theta_r, \hat{\lambda}_{D,i}) \Phi_{I,i}(\tau_{ij}; dy|\theta_r, \hat{\lambda}_{D,i}) \Big\}^2,
\end{aligned}$$

for some positive weights $(w_t, w_q) > 0$. To solve for the model equilibrium objects in the above equation, we first estimate the equilibrium distribution of dealer states from the observed dealer states, then we use a nested fixed point algorithm to solve for dealers' and investors' value functions as well as the equilibrium distribution of investor states (Rust, 1987). We denote $(\hat{\theta}_{r,i}, \hat{\lambda}_{D,i})$ by $\hat{\theta}_i$.

5.4. **Step 2: Trading Market Parameters as a Function of Bond Attributes.** Given our estimates of $\theta_i$ for each bond $i$, $\hat{\theta}_i$ we estimate functions $\tilde{\theta}(s, \mathbf{x})$, as defined in (26), which describe how the trading market parameters depend on bond attributes. Given orthogonality condition (30), we have the following moment condition:

$$\mathbb{E}\Big[\Big\{\log \hat{\theta}_i - \theta(s_i, \mathbf{x}_i; \theta_\theta)\Big\} h_i\Big] = 0. \tag{36}$$

We estimate $\theta_\theta$, as specified in (27), by running a IV regression on $\hat{\theta}_i$ using the revolving-door regulation indicator variable, $h_i$, as an instrument. Let us denote the estimated parameters by $\hat{\theta}$ and the estimated unobserved bond attributes by $\hat{\xi}_i \equiv \log \hat{\theta}_i - \theta(s, \mathbf{x}; \hat{\theta}_\theta)$.

Table 6. Search Cost Estimates and Meeting Rates

| | Average dealer | Underwriter |
|---|---|---|
| Marginal search cost at $\lambda = 0$ | \$785 | \$471 |
| Average search cost | \$1,440 | \$4,393 |
| Average meeting rate | 0.05 | 0.13 |

*Notes*: The numbers presented in this table are based on the search cost parameter estimates, evaluated at the median bond in terms of $(s, r, \mathbf{x}, \hat{\xi})$. The unit of period is a month.

5.5. **Step 3: Government Preferences.** The last step of our empirical strategy boils down to estimating the parameters of the issuing government's cost of paying debt, $c_0(s, \mathbf{x}; \theta_c)$, and the conflict-of-interest parameter $\psi(\mathbf{x}; \theta_\psi)$, as specified in (28) and (29). Exploiting the optimality condition of (**??**) and the Step 2 estimates, we estimate $(\theta_c, \theta_\psi)$ by minimizing the sum of squared distances between the observed endogenous bond attributes and the corresponding model predictions. Specifically, let us denote the model predicted endogenous bond attributes for bond $i$ given the Step 2 estimates and a chosen parameter vector $(\theta_c, \theta_\psi)$ by $s^*(\theta_c, \theta_\psi; \hat{\theta}_\theta, \hat{\xi}_i)$ and $r^*(\theta_c, \theta_\psi; \hat{\theta}_\theta, \hat{\xi}_i)$.

$$\begin{aligned}\left(s^*(\theta_c, \theta_\psi; \hat{\theta}_\theta, \hat{\xi}_i), r^*(\theta_c, \theta_\psi; \hat{\theta}_\theta, \hat{\xi}_i)\right) \quad &= \quad \arg\max_{(s,r)} V(T_i; A_i, 0, \hat{\phi}_{0,U,i} | s, r, \mathbf{x}_i, \hat{\theta}_\theta, \hat{\xi}_i) \\ &\times \{1 + (1 - h_i)\psi(\mathbf{x}_i; \theta_\psi)\} - c_0(s, \mathbf{x}_i; \theta_c) A_i (1 + rT_i).\end{aligned}$$

We define the minimum-distance estimator for $(\theta_c, \theta_\psi)$ for a positive weight of $w_s > 0$:

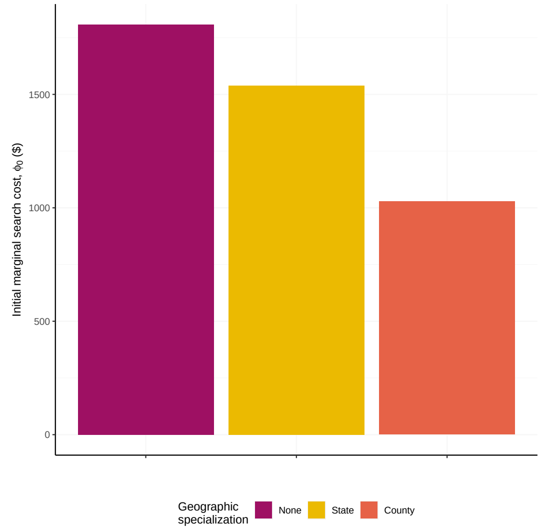
$$(\hat{\theta}_c, \hat{\theta}_\psi) = \arg\min_{(\theta_c, \theta_\psi)} \sum_i w_s \Big\{ s_i - s^*(\theta_c, \theta_\psi; \hat{\theta}_\theta, \hat{\xi}_i) \Big\}^2 + \Big\{ r_i - r^*(\theta_c, \theta_\psi; \hat{\theta}_\theta, \hat{\xi}_i) \Big\}^2 . \tag{37}$$

## 6. Preliminary Estimation Results

This section describes our preliminary estimates of the primitives of the model, based on the estimator developed in the previous section.

6.1. **Search Frictions.** Table 6 presents the monthly marginal and average search cost estimates for a bond with median values of $(s, r, \mathbf{x}, \hat{\xi})$, and how these estimates differ between an underwriter and average dealers. The marginal search cost at $\lambda = 0$ for an underwriter is \$471 per month, which is 40% lower than the counterpart for an average dealer. However, the monthly average search costs are much higher for an underwriter (\$4,393) than an average dealer (\$1,440). This is because an underwriter takes advantage of its competitive advantage, as represented by his low marginal search cost, and meets investors at a much higher rate (0.13), almost triple of the meeting rate of an average dealer (0.05).

Figure 1. Dealer Heterogeneity in Initial Search Costs




*Notes*: Each bar represents the average estimate of $\phi_0$ for three types of dealers, depending on their trading history regarding a given bond during one year before the bond's origination: (1) those who didn't trade a bond originated from the same state as the bond (indicated as "None"); (2) those who traded a bond originated in the same state but in a different county ("State"); and (3) those who traded a bond originated in the same county.

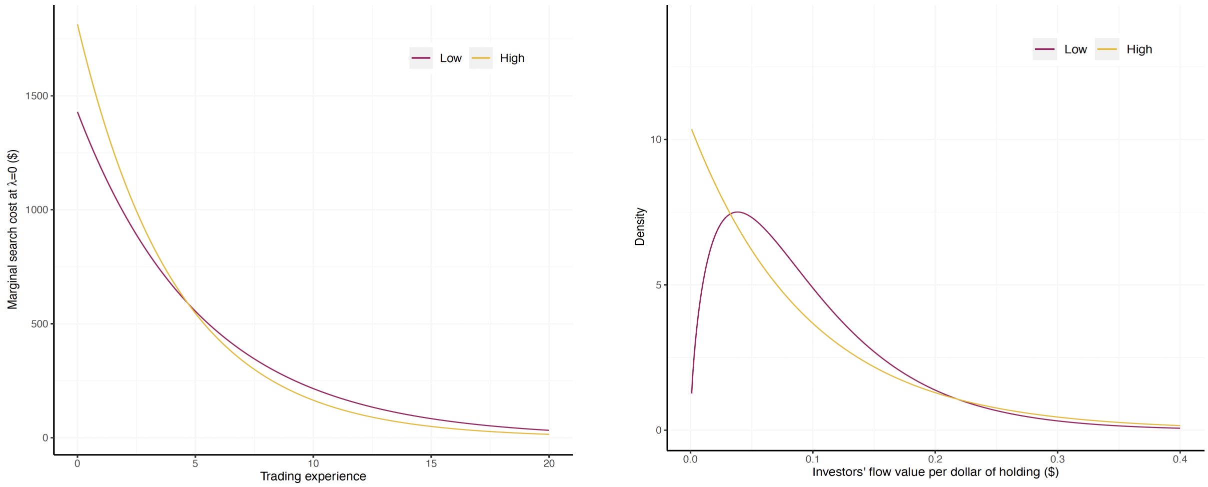
We find that the initial search cost parameter, $\phi_0$, significantly vary with dealers' geographic specialization. Figure 1 presents the average estimates of $\phi_0$ for three types of dealers for a bond, depending on their past trading history during one year before the bond's origination. It shows that for any given bond, the average value of $\phi_0$ for a dealer who traded a bond originated from the same county before (indicated in the far left, dark purple bar) is about half of the counterpart for a dealer who didn't trade a bond originated from the same state (indicated in the right, orange bar).

Panel (A) of Figure 2 presents how our estimates of search costs depend on complexity, focusing on an average dealer's marginal search costs at $\lambda = 0$ as a function of trading experience, $b$:

$$\phi_0 \exp[-\phi_1(s, \mathbf{x}, \xi)b].$$

The purple graph in the panel shows the function evaluated at the median values of $(r, \mathbf{x}, \hat{\xi})$ and the $25^{th}$ percentile value of complexity index, $s$; and the yellow graph is the counterpart function for a similar bond with the $75^{th}$ percentile value of $s$. The estimates indicate that the initial marginal search cost, at $b = 0$, is lower for the low-complexity bond than the high-complexity one. For both bonds, we find that the marginal search costs decrease in dealers' trading experience with investors, but the rate of return for experience is higher for the low-complexity bond. These patterns illustrate that although bond complexity increases

Figure 2. Effects of Bond Complexity on Demand and Search Costs




(A) Marginal Search Costs at $\lambda = 0$ (B) Investor Flow Value Distributions

*Notes*: Panel (A) shows the estimated distribution of investors' flow value per dollar of holding a representative bond whose complexity index is at the $25^{th}$ percentile level (indicated as "low") and the $75^{th}$ percentile level (indicated as "high"). In Panel (B), we plot the estimated search cost functions of (9) at $\lambda = 0$ for two representative bonds with low and high complexity, respectively.

the search costs for all dealers including underwriters initially, underwriters's benefits from initial sales experience are higher for complex bonds than simple ones.

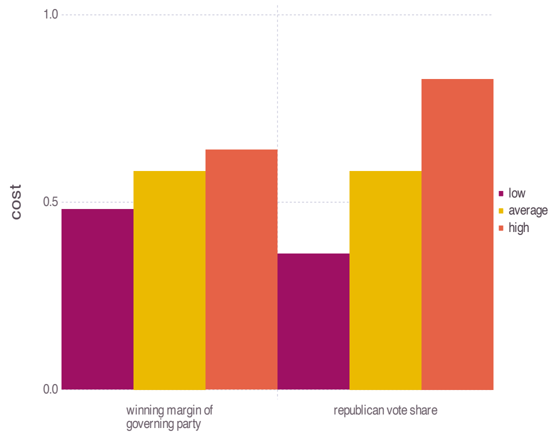
6.2. **Investor Demand and Government Payoffs.** Panel (B) of Figure 2 presents the probability density distribution of investors' flow value per dollar of holding a bond, $\nu\sqrt{r}$, for the two bonds considered in Panel (A). footnoteWe assume that the investors' utility is concave in the interest rate $r$ to capture the higher risk of default associated with a large interest rate Recall our assumption that the distribution of $\nu$ is a Gamma distribution with parameters depending on $(s, \mathbf{x}, \xi)$. We find that the fraction of high-value investors and the standard deviation of the values are larger for the latter than the former. These findings correspond to the idea that complex bonds tend to be favored by specific sets of investors, while simple bonds may cater to a broader range of investors albeit at a relatively lower value.

Finally, we recover the government marginal cost of debt payments, $c_0(s, \mathbf{x}; \theta_c)$. It is important to emphasize that $c_0$ captures this cost *as perceived by the government official* who participates to the issuance negotiations. For this reason, the recovered cost reflects as much the government official's incentives as the cost born by the "government" itself to complete the payments. Panel (A) of Figure 3 plots the average marginal cost of bonds payment and shows how it varies with some government attributes. We find that for the average issuer the marginal cost of future bond payments is 0.58. Therefore, government officials don't fully internalize the cost of future bond payments. Indeed, bond maturity is on average 15 years, a much longer horizon compared to the normal tenure in office of local government officials. Consistent with this, we find that that the perceived cost $c_0$ tends to be lower in electorally vulnerable districts, where the turnover of government officials is higher. Finally, the figure also shows that the perceived cost of debt payments is larger for Republican leaning counties. This result is consistent with the stance of fiscal conservatism traditionally taken by the Republican party at the national level and reveals that a similar position carries through also at the local level, in contrast with the view of local governments as "less partisan."

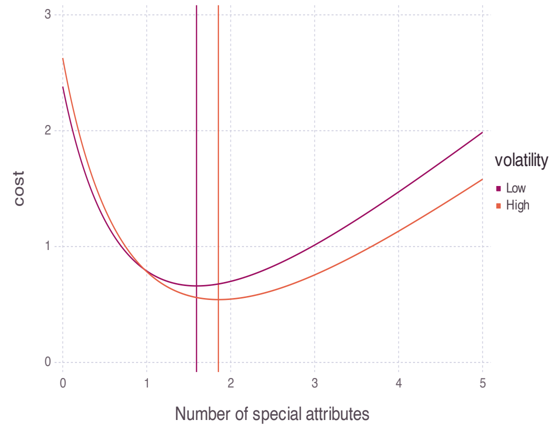
Panel (B) of Figure 3 displays how the cost of debt payments, $c_0(s, \mathbf{x}; \theta_c)$ varies depending on the number of special bond attributes and how that depends on the volatility of the government revenues. Our estimates imply that $c_0(s, \mathbf{x}; \theta_c)$ is convex in $s$. Indeed, from the perspective of the government the benefits of adding special attributes and contingencies must be weighted against the increased cost of managing the bond payments as these attributes increase. As an example, the government might have a financial advisor on retainer to manage payments and execution for particularly complex bonds. Our results suggest that the benefits of an additional special bond attribute taper out and they are outweighed by the cost for larger values of $s$. Furthermore, the plot compares the marginal cost $c_0$ for local governments who face high (75th percentile) and low (25th percentile) revenue volatility. For $s = 0$ high-revenue-volatility governments face a larger marginal cost of payment. However, special bond attributes are more valuable for these governments, and for high level of $s$ their marginal cost becomes smaller than that of low-revenue-volatility governments. Indeed, high-revenue-volatility governments value more the ability to leverage special bond attributes to align the timing of bond payments periods of large cash influxes.

6.3. **Counterfactual Policies.** Given our estimates of the model, we study how the selection of bond attributes affects search frictions and welfare. In doing so, we consider three counterfactual scenarios. First, we quantify the consequences of a policy to standardize the bond provisions. Specifically, we consider a policy mandating that the level of bond complexity, or the number of special bond provisions, be at or below the current $25^{th}$ percentile value. Second, we study the impact of policies to reduce underwriters' incentives to distort the choice of bond attributes to gain a competitive advantage via-à-vis other dealers. One such policy is to ban underwriters' participation in the trading market, and the other policy is to ban other dealers' participation in the trading market, thus granting monopoly to the underwriter. The estimates of these counterfactual scenarios are to be presented in the next version of the paper.

FIGURE 3. Government cost of debt payments




(A) The political economy of debt payment




(B) Government's value of special bond attributes

*Notes*: Panel (A) shows how the estimated government marginal cost of debt payments $c_0$ covaries with political economy variables . In Panel (B), we show how the estimated government marginal cost of debt payments $c_0$ depends on the number of bond attributes and how this varies with the volatility of the government's revenues.

## 7. CONCLUSION

This paper presents empirical evidence, along with market institutions, suggesting that underwriters' and government officials' rent-seeking behavior increases prevalence of bonds with special provisions. Using our estimated model, we plan to assess market outcomes and welfare implications of a counterfactual policy where the use of special bond provisions are limited so that bonds are relatively standardized. Another important counterfactual policies to consider are to address the vertical integration in the municipal bonds market in that underwriters participate in both the primary and the secondary markets; specifically, the federal government may consider banning the underwriters from trading in the secondary market as a dealer.

## REFERENCES

**Aguilar, Luis A.**, "Statement on Making the Municipal Securities Market More Transparent, Liquid, and Fair," *U.S. Securities and Exchange Commission Public Statement*, 2015. Available at `https://www.sec.gov/news/statement/making-municipal-securities-market-more-transparent-liquid-fair.html`.

**Allen, Jason, Robert Clark, and Jean-François Houde**, "Search Frictions and Market Power in Negotiated-Price Markets," *Journal of Political Economy*, 2019, *127* (4), 1550–1598.

**Asker, John and Heski Bar-Isaac**, "Raising Retailers' Profits: On Vertical Practices and the Exclusion of Rivals," *American Economic Review*, 2014, *104* (2), 672–86.

**Bernard, Tara Siegel**, "Even Math Teachers Are at a Loss to Understand Annuities.," *The New York Times*, Oct 2016.

**Bhattacharya, Vivek, Gaston Illanes, and Manisha Padi**, "Fiduciary Duty and the market for Financial Advice," *NBER working paper*, 2019, *w25861.*

**Braun, Martin Z**, "Where Have All the Muni-Bond Dealers Gone?," *Bloomberg*, 12 2015.

**DeHaan, Ed, Simi Kedia, Kevin Koh, and Shivaram Rajgopal**, "The Revolving Door and the SEC's Enforcement Outcomes: Initial Evidence from Civil Litigation," *Journal of Accounting and Economics*, 2015, *60* (2-3), 65–96.

**Egan, Mark**, "Brokers versus Retail Investors: Conflicting Interests and Dominated Products," *The Journal of Finance*, 2019, *74* (3), 1217–1260.

———, **Gregor Matvos, and Amit Seru**, "The Market for Financial Adviser Misconduct," *Journal of Political Economy*, 2019, *127* (1), 233–295.

**Ellison, Glenn and Sara Fisher Ellison**, "Search, obfuscation, and price elasticities on the internet," *Econometrica*, 2009, *77* (2), 427–452.

**Feldstein, Sylvan G and Frank J Fabozzi**, *The Handbook of Municipal Bonds*, Vol. 155, John Wiley & Sons, 2008.

**Garrett, Daniel G**, "Conflicts of Interest in Municipal Bond Advising and Underwriting," *Mimeo*, 2020.

**Gavazza, Alessandro**, "The Role of Trading Frictions in Real Asset Markets," *American Economic Review*, 2011, *101* (4), 1106–43.

———, "An Empirical Equilibrium Model of a Decentralized Asset Market," *Econometrica*, 2016, *84* (5), 1755–1798.

**Harris, Lawrence E and Michael S Piwowar**, "Secondary Trading Costs in the Municipal Bond Market," *The Journal of Finance*, 2006, *61* (3), 1361–1397.

**Ho, Kate and Robin S Lee**, "Equilibrium Provider Networks: Bargaining and Exclusion in Health Care Markets," *American Economic Review*, 2019, *109* (2), 473–522.

**Hristakeva, Sylvia**, "Vertical Contracts with Endogenous Product Selection: An Empirical Analysis of Vendor-Allowance Contracts," 2019. Available at `https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3506265`.

**Li, Dan and Norman Schürhoff**, "Dealer Networks," *The Journal of Finance*, 2019, *74* (1), 91–144.

**Liu, Gao**, "Relationships between Financial Advisors, Issuers, and Underwriters and the Pricing of Municipal Bonds," *Municipal Finance Journal*, 2015, *36* (1).

**Lucca, David, Amit Seru, and Francesco Trebbi**, "The Revolving Door and Worker Flows in Banking Regulation," *Journal of Monetary Economics*, 2014, *65*, 17–32.

**Rust, John**, "Optimal replacement of GMC bus engines: An empirical model of Harold Zurcher," *Econometrica*, 1987, pp. 999–1033.

**Schweich, Thomas A.**, "State Auditor's Report on the General Obligation Bond Sales Practices," *Missouri State Audit Report No. 2013-116*, 2013.

**Shive, Sophie A and Margaret M Forster**, "The Revolving Door for Financial Regulators," *Review of Finance*, 2017, *21* (4), 1445–1484.

**Tenekedjieva, Ana-Maria**, "The Revolving Door and Insurance Solvency Regulation," *Mimeo*, 2020.

**US Government Accountability Office**, "Municipal Securities: Overview of Market Structure, Pricing, and Regulation," *Report to Congressional Committees*, 2012, *GAO-12-265.*

**Üslü, Semih**, "Pricing and Liquidity in Decentralized Asset Markets," *Econometrica*, 2019, *87* (6), 2079–2140.

**Wang, Junbo, Chunchi Wu, and Frank X Zhang**, "Liquidity, default, taxes, and yields on municipal bonds," *Journal of Banking & Finance*, 2008, *32* (6), 1133–1149.

Table A1. 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 |

## Appendix A. Revolving-door Regulations

Based on the Ethics and Lobbying State Law and Legislation database by National Conference of State Legislatures, we identify the 14 enactments of state legislation regarding revolving-door practices. Among them, five pieces of state legislation introduced revolving-door regulations to a state or local government officials. Table A1 provides the list of these five pieces of legislation, which provides the variation in regulations during the period of study. The rest, nine pieces of legislation, is to strengthen the existing revolving-door regulations.

In New Mexico, S 432 was enacted on April 7, 2011. This Act 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," was enacted on March 25, 2011. This act prohibited 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 the 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 to 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.