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 often also acts as an intermediary. 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 price, 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 origination 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, including real estate, used goods markets, healthcare, and 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. Consumers often find themselves choosing among a variety of highly customized products. This wealth of alternatives can cater to heterogeneous consumer preferences. However, it can complicate the search process by making it harder to compare alternatives and find the option best suited to one's needs. How this trade-off from product variety is resolved is determined by producers' incentives when they design their products. This paper empirically demonstrates the effects of product design on demand, search frictions, and producer costs, and studies

Date: March 31, 2022.
Brancaccio (email: giulia.brancaccio@nyu.edu), New York University, CEPR, and NBER.
Kang (email: kangk@andrew.cmu.edu): Carnegie Mellon University. We thank Panle Jia Barwick, Matilde Bombardini, Gaston Illanes, Burton Hollifield, Jihye Jeon, Teddy Kim, Marc Rysman, Francesco Trebbi, Kenneth Winston, Milena Wittwer, and the participants at seminars and conferences. Special thanks to Santiago Tellez Alzate, Abigail Kessler, and Aneil Gir for excellent research assistance. Th research reported here was supported by the National Science Foundation through Grants #2117227 and #2117297.

producers' incentives to offer highly customized products in order to hinder the customers' search process and increase their own rents.

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 origination a government official and an underwriter, a financial institution in charge of the initial marketing of the bond, negotiate over the bond contract. The simplest bond contracts only specify a maturity and fixed interest rate paid on a semiannual base. However, the majority of bonds in this market have a variety of special provisions, such as flexible maturities, variable interest rates, and unique redemption clauses contingent on elaborate circumstances. We show that the decision to add these special provisions to a bond involves a delicate trade-off. On the one hand, special bond provisions introduce flexibility that can accommodate investors' or an issuing government's financial needs. However, they also decrease the bond's liquidity, to the detriment of investors and the issuing government. Moreover, we find suggestive evidence that the underwriter may benefit from including various special provisions in the bond. After origination, the underwriter competes with other financial institutions to intermediate trades in the bond's trading market. We show that special provisions can make it harder for the underwriter's competitors to trade the bond, increasing the underwriters' market share.

The goal of this paper is two-fold. First, we capture how the underwriters' incentives affect bond variety and shape search frictions in the municipal bond market. In this respect, our study offers an important perspective for several other financial markets– including insurance, fixed-income asset, annuity, and mortgage markets– where the proliferation of highly customized and increasingly complex products has recently ignited a policy debate concerning whether reining in product complexity could be beneficial (Aguilar, 2015; Bernard, 2016). Second, we measure the impact of nonstandard bond attributes on overall welfare and the cost of capital for state and local governments. Our findings 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 begin by combining rich issue-level data with proprietary transaction-level data on bond trades to document key empirical patterns regarding underwriters' and officials' incentives during negotiations over bond attributes. To do so, we leverage changes to state revolving door regulations to build an instrument that exogenously changes the attributes of newly issued bonds. Revolving door regulations are intended to reduce conflicts of interest 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. While not directly affecting the demand for municipal bonds, these regulations may affect the incentives of government officials when negotiating with the underwriters and reduce the underwriter's influence over the choice of bond attributes.

We find that enacting revolving door regulations reduces the number of special provisions in newly issued bonds. Next, using revolving door regulations as an 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 points to a potential distortion in bond design, suggesting that an underwriter might have anti-competitive incentives to include special provisions when originating a bond. In particular, the underwriter's exclusive right to sell the bond at origination 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, the intermediation spread of the bond rises, implying that investors have to pay more when buying and selling the bond to the dealer. However, the bonds' default risk also decreases, suggesting that the flexibility introduced by a bond's special attributes can be valuable for the issuing government. These findings implies that the welfare consequences of mandating simple, standardized bonds are not necessarily clear.

Motivated by the aforementioned empirical findings, we build and estimate a model of bond origination and decentralized trading with intermediaries in the spirit of Üslü (2019). 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 resells it to investors and other dealers. Investors and dealers then 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 interest, which is allowed to vary with the bond's special provisions. 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. These bond attributes are observed by all participants in the market, although some may not be observed by the researcher.

We follow a multi-step strategy to estimate the model. First, we use trading prices, quantities, and meeting rates to estimate bond-specific dealer costs and investor valuations by matching the predicted trading prices and quantities in the trading market. 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 affect the choice of bond attributes: investor demand, dealer costs, and issuer preferences. Third, we leverage the bond attributes determined at origination to estimate the preferences of government officials involved in the negotiations: the cost of paying debt, and the extent to which these officials internalize the underwriter's payoff in negotiations.

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.

Related Literature. This paper studies municipal bond design, where bonds are traded in a decentralized market. In this respect, we contribute to the literature on product design and search frictions. One strand of this literature analyzes a search model where firms choose product design or differentiation (Bar-Isaac, Caruana and Cuñat, 2012; Menzio, 2021; Albrecht, Menzio and Vroman, 2022), studying how product design may change as the extent of search frictions varies. On the other hand, we treat search frictions as endogenous: we allow that various provisions in a bond, which are determined at origination, can directly affect dealers' search costs of finding an investor and helping her learn whether that bond suits her financial circumstances and goals.

The paper focuses on the incentives of underwriters to increase search frictions by adding various provisions at origination. The idea that producers may benefit from an increase in search costs is not new (Diamond, 1971). One way of raising search costs is to make shopping complicated, difficult, or confusing as documented by Ellison and Ellison (2009) in the context of online retail practices, and Ellison and Wolitzky (2012) argue that engaging in such obfuscation practices can be individually rational. In financial markets, evidence suggest that more complex retail structured products yield higher markups to the banks that issue them (Célérier and Vallée, 2017) and lower realized returns to investors (Ghent, Torous and Valkanov, 2019). Our paper contributes to this literature, by providing empirical findings that special provisions in a bond reduce secondary market liquidity and benefit the bond's underwriter.

In addition, we shed a light on a novel mechanism explaining why increasing search frictions can be anti-competitive. While the extant literature has focused on competition among producers, we study competition among intermediaries, and show that special bond provisions help position the bond's underwriter at an advantage, compared to other dealers. In this regard, we also contribute to the literature on how vertical relations affect product design (Asker and Bar-Isaac, 2014; Ho and Lee, 2019; Hristakeva, 2019).

We show that this novel mechanism is amplified when government officials' private interests are aligned with those of the underwriter, exploiting time-varying state-level regulations on revolving-door practices. These findings add to the literature on conflict of interests 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).

Lastly, 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] As we describe in detail below, a bond is originated by an issuing government and an underwriter, a financial institution in charge of the initial marketing of the bond. Once the issuer 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.

[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/`).

2.2. **Bond Origination.** 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 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 origination, 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.

2.3. **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

[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).

[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.

of 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 origination process and in the secondary market as dealers. According to US Government Accountability Office (2012), the top 10 underwriting firms underwrote over 70% of primary market volume in 2010–11, and these top 10 broker-dealer firms executed about 55% of secondary market trades during the same period. The 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.

2.4. **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] 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.

[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 origination 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 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 advisor of a bond issue is rarely its underwriter (less then 0.2% of our final sample).

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.

2.5. **Data and Scope of Study.** We draw 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 issues of tax-exempt general obligation or revenue bonds by local governments during the period of study, 55% of them (14,582) were sold via a negotiation, 42% (11,208) via 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.[5] 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 bond issues with at least one trade in the secondary market, leading to the final sample of 13,120 bond issues, with the total maturity amount $255.5 billion, in nominal USD.

3. Motivating Evidence

In this section we argue that underwriters may have an incentive to add special provisions when originating bonds. We show that by doing so, they increase their market share and gross profits from intermediating secondary trades of the bond that they originate. We

[5]Note that a bond issue may include multiple bonds, as indicated in Table 1.

Table 1. Summary Statistics

	Mean	SD	Median	Min	Max
Issue 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 # special attributes †	0.885	0.181	0.894	0.000	1.609
Weighted average # special attributes†	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: This table is based on the 13,120 negotiated issues of general obligation or revenue bonds with any secondary market trades originated 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.

also show that the welfare implications of special bonds provisions are not necessarily clear-cut. While they increase trading frictions for investors, they lower the default risk for the issuing government.

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 bond issues. The average size of capital raised by a bond issue is $19.5 million, and the length of maturity is on average 8.4

years. A bond issue, on average, comprises with 12.1 bonds with different maturities and attributes. 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 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 special bond provisions 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 negotiations during bond origination, and accordingly the bond design. We construct two dummy variables regarding the regulations, depending on the scope of the revolving door legislation. Local Reg_i indicates that, when bond i was issued, there was a revolving-door regulation in place covering local government officials. Instead, State 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:

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

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 variable, as denoted by s_i, we employ the average complexity measure as described earlier. Our coefficients of interest, β_1 and β_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. This

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

	Num. of Special Bond Provisions (log)			
	(1)	(2)	(3)	(4)
Local officials regulated	-0.077***	-0.094***	-0.077***	-0.0937***
	(0.014)	(0.016)	(0.014)	(0.015)
State officials regulated			-0.022***	-0.023***
			(0.007)	(0.006)
Issue attributes†	Yes	Yes	Yes	Yes
Issuer type†	Yes	Yes	Yes	Yes
Other issuer attributes†	No	Yes	No	Yes
Year-month FE, 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, based on the negotiated issues of general obligation or revenue bonds with any secondary market trades originated by local governments in 2010–2013. Standard errors are adjusted for clustering at the state level, and are provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. † : Issue attributes include the logarithm of the total face value and the maturity length averaged across bonds within the issue, two dummy variables on the type of assets to pay the debt (limited general obligation and revenue, as opposed to unlimited general obligation, respectively). We include three dummy variables on the issuer type (city, school districts, and other special-purpose governments, as opposed to county governments, respectively). As for other issuer attributes, we include the three issuer finance variables in Table 1, as well as demographic, economic, and political variables aggregated at the county-level: 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, the vote share for the Republican candidate and the vote share difference between the top two candidates in the most recent Presidential election before the origination.

finding is consistent with the idea that revolving-door practices may reduce the degree of collusion between underwriters and the local government officials in charge of originating municipal bonds, as long as 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 only targeting state government officials also decrease 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. Note that state officials are not directly involved in the bond origination negotiations, at least officially. However, state officials have levers to indirectly influence the negotiations: as an example, they help determine the current and future allocations of the state budget to local governments. However, it is beyond our scope of study to elucidate the mechanism through which state officials may influence local officials.

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 officials regulated	0.227	0.225	-0.044	-0.045	-0.0187	-0.0190
	(0.171)	(0.170)	(0.031)	(0.031)	(0.0366)	(0.0368)
State officials regulated		-0.367		0.003		-0.0190
		(0.262)		(0.012)		(0.0197)
Issue 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, County FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	14,237	14,237	286,554	286,554	26,087	26,087
R^2	0.535	0.535	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; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

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 origination. 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), the credit ratings of existing bonds for Columns (3) and (4), and whether the selection mechanism for an underwriter for Columns (5) and (6). 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 middle 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. The last two columns indicate that there is no statistically significant relationship between 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. First, Column (1) shows that the magnitude of the effects on bond complexity increases with the length of the bond maturity, which we interpret as a proxy for the rent from intermediation of secondary trades.

Second, Column (2) indicates that the tighter the Presidential election is for a given county, the larger the magnitude of the effects of revolving-door regulations is. We measure

Table 4. Heterogeneous Effects of Revolving-door Regulations

	Num. of Special Bond Provisions (log)			
	(1)	(2)	(3)	(4)
Local officials regulated	0.863***	0.119***	-0.106***	-0.045***
	(0.22)	(0.033)	(0.015)	(0.006)
State officials regulated	-0.023***	-0.023***	-0.023***	-0.094***
	(0.006)	(0.006)	(0.06)	(0.015)
Local officials × Log (maturity)	-0.206***			
	(0.06)			
Local officials × Electoral vulnerability†		-0.286***		
		(0.045)		
Local officials × Divided government††			-0.020	
			(0.045)	
State officials × Divided government††				0.055***
				(0.013)
Issue attributes	Yes	Yes	Yes	Yes
Issuer type	Yes	Yes	Yes	Yes
Other issuer attributes	No	Yes	No	Yes
Year-month FE, County FE	Yes	Yes	Yes	Yes
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, based on the negotiated issues of general obligation or revenue bonds with any secondary market trades originated by local governments in 2010–2013. Standard errors are adjusted for clustering at the state level, and are provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. †: The "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. Therefore, this variable can vary from 0 (when the vote share is 1 or 0; not electorally competitive or vulnerable) to 1 (when the vote share is 0.5; electorally competitive or vulnerable). ††: Te "divided government" variable takes 1 if both chambers in the state legislature are controlled by another party than the governor's, or two chambers of the legislature are controlled by different parties.

the extent to which state and local elections are likely to be a toss-up, using the vote share of the Republican candidate in the most recent Presidential election as a proxy for the political climate of a county. Specifically, we define the extent of "electoral vulnerability" as one minus the absolute value of the difference between the county's Republican vote share of the most recent Presidential election and 0.5, divided by 0.5, so that it takes a value between 0 and 1. Our finding in Column (2) may be related to the possibility that local government officials' turnover rate in the electorally vulnerable counties is higher than other counties, increasing the value of post-government job opportunities. Thus, for the electorally vulnerable counties, we expect that revolving-door regulations are more effective, in so far as the effects are channeled through government officials' career incentives.

Third, Columns (3)-(4) explore whether the impact of the revolving-door regulations varies depending on whether the state government is divided. A state government is divided if both chambers in the state legislature are controlled by another party than the governor's, or if two chambers of the legislature are controlled by different parties. While the effects of revolving-door regulations for local officials on bond complexity don't vary with the divided control over the state government (Column (3)), the effects of revolving-door regulations for state officials are dampened when the state government is divided (Column (4)). The latter finding is consistent with the idea that state officials may influence local officials' dealings at bond origination, and that such influence may wane with a divided government, as scrutiny on state officials becomes stronger.

3.3. **Underwriter's Incentives for 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 including special provisions when originating bonds. To explore the nature of this rent, we estimate the following equation:

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

where Undrerwriter Market Share$_i$ is the underwriter's share in the market for secondary transactions of bond i. Specifically, we focus on all dealers' purchases of the bond from investors within two years after the origination of the bond.[6] In this specification, we control for exogenous issuer and bond attributes, $\mathbf{X}_i$, county fixed effects, and monthly period fixed effects. The number of special provisions, s_i, and the coupon rate, r_i, are treated as endogenous bond attributes, and thus we employ instruments as motivated by Table 4: the two revolving-door regulation dummy variables, interacted with the length of maturity of the bond, the county-level electoral vulnerability measure, and whether or not the state government is divided.

Column (1) of Table 5 shows OLS estimates, and Column (2) of the table presents 2SLS estimates. Based on the latter results, we find that increasing the number of special provisions from 1 to 2 raises the underwriter's share in the bonds' secondary market by 0.04, corresponding to a 50% 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,

[6]The purchases from investors by any dealer, including the underwriter, are secondary transactions. However, an underwriter's sale to an investor may not necessarily be secondary transactions, because the underwriter may have remaining inventory from the primary market and sell it afterwards. Thus, by focusing on the dealers' purchases from investors, we measure the market share of the underwriter in the secondary market. In addition, given that we observe transactions from 2010 to 2014 for the bonds originated in 2010–2013, we limit our window of transactions to two years, but not imposing this window does not qualitatively affect the results presented in Table 5.

Table 5. Special Bond Provisions and Underwriter in the Secondary Market

	Market Share†		Gross Profit†	
	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)
Num. of special bond provisions (log)	0.029	0.233***	-0.110	0.608*
	(0.024)	(0.088)	(0.137)	(0.344)
Coupon rate	Yes	Yes	Yes	Yes
Issue attributes	Yes	Yes	Yes	Yes
Issuer attributes	Yes	Yes	Yes	Yes
Year-month FE, County FE	Yes	Yes	Yes	Yes
Number of observations	11,508	11,508	11,508	10,179
Average dependent variable	0.080	0.080	0.084	0.084
First stage F-stat	-	148.625	-	130.300

Notes: This table reports both OLS and 2SLS estimates, based on the negotiated issues of general obligation or revenue bonds with any secondary market trades originated by local governments in 2010–2013. The instruments are dummy variables for revolving-door regulations (see Table 2 for the first stage estimates), interacted with the length of maturity of the bond, the county-level electoral vulnerability measure, and whether or not the state government is divided. †: The "market share" is defined as the ratio of the underwriter's purchases from investors to all dealers' purchases from investors within 2 years after origination. The "gross profit" is defined as the value of total sales (the sum of the transaction price multiplied by the transaction amount over all sales transactions) minus that of total purchases made by the underwriter within 2 years after origination. For both variables, if there are more than one underwriter for a bond, then we take the average value across the underwriters. For the ease of interpretation of the coefficients, we divide the gross profit variable by its standard deviation. 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.

enabling him to quickly locate potential buyers and sellers and increase its market size vis-a'-vis other dealers. It is notable that the estimate of the same parameter, β_s in (2), by OLS is much smaller and statistically insignificant. This implies that omitted factors that increase the underwriter's market share tend to be negatively correlated with the number of special provisions. For instance, when the underwriter has sizeable market power, the incentive for further solidifying the power by adding more special provisions might be smaller.

Note, however, that the underwriter may not necessarily benefit from raising the their market share, if it coincides with a smaller market size. In this regard, it is ideal to look at the underwriter's profit as an outcome variable, but the profit is hard to measure because the cost is not fully observed. As an incomplete, but reasonable, measure of profits, we consider the revenue associated with a bond (the value of total sales of the bond) minus the direct cost, which is the the value of total purchases of the bond by the underwriter within two years after origination. Borrowing an accounting terminology, we call this measure as "gross profit" and provide the estimates of the following equation in Columns (3)–(4) of Table 5. Note that we standardize the outcome variable to ease interpretation.

$$\text{Underwriter Gross Profit}_i = \beta_s \log(s_i + 1) + \beta_r r_i + \gamma \mathbf{X}_i + \kappa_{c(i)} + \theta_{t(i)} + \epsilon_i. \qquad (3)$$

The results of Column (4) indicate the gross profits increase as the number of special provisions increases. In particular, as the number of special provisions increases from 1 to 2, the underwriter's gross profit increases by 0.1 standard deviations. Note that the gross profits do not take into account other costs associated with dealers' activities such as search costs. Our structural analyses can help shed light on the value of special provisions to the underwriter.

3.4. **Implications for Investors and Issuing Government.** To consider the welfare implications of special bond provisions, we look at the investors and the issuing government. On the one hand, special provisions can help tailor the debt payment schedule to the issuer's 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 other hand, as the issuing government and underwriter enrich a bond with special attributes and contingencies, the process of trading the bond becomes more involved for investors. Indeed, it is more time consuming for dealers to explain to investors the risks and flow payments associated with the purchase of the bond, increasing the frictions investors face in the trading process.

To better understand this trade-off, we consider the following specifications. Columns (1)–(2) of Table 6 present the OLS and 2SLS results based on:

$$\text{Intermediation Spread}_i = \beta_s \log(s_i + 1) + \beta_r r_i + \gamma \mathbf{X}_i + \kappa_{c(i)} + \theta_{t(i)} + \epsilon_i, \tag{4}$$

where the intermediation spread for a bond is defined as the logarithm of the average dealer-to-investor sale price minus the logarithm of the average dealer-from-investor purchase price. In our sample, the average intermediation spread is 0.012. Columns (3)–(4) of Table 6 show the estimation results of:

$$\text{Num. Negative Rating Events}_i = \beta_s \log(s_i + 1) + \beta_r r_i + \gamma \mathbf{X}_i + \kappa_{c(i)} + \theta_{t(i)} + \epsilon_i. \tag{5}$$

The outcome variable is the number of negative "credit watch" incidences during the first five years after origination, where the Standard & Poor's rating agency detected an event or a trend that is likely to result in lowering the credit rating.[7] The average number of such incidences in our sample is 0.074, with the max being 5.

Column (2) of Table 6 shows that special provisions tend to increase the intermediation spread, increasing the frictions investors face in the trading process: a 1% increase in the

[7]This variable is based on Standard & Poor's CreditWatch service. Their explanation on the service says "CreditWatch highlights the potential direction of a short- or long-term rating. It focuses on identifiable events and short-term trends that may cause ratings to be placed under special surveillance by Standard & Poor's. These may include mergers, recapitalizations, voter referendums, regulatory action, performance deterioration of securitized assets, or anticipated operating developments." We count the number of CreditWatch cases associated with either developing or negative code.

Table 6. Implications of Special Bond Provisions for Investors and Governments

	Intermediation Spread†		Num. Negative Rating Events†	
	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)
Num. of special bond provisions (log)	0.001	0.048***	0.034	-0.243**
	(0.002)	(0.017)	(0.034)	(0.091)
Coupon rate	Yes	Yes	Yes	Yes
Issue attributes	Yes	Yes	Yes	Yes
Issuer attributes	Yes	Yes	Yes	Yes
Year-month FE, County FE	Yes	Yes	Yes	Yes
Number of observations	11,059	11,059	13,008	13,008
First stage F-stat	-	128.892	-	135.023

Notes: This table reports both OLS and 2SLS estimates, based on the negotiated issues of general obligation or revenue bonds with any secondary market trades originated by local governments in 2010–2013. The instruments are dummy variables for revolving-door regulations (see Table 2 for the first stage estimates), interacted with the length of maturity of the bond, the county-level electoral vulnerability measure, and whether or not the state government is divided. †: The "intermediation spread" is the logarithm of the average dealer-to-investor sale price minus the logarithm of the average dealer-from-investor purchase price. The "negative rating event" refers to a "credit watch" incidence associated with a probable downgrade of the bond's credit rating during the first five years after origination, as detected by the Standard & Poors. 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.

number of special provisions in a bond increases the bond's intermediation spread by 4.8 basis point, which corresponds to an increase of 4% over the mean level.

Column (4), in turn, shows that special provisions can have a substantial impact on the bond's default probability: a 1% increase in the number of special bond provisions can decrease the number of negative credit incidences by 0.002, which corresponds to a decrease of 3% over the mean level.

Here we make our case that the welfare implications can be ambiguous by showing that special bond provisions increases intermediation spread while decreasing the credit risk of the issuing government. Our structural analysis, based on the model provided in the next section, quantifies the trade-off by computing the consumer surplus and the government costs associated with special bond provisions.

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 origination 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 during negotiation at origination, 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:

$$V_U(s, r, \mathbf{x}, \xi) - F. \tag{6}$$

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:

$$c_0(s, \mathbf{x}, \xi)A(1 + rT). \tag{7}$$

We interpret c_0 as capturing two factors. First it captures the minimal attainable marginal cost of making the future payments associated with the bond. When evaluating such cost for the issuing government, it is important to account for the covariance of the bond payments with its cash flows. Indeed, the cost of making a payment in the future is larger in "bad states" where a dollar is more valuable, and smaller in "good states" where a dollar is less valuable. For this reason, movements in the cash flow of the issuing government affect the marginal cost of debt payment and c_0 might be be different from one. Note that c_0 also depends on the number of special attributes s, since they allow the issuing government to postpone or advance 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, ψ, may vary with revolving-door regulations, denoted by h. We write the official's payoff as:

$$F - c_0(s, \mathbf{x}, \xi)A(1 + rT) + \psi(\mathbf{x}, h, \xi) \left\{ V_U(s, r, \mathbf{x}, \xi) - F \right\}. \tag{8}$$

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 τ 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 δ. 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 $v_D(a, s, r, \mathbf{x}, \xi)$, is:

$$v_D(a, s, r, \mathbf{x}, \xi) = \nu_D(\mathbf{x}, \xi) ra + \kappa_D(\mathbf{x}, \xi) a^2, \tag{9}$$

where ν_D reflects the payoff from receiving interests, and κ_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:

$$v_I(a, \nu, s, r, \mathbf{x}, \xi) = \nu ra + \kappa_I(\mathbf{x}, \xi) a^2. \tag{10}$$

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 $F_{\nu|(\tau,s,\mathbf{x},\xi)}$. Note that the investor taste type distribution is allowed to vary with bond attributes: some bond attributes may increase or decrease investors' average valuations of a bond, while other attributes may influence the dispersion of valuations, appealing to a niche or "mass market" of potential investors (Johnson and Myatt, 2006). 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, λ, is chosen by each dealer at costly search efforts. We assume that such costs depend on the dealer's initial cost, ϕ_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 λ:

$$\phi_0 \exp[-\phi_1(s, \mathbf{x}, \xi) b] \exp(\lambda). \tag{11}$$

Each dealer draws their initial cost parameter ϕ_0 from a distribution that varies with bond attributes, $F_{\phi_0|(s,\mathbf{x},\xi)}$, whose support is $\mathbb{R}_+$. Note that if ϕ_1 is strictly positive, then the search cost decreases with the dealer's experience of trading the bond with investors. With that, ϕ_0 reflects the dealer-specific clientele network in the beginning, and ϕ_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 origination as a result of bargaining between the issuing government and the underwriter in Section 4.3. To ease notation, 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 $u \equiv (a, b, \phi_0)$ 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 u and u' at τ by $p_D(\tau; u, u')$ and $q_D(\tau; u, u')$; and similarly, those for a trade between a dealer of state u and an investor of state y by $p_I(\tau; u, y)$ and $q_I(\tau; u, y)$. The equilibrium distributions of dealers' and investors' state at time τ are denoted by $\Phi_D(\tau; u)$ and $\Phi_I(\tau; y)$.

The value function of a dealer of initial search type ϕ_0 who holds a units of the bond and has transacted q amount of the bond at $\tau > 0$, denoted as $V(\tau; a, b, \phi_0) \equiv V(\tau; u)$, evolves according to

$$\begin{aligned}\dot{V}(\tau; u) = -\delta V(\tau; u) + v_D(a) + \lambda_D \int_{u'} \Big\{ V\left(\tau; a + q_D(\tau; u, u'), b, \phi_0\right) - V\left(\tau, u\right) \\ - p_D(\tau; u, u') \Big\} \phi_D(\tau; du') + \max_{\lambda} \Big[\lambda \int_{y} \Big\{ V\left(\tau; a - q_I(\tau; u, y), b + |q_I(\tau; u, y)|, \phi_0\right) \\ - V\left(\tau; u\right) + p_I(\tau; u, y) \Big\} d\Phi_I(\tau; dy) - \phi_0 \exp(-\phi_1 b) \exp(\lambda) \Big],\end{aligned} \tag{12}$$

The first term on the right hand side of (12) 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 λ_D. The potential trading party's state, u', is randomly drawn from the equilibrium distribution $\phi_D(\tau; u)$. The fourth term represents the expected change in the continuation utility associated with a trade with an investor. The dealer chooses meeting rate λ subject to a 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:

$$V(0; u) = \omega_D a. \tag{13}$$

Noting that the dealer chooses the optimal meeting rate with investors as indicated in (12), we characterize the equilibrium meeting rate by taking the first order condition:

$$\begin{aligned}\lambda(\tau;u) &= \log\left(\frac{1}{\phi_0\exp(-\phi_1 b)}\int_y \Big\{V\left(\tau;a-q_I(\tau;u,y),b+|q_I(\tau;u,y)|,\phi_0\right)\right.\\ &\quad \left. - \ V\left(\tau;u\right)+p_I(\tau;u,y)\Big\}d\Phi_I(\tau;dy)\right). \qquad (14)\end{aligned}$$

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 ν, when the time until the maturity of bond is τ:

$$\begin{aligned}\dot{W}(\tau;y) &= -\delta W(\tau;y)+v_I(y)+\alpha\int\left[W(\tau;a,\nu')-W(\tau;y)\right]f(\nu'|\tau)d\nu' \qquad (15)\\ &\quad + \ \frac{m_D}{m_I}\int_u \lambda(\tau;u)\Big\{W(\tau;a+q_I(\tau;u,y))-W(\tau;y)-p_I(\tau;u,y)\Big\}\Phi_D(\tau;du).\end{aligned}$$

The first term on the right hand side of (15) 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 α; 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 u is $\frac{m_D}{m_I}\lambda(\tau;u)\Phi_D(\tau;du)$. When $\tau=0$, the investor receives the face value of the bond:

$$W(0;a,\nu)=\omega_I a. \qquad (16)$$

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

$$q_I(\tau;u,y')=\arg\max_q\Big\{W(\tau;a'+q,\nu')-W(\tau;y)+V\left(\tau;a-q,b+|q|,\phi_0\right)-V\left(\tau;u\right)\Big\}, \qquad (17)$$

$$q_D(\tau;u,u')=\arg\max_q\Big\{V(\tau;a+q,b,\phi_0)-V(\tau;u)+V\left(\tau;a'-q,b',\phi_0'\right)-V\left(\tau;u'\right)\Big\}, \qquad (18)$$

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

$$p_I(\tau;u,y')=(1-\rho)\max_q\Big\{W(\tau;a'+q,\nu')-W(\tau;y')-V\left(\tau;a-q,b+|q|,\phi_0\right)+V\left(\tau;u\right)\Big\}, \qquad (19)$$

$$p_D(\tau;u,u')=(1-\rho_D)\max_q\Big\{V(\tau;a+q,b,\phi_0)-V(\tau;u)-V\left(\tau;a'-q,b,\phi_0\right)+V\left(\tau;u'\right)\Big\}. \qquad (20)$$

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

$$
\begin{aligned}
-\dot{\Phi}_I(\tau;u) &= -\alpha\Phi_I(\tau;a,\nu)\left[1-F(\nu|\tau)\right]+\alpha\int_{-\infty}^{a}\int_{\nu}^{\infty}\Phi_I(\tau;da,d\nu')F(\nu'|\tau) \qquad (21)\\
&- \int_{-\infty}^{\nu}\int_{-\infty}^{a}\int_{u}\lambda(\tau;u)\mathbb{I}_{\{\tilde{a}+q_I(\tau;u,\tilde{a},\tilde{\nu})>a\}}\Phi_D(\tau;du)\Phi_I(\tau;d\tilde{a},d\tilde{\nu})\\
&+ \int_{-\infty}^{\nu}\int_{a}^{\infty}\int_{u}\lambda(\tau;u)\mathbb{I}_{\{\tilde{a}+q_I(\tau;u,\tilde{a},\tilde{\nu})\le a\}}\Phi_D(\tau;du)\Phi(\tau;d\tilde{a},d\tilde{\nu}).
\end{aligned}
$$

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 (21) capture the flow of investors due to the idiosyncratic taste shock; and the last two terms are associated with trades. Specifically, the first term represents the outflow of investors who draw a new taste type greater than ν, which occurs with probability $\alpha\left[1-F(\nu|\tau)\right]$. The second term shows the inflow of investors who draw a new taste type less than ν and have inventory less than a. The third term presents the outflow of investors whose asset holding after a trade becomes greater than a; and the fourth term reflects the inflow of investors whose post-trade inventory becomes less than a.

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

$$
\begin{aligned}
&-\dot{\Phi}_D(\tau;a,\varphi) \qquad (22)\\
= &-\int_{0}^{\varphi}\int_{-\infty}^{a}\int_{y}\lambda(\tau;\tilde{a},\tilde{\varphi})\max\left[\mathbb{I}_{\{\tilde{a}-q_I(\tau;y,\tilde{a},\tilde{\varphi})>a\}},\mathbb{I}_{\{\tilde{\varphi}e^{-\phi_1|q_I(\tau;y,\tilde{a},\tilde{\varphi})|}>\varphi\}}\right]\Phi_I(\tau;dy)\Phi_D(\tau;d\tilde{a},d\tilde{\varphi})\\
+ &\int_{0}^{\varphi}\int_{a}^{\infty}\int_{y}\lambda(\tau;\tilde{a},\tilde{\varphi})\min\left[\mathbb{I}_{\{\tilde{a}-q_I(\tau;y,\tilde{a},d\tilde{\varphi})\le a\}},\mathbb{I}_{\{\tilde{\varphi}e^{-\phi_1|q_I(\tau;y,\tilde{a},d\tilde{\varphi})|}\le\varphi\}}\right]\Phi_I(\tau;dy)\Phi_D(\tau;d\tilde{a},d\tilde{\varphi})\\
+ &\int_{\varphi}^{\infty}\int_{\tilde{a}}\int_{y}\lambda(\tau;\tilde{a},\tilde{\varphi})\min\left[\mathbb{I}_{\{\tilde{a}-q_I(\tau;y,\tilde{a},\tilde{\varphi})\le a\}},\mathbb{I}_{\{\tilde{\varphi}e^{-\phi_1|q_I(\tau;y,\tilde{a},\tilde{\varphi})|}\le\varphi\}}\right]\Phi_I(\tau;dy)\Phi_D(\tau;d\tilde{a},d\tilde{\varphi})\\
- &\lambda_D\int_{0}^{\varphi}\int_{-\infty}^{a}\int_{u'}\mathbb{I}_{\{\tilde{a}+q_D(\tau;\tilde{a},\tilde{\varphi},u')>a\}}\Phi_D(\tau;du')\Phi_D(\tau;d\tilde{a},d\tilde{\varphi})\\
+ &\lambda_D\int_{0}^{\varphi}\int_{a}^{\infty}\int_{u'}\mathbb{I}_{\{\tilde{a}+q_D(\tau;\tilde{a},\tilde{\varphi},u')\le a\}}\Phi_D(\tau;du')\Phi_D(\tau;d\tilde{a},d\tilde{\varphi}).
\end{aligned}
$$

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

$$\Phi_I(T;a,\nu)=\mathbb{I}_{\{a\ge 0\}}F_{\nu|\tau}(\nu|T). \qquad (23)$$

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

$$\Phi_D(T;a,b,\phi_0) = \begin{cases} \mathbb{I}_{\{a\geq 0, b\geq 0\}} F_{\phi_0}(\phi_0), & \text{if } \phi_0 \neq \phi_{0,U} \\ (1-m_U)\mathbb{I}_{\{a\geq 0, b\geq 0\}} F_{\phi_0}(\phi_0) + m_U \mathbb{I}_{\{a\geq A, b\geq 0\}} F_{\phi_0}(\phi_0), & \text{if } \phi_0 = \phi_{0,U} \end{cases} \tag{24}$$

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 (21) and (22) subject to (23) and (24), given (ii)–(iv);*
2. *(ii) satisfies (12), (13), (15), and (16) ,given (i);*
3. *(iii) satisfies (14), given (i)–(ii);*
4. *(iv) satisfies (17), (18), (19), and (20), 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:

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

subject to

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

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

$$\frac{\rho}{1-\rho} = \frac{F - c_0(s,\mathbf{x},\xi)A(1+rT) + \psi(\mathbf{x},h,\xi)\left\{V_U(s,r,\mathbf{x},\xi) - F\right\} - J_G(\mathbf{x},\xi,h)}{V(T;A,0,\phi_{0,U}|s,r,\mathbf{x},\xi) - F - J_U(\mathbf{x},\xi,h)}, \tag{25}$$

$$0 = -\frac{\partial}{\partial s}c_0(s,\mathbf{x},\xi)A(1+rT) + \left\{1+\psi(\mathbf{x},h,\xi)\right\}\frac{\partial}{\partial s}V(T;A,0,\phi_{0,U}|s,r,\mathbf{x},\xi), \tag{26}$$

$$0 = -c_0(s,\mathbf{x},\xi)AT + \left\{1+\psi(\mathbf{x},h,\xi)\right\}\frac{\partial}{\partial r}V(T;A,0,\phi_{0,U}|s,r,\mathbf{x},\xi). \tag{27}$$

The negotiated bond attributes, (s^*, r^*), maximize the sum of the government official's and the underwriter's payoffs, as represented by (26) and (27). The purchase price, F^*, divides the surplus of the negotiation by (25).

In summary, first, the choice of special provisions for a bond directly affects investor taste distribution, and issuer costs. This allows us to capture the idea that these provisions might cater to the specific risk preferences of certain groups of investors, while providing issuers with flexibility in paying interests and the principal.

Second, we also allow special provisions to affect dealers' costs of finding and educating investors in two distinct ways. On the one hand, the more special provisions are included in a bond, the more difficult and time-consuming it can be for dealers, including an underwriter, to meet and communicate with an extra investor, by increasing the initial search cost parameter ϕ_0. On the other hand, special provisions may increase the value of a dealer's client network, by raising the network effect parameter ϕ_1. When an investor gets first acquainted with a bond, the dealer needs spend time and effort to help him figure out whether the bond attributes suit with his needs. For this reason, it might be substantially easier to sell a bond to investors who have already traded it in the past and, therefore, is familiar with its attributes. This might create a cost advantage for dealers that have developed a large investor network. This cost advantage might depend on how difficult it is for the dealer to explain the bond attributes to investors, and thus it can be greater for bonds with many special provisions than plain vanilla ones.

It is important to emphasize that when the underwriter is active as a dealer, they can disproportionally benefit from strengthening the network effects as it allows her to raise her rivals' search costs more than her own. Her advantage as a dealer comes from the exclusive right for initial sales of the entirety of a bond, which allows her to build her client network ahead of other dealers. If more special provisions can further enlarge the extent of this advantage through their impact on the network effect parameter ϕ_1, then the underwriter's dual role can increase the amount of special provisions in a bond.

5. Estimation

5.1. **Observables in the Data.** To estimate our model, we employ two sets of data: bond origination and transaction data. First, for each bond issue i, we use the number of special provisions included in the bond contract to construct an index s_i corresponding to s in the model. 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 ($\tilde{\mathbf{x}}_i$). 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 $\mathbf{x}_i \equiv (A_i, T_i, \tilde{\mathbf{x}}_i)$. We observe whether there was a state revolving-door regulation in place at the time of the origination, represented by a dummy variable, h_i, and the price at which the underwriter purchase the entirety of the bond, F_i. In addition, we observe various attributes summarizing the new bond supply from neighboring counties during the year of bond i's origination, denoted by $\mathbf{z}_i$, which may affect the demand for bond i.

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

Finally, we observe the geographical specialization of the dealer(s) involved in each transaction, during one year prior to the origination of the bond. 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; $g_{ij} = 1$ if she has experience of trading the same-state bonds, but no experience of trading the same-county bonds; and no experience of the same-state bond trading implies $g_{ij} = 2$.

5.2. **Model Primitives and Parametric Assumptions.** The model primitives that we estimate are (i) government preferences, $c_0(s, \mathbf{x}, \xi)$ and $\psi(\mathbf{x}, h, \xi)$; (ii) the outside option values of a government in case of a failure in negotiations, $J_G(\mathbf{x}, \xi)$; (iii) 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 $\omega_I(\mathbf{x}, \xi)$; (iv) dealer preferences, $\nu_D(\mathbf{x}, \xi)$, $\kappa_D(\mathbf{x}, \xi)$, and $\omega_D(\mathbf{x}, \xi)$; (v) search cost, $F_{\phi_0|(s,\mathbf{x},\xi)}(\cdot|s, \mathbf{x}, \xi)$ and $\phi_1(s, \mathbf{x}, \xi)$; (vi) inter-dealer meeting rates, $\lambda_D(\mathbf{x}, \xi)$. We set the discount rate $\delta = 0.05$, the bargaining parameter $\rho = 0.5$, and the underwriter's outside option $J_U(\mathbf{x}, \xi, h) = 0$. We also 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 origination of a given bond, divided by the total number of dealers in that state. Given our moderate sample size, we make several parametric assumptions.

First, we assume that investors' valuation of a bond, ν, is Normally distributed with mean and standard deviation, $\gamma(s, \mathbf{x}, \xi) \equiv (\gamma_1(s, \mathbf{x}, \xi), \gamma_2(s, \mathbf{x}, \xi))$ for all $\tau \in [0, T]$.

Second, we assume that the realization of ϕ_0 for a given dealer and a bond depends on the bond attributes $(s, \mathbf{x}, \xi)$ and the dealer's geographical specialization, g. Since there are three types of geographical specialization, the parameters of $F_{\phi_0|(s,\mathbf{x},\xi)}(\cdot|s,\mathbf{x},\xi)$ are reduced to the three values of ϕ_0 conditional on $(s,\mathbf{x},\xi)$: $\phi_{0,k}(s,\mathbf{x},\xi)$ for $k=0,1,2$.

Third, since we cannot separately identify the two parameters of government preferences, the marginal cost of financing (c_0) and the officials' weight for the underwriter (ψ), we normalize that the marginal cost of financing when there are no special bond provisions ($s=0$) is one; i.e., for all $(\mathbf{x},\xi)$,

$$c_0(s=0,\mathbf{x},\xi)=1. \tag{28}$$

In addition, we reduce the parameter space by assuming that the parameter ψ does not depend on $(\mathbf{x},\xi)$ and satisfies

$$\psi(\mathbf{x},h,\xi)=\psi_0(1-h)+\psi_1 h. \tag{29}$$

Fourth, we assume that endogenous bond attributes, (s,r), do not affect the following parameters: the government outside option, J_G; the dealer preferences and the inter-dealer market parameters, $(\nu_D,\kappa_D,\omega_D,\lambda_D)$; and some of the investor preference parameters, $(\alpha,\kappa_I,\omega_I)$. In light of this, our counterfactual analyses do not require an understanding of how these parameters vary by bond attributes, and accordingly, we estimate the bond-specific realizations of the parameters. Note that, instead, we allow investors' taste distribution, dealers' search cost, and government marginal cost of financing to depend on the endogenous attributes (s,r).

Lastly, we assume $\xi\equiv\left(\xi_c,\xi_{\gamma_1},\xi_{\gamma_2},\xi_{\phi_{0,0}},\xi_{\phi_{0,1}},\xi_{\phi_{0,2}},\xi_{\phi_1}\right)$ is a random vector of mean zero and further assume the following:

$$c_o(s,\mathbf{x},\xi)=\theta_{c,x}\mathbf{x}+\theta_{c,s_1}s\mathbf{x}+\theta_{c,s_2}s^2+s\xi_c, \tag{30}$$

$$\log\gamma_k(s,\mathbf{x},\xi)=\theta_{\gamma,x}\mathbf{x}+\theta_{\gamma,s}s+\xi_{\gamma_k}, \text{for } k=1,2, \tag{31}$$

$$\log\phi_{0,k}(s,\mathbf{x},\xi)=\theta_{\phi_{0,k},x}\mathbf{x}+\theta_{\phi_{0,k},s}s+\xi_{\phi_{0,k}}, \text{for } k=0,1,2, \tag{32}$$

$$\log\phi_1(s,\mathbf{x},\xi)=\theta_{\phi_1,x}\mathbf{x}+\theta_{\phi_1,s}s+\xi_{\phi_1}, \tag{33}$$

where the vector of observed exogenous bond attributes, $\mathbf{x}$, includes a constant. This specification accounts for rich heterogeneity at the bond level, and given our model, the endogenous bond attribute, s, depends on ξ. 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 in when negotiating over (s,r), which complicates identification. To address this, we assume that the unobserved bond attribute related to the marginal financing cost, ξ_c, is uncorrelated with observed exogenous bond attributes $\mathbf{x}$, revolving door regulations h, and bond supply from the neighboring counties $\mathbf{z}$; and that the remaining unobserved bond attributes, $\xi_{-c}\equiv\left(\xi_{\gamma_1},\xi_{\gamma_2},\xi_{\phi_{0,0}},\xi_{\phi_{0,1}},\xi_{\phi_{0,2}},\xi_{\phi_1}\right)$, are uncorrelated with $(\mathbf{x},h)$.

In other words, we assume the following orthogonality conditions:

$$\mathbb{E}\left(\xi_c[\mathbf{x}, h, \mathbf{z}]\right) = 0. \tag{34}$$

$$\mathbb{E}\left(\xi_{-c}[\mathbf{x}, h]\right) = 0. \tag{35}$$

Importantly, note that we do not make restrictions on the correlation between the unobserved shock to the government cost of financing (ξ_c) and the unobserved shocks to secondary market trading (ξ_{-c}).

In summary, given the assumptions above, the parameters to be estimated are the government preference parameters, $(\theta_c, \psi_0, \psi_1)$, the investor preference parameters, $(\theta_{\gamma_1}, \theta_{\gamma_2})$, the search cost parameters, $\left(\theta_{\phi_{0,0}}, \theta_{\phi_{0,1}}, \theta_{\phi_{0,2}}, \theta_{\phi_1}\right)$, and the bond-specific parameters, $J_{G,i}$ and $(\nu_{D,i}, \kappa_{D,i}, \omega_{D,i}, \lambda_{D,i}, \alpha_i, \kappa_{I,i}, \omega_{I,i})$, for each bond i. In addition, we estimate the realizations of unobserved bond attributes, ξ_i.

5.3. **Estimation Strategy: Overview.** We estimate the model primitives described in Section 5.2 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 a maximum likelihood estimator based on bond transaction data to recover the parameters of the trading market for each bond i. These parameters include investor demand parameters, $(\gamma_i, \kappa_{I,i}, \omega_{I,i}, \alpha_i)$; dealer search cost parameters, $\phi_{0,i} \equiv (\phi_{0,0,i}, \phi_{0,1,i}, \phi_{0,2,i})$ and $\phi_{1,i}$; dealers' utility parameters $(\nu_{D,i}, \kappa_{D,i}, \omega_{D,i})$; and the inter-dealer meeting rate $\lambda_{D,i}$. With a slight abuse of notations, let us denote the bond-specific parameters estimated in this step by

$$\theta_i \equiv \left\{\gamma_i, \nu_{D,i}, \kappa_{I,i}, \kappa_{D,i}, \alpha_i, \omega_{I,i}, \omega_{D,i}, \phi_{0,i}, \phi_{1,i}, \lambda_{D,i}\right\}.$$

To simulate the impact of policies targeting the endogenous bond provisions it is essential to measure how these provisions affect the key parameters governing secondary market trading. For this reason, in the second step, we estimate how investor demand and search costs depend on special bond provisions, which are endogenously determined, as well as other observed and unobserved bond attributes. In doing so, we use the bond-level estimates of $(\gamma_i, \phi_{0,i}, \phi_{1,i})$ for all bonds and employ an instrumental variable approach based on the orthogonality condition of (35) to estimate $(\theta_\gamma, \theta_{\phi_0}, \theta_{\phi_1})$, as defined in (31)–(33). Importantly, this allows us to also recover the realized values of the unobserved bond attribute vector, $\xi_{-c,i}$ for each bond.

In the last step, we estimate the government preference parameters, θ_c, as defined in (30), and (ψ_0, ψ_1), using the optimality conditions regarding bond attributes (s, r), (26) and (27), and the orthogonality condition of (34). Given the estimates of (θ_c, ψ) and the optimality conditions of (26) and (27), we estimate the realized values of $\xi_{c,i}$. Employing these, along with the estimates from all previous steps, we estimate the government's outside option value $J_{G,i}$ from the optimality condition regarding the bond price F, (25).

5.4. **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. We employ a maximum likelihood estimator, and below we describe parts of the joint likelihood of observing transaction timing, price, and quantity.

First, let $\tau_{ij,-1}$ denote the time of the most recent trade by the dealer of trade j for bond i prior to that trade, and let us denote the dealer's state for trade j of bond i by $u_{ij} \equiv (a_{ij}, b_{ij}, g_{ij})$, which is observed from the data. We denote the equilibrium dealer-to-investor meeting rate for bond i at time τ_{ij}, as characterized by (14), by $\lambda(\tau_{ij}, u_{ij}|\theta_i)$, and recall that the inter-dealer meeting rate, denoted by $\lambda_{D,i}$, is a part of trading market parameters, θ_i. It can be shown that the log-likelihood of timing of the transaction, τ_{ij}, conditional on $(\tau_{ij,-1}, u_{ij}, d_{ij})$, denoted by $\log \mathcal{L}(\tau_{ij}|\tau_{ij,-1}, u_{ij}, d_{ij}, \theta_i)$, satisfies:

$$\begin{aligned} \log \mathcal{L}(\tau_{ij}|\tau_{ij,-1}, u_{ij}, d_{ij}, \theta_i) &= d_{ij} \left[\log \left\{ \lambda(\tau_{jj}; u_{ij}|\theta_i) \right\} - \int_{\tau_{ij,-1}}^{\tau_{ij}} \lambda(s, u_{ij}|\theta_i) ds \right] \\ &+ (1 - d_{ij}) \left\{ \log \lambda_{D,i} - (\tau_{ij} - \tau_{ij,-1}) \lambda_{D,i} \right\}. \end{aligned} \tag{36}$$

Second, we allow that prices and quantities are observed with error. For the j^{th} transaction of bond i, the observed price and quantity, P_{ij} and Q_{ij}, differ from the true counterparts, P^*_{ij} and Q^*_{ij} as follows:

$$P_{ij} = P^*_{ij} + \epsilon_{p,ij}, \tag{37}$$

$$Q_{ij} = Q^*_{ij} + \epsilon_{q,ij}. \tag{38}$$

We assume that $(\epsilon_{p,ij}, \epsilon_{q,ij})$ is Normally distributed with variances σ_p^2 and σ_q^2, respectively, and zero covariance. We denote the equilibrium trade outcomes in terms of price and quantity, $p_I(\tau, u, y|\theta)$, $q_I(\tau, u, y|\theta)$, $p_D(\tau, u, u'|\theta)$ and $q_D(\tau, u, u'|\theta)$, as characterized by (14) and (17)–(20). Letting $\phi_I(y|\tau; \theta)$ denote the equilibrium distribution of investor states at τ characterized by (21) and (23), $\phi_D(u|\tau; \theta)$ denote the equilibrium distribution of dealer states at τ characterized by (22) and (24), and $\phi_{\mathcal{N}}(\cdot)$ denote the probability density function of a standard Normal distribution, we have the following likelihood function:

$$
\begin{aligned}
& \log \mathcal{L}\left(p_{ij}, q_{ij} | \tau_{ij}, u_{ij}, d_{ij}, \theta_i\right) \qquad (39) \\
= \;& d_{ij} \log\left[\int \frac{1}{\sigma_q}\phi_{\mathcal{N}}\left(\frac{q_{ij} - q_I\left(\tau_{ij}; u_{ij}, y|\theta_i\right)}{\sigma_q}\right)\frac{1}{\sigma_p}\phi_{\mathcal{N}}\left(\frac{p_{ij} - p_I\left(\tau_{ij}; u_{ij}, y|\theta_i\right)}{\sigma_p}\right)\phi_I(y|\tau_{ij}, \theta_i)dy\right] \\
+ \;& (1 - d_{ij}) \log\left[\int \frac{1}{\sigma_q}\phi_{\mathcal{N}}\left(\frac{q_{ij} - q_D\left(\tau_{ij}; u_{ij}, u|\theta_i\right)}{\sigma_q}\right)\frac{1}{\sigma_p}\phi_{\mathcal{N}}\left(\frac{p_{ij} - p_D\left(\tau_{ij}; u_{ij}, u|\theta_i\right)}{\sigma_p}\right)\right. \\
& \left.\times \phi_D(u|\tau_{ij}, \theta_i)du\right].
\end{aligned}
$$

Now, the log likelihood for $(\tau_{ij}, p_{ij}, q_{ij})$ conditional on $(\tau_{ij,-1}, u_{ij}, d_{ij})$ is:

$$
\log \mathcal{L}(\tau_{ij}, p_{ij}, q_{ij}|\tau_{ij,-1}, u_{ij}, d_{ij}, \theta_i) = \log \mathcal{L}(\tau_{ij}|\tau_{ij,-1}, u_{ij}, d_{ij}, \theta_i) + \log \mathcal{L}(p_{ij}, q_{ij}|\tau_{ij}, u_{ij}, d_{ij}, \theta_i).
$$

We estimate θ_i by maximizing the sum of $\log \mathcal{L}(\tau_{ij}, p_{ij}, q_{ij}|\tau_{ij,-1}, u_{ij}, d_{ij}, \theta_i)$ over all j transactions for a given bond i:

$$
\hat{\theta}_i = \arg\max_{\theta_i} \sum_j \log \mathcal{L}(\tau_{ij}, p_{ij}, q_{ij}|\tau_{ij,-1}, z_{ij}, d_{ij}, \theta_i).
$$

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 distributions of states (Rust, 1987).

We outline how different aspects of the data help pin down each parameter. First, the inter-dealer meeting rate is identified by the observed frequency of such meetings. Second, the observed inter-dealer trading price and quantity help identify dealer preference parameters, $\nu_{D,i}$ and $\kappa_{D,i}$. Consider two dealers with the same geographic specialization but different inventory: if $\kappa_{D,i}$ is large, the inventories of these dealers after their trade will be close to each other because the quantity traded maximizes the gains from trade. Next, the observed frequency of meetings between dealers and investors, conditional on the observed distribution of trading prices and quantities, allows us to pin down the search parameters ϕ_1 and ϕ_0. Finally, the entire distribution of prices and quantities for the trades between investors and dealers helps identify the investors' preferences. Recall we do not observe investors' inventory, while we observe dealers' inventory. This can complicate the identification of inventors' preferences, in contrast to dealer preferences. For example, an investor may pay a relatively low price for a bond because he has drawn a low taste type or because he has a large inventory of that bond. We exploit the conditions for the equilibrium distribution of investors' asset holdings and tastes to identify investor preference parameters.

5.5. **Step 2: Trading Market Parameters as a Function of Bond Attributes.** Given our estimates of the investors' demand parameters γ_i and search parameters $\phi_{0,i}$ and $\phi_{1,i}$

for each bond i, we estimate $(\theta_\gamma, \theta_{\phi_0}, \theta_{\phi_1})$, as defined in (31)–(33), which describe how the trading market parameters depend on bond attributes.

We leverage the orthogonality condition of (35) to derive the following moment conditions:

$$\mathbb{E}\Big(\big\{\log\hat{\gamma}_{k,i} - \tilde{\gamma}_k(s_i, \mathbf{x}_i; \theta_\gamma)\big\}[x_i, h_i]\Big) = 0, \text{for } k = 1, 2 \tag{40}$$

$$\mathbb{E}\Big(\big\{\log\hat{\phi}_{0,k,i} - \tilde{\phi}_{0,k}(s_i, \mathbf{x}_i; \theta_{\phi_0})\big\}[x_i, h_i]\Big) = 0, \text{for } k = 0, 1, 2, \tag{41}$$

$$\mathbb{E}\Big(\big\{\log\hat{\phi}_{1,i} - \tilde{\phi}_1(s_i, \mathbf{x}_i; \theta_{\phi_1})\big\}[x_i, h_i]\Big) = 0. \tag{42}$$

Given our linear specifications of (31)–(33), we estimate $(\theta_\gamma, \theta_{\phi_0}, \theta_{\phi_1})$ by running a IV regression. Let us denote the estimated parameters by $\left(\hat{\theta}_\gamma, \hat{\theta}_{\phi_0}, \hat{\theta}_{\phi_1}\right)$. We recover the unobserved bond attributed $\xi_{-c,i}$ by

$$\begin{aligned}
\hat{\xi}_{\gamma_k,i} &= \log\hat{\gamma}_{k,i} - \log\tilde{\gamma}_k(s_i, \mathbf{x}_i; \hat{\theta}_\gamma), \text{for } k = 1, 2,\\
\hat{\xi}_{\phi_{0,k},i} &= \log\hat{\phi}_{0,k,i} - \tilde{\phi}_{0,k}(s_i, \mathbf{x}_i; \hat{\theta}_{\phi_0}), \text{for } k = 0, 1, 2,\\
\hat{\xi}_{\phi_1,i} &= \log\hat{\phi}_{1,i} - \tilde{\phi}_1(s_i, \mathbf{x}_i; \theta_{\phi_1}).
\end{aligned}$$

5.6. **Step 3: Government Preferences.** The last step of our empirical strategy boils down to estimating the government preference parameters, $(\theta_c, \psi_0, \psi_1)$, and the bond-specific outside option for the government, $J_{G,i}$ for each bond i. Denote $\frac{\partial}{\partial s}V_U(T_i; A_i, 0|s_i, r_i, \mathbf{x}_{-c,i}, \xi_i, \theta_i)$ and $\frac{\partial}{\partial r}V_U(T_i; A_i, 0|s_i, r_i, \mathbf{x}_{-c,i}, \xi_i, \theta_i)$ by $V_{s,i}$ and $V_{r,i}$, respectively. Then employing the specification of (30), the optimality conditions of (26) and (27) can be rewritten as

$$\begin{aligned}
-\left(\theta_{c,s_1}\mathbf{x}_i + 2\theta_{c,s_2}s_i + \xi_{c,i}\right)A_i\left(1 + r_iT_i\right) + \left(1 + \psi_{h_i}\right)V_{s,i} = 0,\\
-\left(\theta_{c,x}\mathbf{x}_i + \theta_{c,s_1}s_i\mathbf{x}_i + \theta_{c,s_2}s_i^2 + \xi_{c,i}s_i\right)A_iT_i + \left(1 + \psi_{h_i}\right)V_{s,i} = 0.
\end{aligned}$$

Given these equations, we can solve for $\xi_{c,i}$ and use the orthogonality condition of (34) to derive the following moment conditions:

$$\begin{aligned}
\mathbb{E}\left(\left\{\frac{(1+\psi_{h_i})V_{s,i}}{A_i(1+r_iT_i)} - \left(\theta_{c,s_1}\mathbf{x}_i + 2\theta_{c,s_2}s_i\right)\right\}[\mathbf{x}_i, h_i, \mathbf{z}_i]\right) = 0,\\
\mathbb{E}\left(\frac{1}{s_i}\left\{\frac{(1+\psi_{h_i})V_{r,i}}{A_iT_i} - \left(\theta_{c,x}\mathbf{x}_i + \theta_{c,s_1}s_i\mathbf{x}_i + \theta_{c,s_2}s_i^2\right)\right\}[\mathbf{x}_i, h_i, \mathbf{z}_i]\right) = 0,
\end{aligned}$$

Using these moment conditions, we build a nonlinear GMM estimator for $(\theta_c, \psi_0, \psi_1)$. Note that the objects $V_{s,i}$ and $V_{r,i}$ are estimated in Step 2. Therefore, we can replace them with their respective estimates: $\frac{\partial}{\partial s}V_U(T_i; A_i, 0|s_i, r_i, \mathbf{x}_i, \hat{\xi}_{-c,i}, \hat{\theta}_i)$ and $\frac{\partial}{\partial r}V_U(T_i; A_i, 0|s_i, r_i, \mathbf{x}_i, \hat{\xi}_{-c,i}, \hat{\theta}_i)$.

Note that, given the estimates of $(\theta_c, \psi_0, \psi_1)$, denoted by $(\hat{\theta}_c, \hat{\psi}_0, \hat{\psi}_1)$, we estimate $\xi_{c,i}$ by

$$\hat{\xi}_{c,i} = \frac{1}{2}\left(\frac{(1+\hat{\psi}_{h_i})\hat{V}_{s,i}}{A_i(1+r_iT_i)} - (\hat{\theta}_{c,s_1}\mathbf{x}_i + 2\hat{\theta}_{c,s_2}s_i)\right) + \frac{1}{2s_i}\left(\frac{(1+\hat{\psi}_{h_i})\hat{V}_{r,i}}{A_iT_i} - \left(\hat{\theta}_{c,x}\mathbf{x}_i + \hat{\theta}_{c,s_1}s_i\mathbf{x}_i + \hat{\theta}_{c,s_2}s_i^2\right)\right).$$

Lastly, the optimality condition regarding the bond purchase price at negotiation, (25), helps us pin down the government outside option value for bond i, $J_{G,i}$. Its consistent estimator is the following:

$$\hat{J}_{G,i} = \left(2 - \hat{\psi}_{h_i}\right)F_i - \left(\hat{\theta}_{c,x}\mathbf{x}_i + \hat{\theta}_{c,s_1}s_i\mathbf{x}_i + \hat{\theta}_{c,s_2}s_i^2 + s_i\hat{\xi}_i\right)A_i(1+r_iT_i) + \left(\hat{\psi}_{h_i} - 1\right)\hat{V}_i,$$

where $\hat{V}_i \equiv V_U(T_i; A_i, 0|s_i, r_i, \mathbf{x}_i, \hat{\xi}_{-c,i}, \hat{\theta}_i)$.

Intuitively, we use the optimality conditions for (s, r) to recover the issuer preference parameters, holding fixed the underwriter's incentives concerning the bond attributes and coupon rate, captured by $V_{i,s}$ and $V_{i,r}$. Note if the issuer's unobserved cost shock $\xi_{i,c}$ were uncorrelated with the secondary market unobserved attributes $\xi_{i,-c}$, variation in the observed s_i and r_i across bonds, holding $V_{i,s}$ and $V_{i,r}$ fixed, would allow us to recover the parameters $(\theta_c, \psi_0, \psi_1)$. However, such restrictions may not be tenable; instead, we introduce BLP-type instruments $\mathbf{z}_i$, which are arguably uncorrelated with the issuer's cost shock ξ_c, while affecting the investors' demand.

6. Estimation Results and Counterfactual Analysis

This section describes our estimates of the primitives of the model, based on the estimator developed in the previous section. Recall that we estimate trading market parameters for each bond, θ_i for bond i, in the first step. Given these estimates, we consider the *average bond*, which we define as a bond with the average value of θ_i's. Most of our discussions below are centered on this average bond.

6.1. **Search Frictions.** Table 7 presents the monthly search cost estimates for the average bond for the underwriter and an average dealer. The monthly cost of maintaining the rate of meeting one investor per year is $2,939.7 for the underwriter, which is 50% lower than the cost for other dealers on average. This cost advantage of underwriters in search for investors explains their higher meeting rate than other dealers' rate (0.24 meetings per month versus 0.22), as shown in Table 7. Despite the higher meeting rate, the monthly average search costs are lower for an underwriter ($7,695) than an average dealer ($9,664). These average search cost estimates are 1.2% of the average value a dealer sells in a month.

Table 7. Search Cost Estimates and Meeting Rates

	Average dealer	Underwriter
Cost of maintaining $\lambda = 1$ per year	\$5,880	\$2,940
Average search cost	\$9,664	\$7,695
Average meeting rate	0.22	0.24

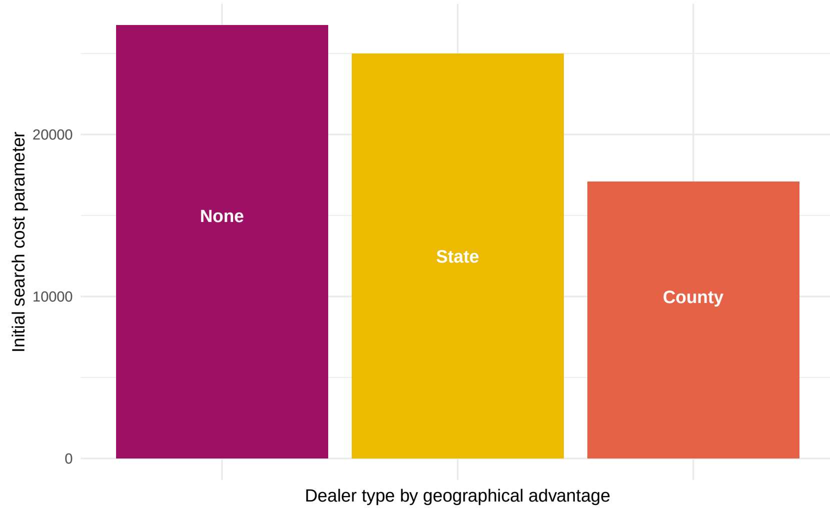
Notes: The numbers presented in this table are based on the average search cost parameter estimates. The unit of period is a month.

How the underwriter's search cost pairs with other dealers is driven by two distinct channels. On the one hand, the estimate of the initial search cost parameter (ϕ_0) of the underwriter is larger than that of other dealers on average (\$25,000 versus \$20,000). Thus, if all dealers, including the underwriter, have the same trading experience regarding a given bond, it is more expensive for the underwriter to increase the rate at which she meets with investors, compared to the other dealers. This is because (i) it is less likely for the underwriter to have prior experience of trading bonds originated from the same county as the bond's county than for other dealers, and (ii) we find that dealers with such prior experience tend to have a low initial search cost parameter values. Figure 1 presents the average estimates of ϕ_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 the average value of ϕ_0 for a dealer who traded a bond originated from the same county before (indicated in the far right, orange bar) is much lower than that of other dealers.

On the other hand, we find that this geographical disadvantage of the underwriter is more than offset by her exclusive initial sales experience. We find that there are economies of scale in search technology; the estimate of ϕ_1 is, on average, 0.47>0. An underwriter's initial sales experience means a leg up in exploiting the economies of scale. The average trading experience for a bond by its underwriter, as measured by the sum of the quantities of the bond sold or bought by the underwriter at any given point in time, is 3.2, where we take the average over the life cycle of the bond and across bonds. It is higher than the average experience for other dealers.

The above discussions are based on the first-step estimates, $\hat{\theta}_i$. To understand how bond's special provisions affects search costs, we employ the parameters estimated in the second step—θ_{ϕ_0} and θ_{ϕ_1}, as defined in (32) and (33)—which account for the endogeneity of bond attributes. Table 8 presents some of the estimates from the second step. We find that including more special provisions in the bond contract at origination increases both the initial search cost and the network effect parameters (ϕ_0 and ϕ_1). The estimate of θ_{ϕ_0} is 1.116 with robust standard error 0.191 (Column (1)) and the estimate of θ_{ϕ_1} is 1.259

FIGURE 1. Dealer Heterogeneity in Initial Search Costs



Notes: Each bar represents the average estimate of ϕ_0 for each type of dealers, where the type is determined by their history of trading bonds during one year before a given bond's origination. "None" represents the dealers that didn't trade a bond originated from the same state as the bond; "State" represents those who traded a bond originated in the same state but in a different county; and "County" represents those who traded a bond originated in the same county.

with robust standard error 0.457 (Column (2)).[8] Put it differently, increasing the number of special provision by one percent leads to a 1.1% increase in ϕ_0 and a 1.2% increase in ϕ_1.

Figure 2 visualizes these estimates by plotting an average dealer's monthly cost of maintaining the rate of meeting one investor per year as a function of trading experience, b. We consider two representative bonds with low and high number of special provisions, which we call *low-customization* and *high-customization* bonds. Specifically, we adjust our average bond's trading market primitives according to a change in the number of special provisions to 1 (the 25^{th} percentile in our data) and 2.14 (the 75^{th} percentile), respectively. The estimates indicate that the monthly search cost, at $b = 0$, is lower for the former bond than the latter. 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 former. These patterns illustrate that although special bond provisions increase the search costs for all dealers including underwriters initially, they help create a cost advantage for dealers through the economies of scale, increasing the value of underwriters' experience from exclusive initial sales.

6.2. **Investor Demand.** Given our model, the investors' flow value from holding a bond of one-dollar face value with interest rate r is $\nu \log r$. We assume that the elasticity ν follows

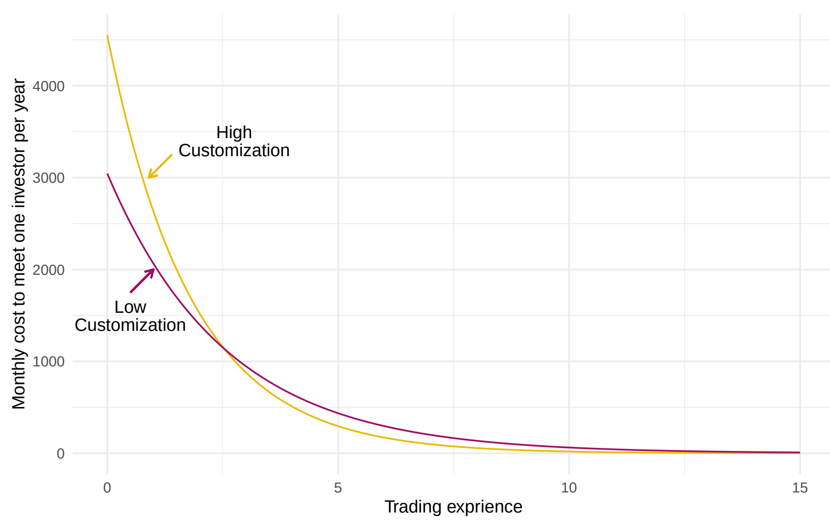
[8]Note that we present robust standard errors under the assumption that the first-step estimates are without error. Bootstrap standard errors without the assumption will be provided in the next version of the draft.

Table 8. Search Cost and Investor Demand as a Function of Bond Attributes

	Search Cost		Investor Valuation	
	Initial	Network	Mean	SD
	$\log \hat{\phi}_{0,i}$	$\log \hat{\phi}_{1,i}$	$\log \hat{\gamma}_{1,i}$	$\log \hat{\gamma}_{2,i}$
	(1)	(2)	(3)	(4)
Number of special bond provisions (log)	1.116	1.259	-0.730	0.543
	(0.191)	(0.457)	(0.237)	(0.405)
Face value (log)	0.116	0.146	-0.106	0.015
	(0.034)	(0.014)	(0.016)	(0.025)
Length of the maturity in months (log)	-0.233	-0.262	-0.043	-0.269
	(0.050)	(0.110)	(0.059)	(0.163)
Average estimates of the parameters	26.73	0.47	0.053	0.071
Number of observations	927	927	927	927
RMSE	0.33	0.28	0.21	0.15

Notes: In the second step, we run a IV regression where the dependent variable is the logarithm of the estimated parameters in the first step for each bond and the instruments are based on the revolving-door regulations. Column (1) presents some of the parameters in (32), $\theta_{0,k}$; Column (2) presents those in (33); and Column (3) and (4) present the parameters in (31). The robust standard errors under the assumption that the estimated parameters in the first step are measured without error are in parenthesis.

Figure 2. The Effects of Bond Design on Search Costs



Notes: This graph presents the estimated search cost functions of (11) at $\lambda = 0$ for two representative bonds with low and high numbers of special provisions or "levels of customization" (25^{th} and 75^{th} percentiles), respectively.

Normal distribution with mean and standard deviation parameters, γ_1 and γ_2, both of which depend on $(s, \mathbf{x}, \xi_\gamma)$. Table 7 shows that an increase in the number of special provisions in a bond contract decreases the average valuation of the bond by 0.89% on average (Column (3)), while increasing the dispersion by 0.35% (Column (4)). These results are consistent with the idea that bonds with special provisions are niche products that investors "either love or loathe," along the lines of Johnson and Myatt (2006) and Bar-Isaac et al. (2012). We find that the average valuation for the high-complexity bond is 0.067, 20% lower than that of the low-complexity one. However, the standard deviation of the investor valuations is smaller for the low-complexity bond (0.09) than for the high-complexity one (0.11), implying that the fraction of investors with extreme valuations for a bond, either low or high, is higher as the number of special provisions in the bond contract is larger.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.

6.3. **Government Preferences.** In the last step, we estimate the government preference parameters, $(\theta_c, \psi_0, \psi_1)$. Recall that θ_c, as defined in (30), characterizes the marginal financial cost of the issuing government to pay interests and the principal of a bond, $c_0(s, \mathbf{x}; \theta_c)$. Given our $\hat{\theta}_c$, we estimate the marginal financial costs for each bond, denoted by $\hat{c}_{0,i}$:

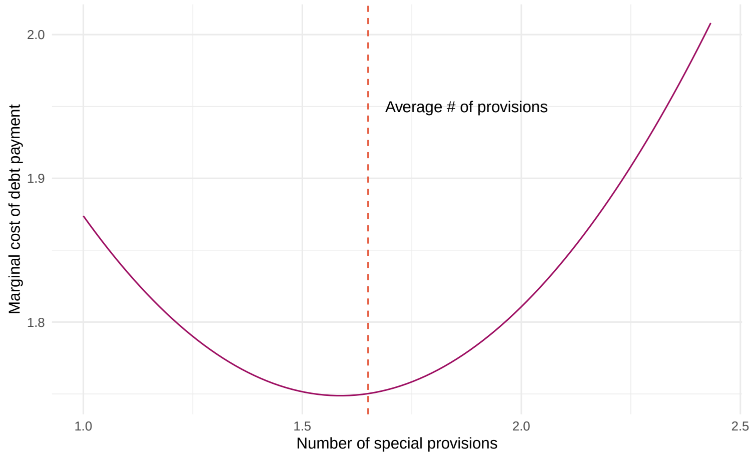
$$\hat{c}_{0,i} = \hat{\theta}_{c,x} + \hat{\theta}_{c,s_1} s_i \mathbf{x}_i + \hat{\theta}_{c,s_2} s_i^2 + s_i \hat{\xi}_{i,c}$$

The estimated marginal cost of the debt payment is on average 1.64 (median 1.227). As discussed in Section 4, c_0 captures how the cost of paying debt payments can be affected by the issuing government's cash flows, in addition to the extent to which the bond-originating officials and politicians internalize future payments when originating the bond. Although it is beyond our scope of analysis to distinguish these two sources of c_0, the estimates of θ_c help us understand the roles of bond design and financial circumstance on such costs.

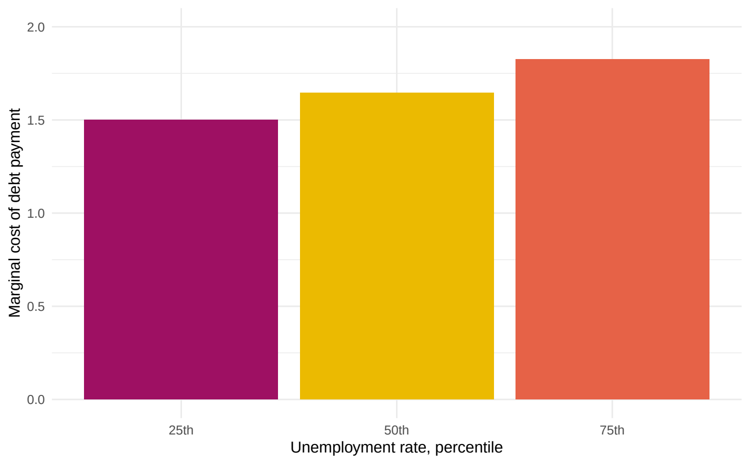
First, we find that the marginal financial cost is strictly convex in the number of special provisions in a bond contract. Panel (A) in Figure 3 displays how c_0 varies with the number of special provisions where we set the value of the exogenous attributes at the sample average, $\mathbf{x} = \bar{\mathbf{x}}$. It is notable that the number of special provisions that minimizes the marginal debt payment costs is not zero, implying that there is a direct benefit of adding special provisions by allowing the debt payment flow to be catered to the contingencies affecting the government cash flow. This is consistent with our results from 2SLS regressions in Column (4) of Table 6, where we show the the risk of getting downgraded is lower as the number of special provisions increases. However, too many of a good thing is not necessarily useful; the complexity brought by such provisions may require the government to have a financial advisor on a high retainer to manage and execute payments.

Second, we find that local economy also affects the marginal financial cost. Panel (B) of Figure 3 shows the marginal financial cost estimates, $\hat{c}_{0,i}$, increase as there is an increase in the unemployment rate during the year of the bond origination in the county where the issuing government is located. This economic indicator may reflect a difficulty in securing

FIGURE 3. Government Cost of Debt Payments



(A) Number of Special Provisions



(B) Local Economy

Notes: Panel (A) plots the estimated relationship between the marginal financial cost, c_0, and the number of special provisions, evaluated at the average value of other bond attributes, $\mathbf{x} = \bar{\mathbf{x}}$. Panel (B) shows the average value of the estimates of the marginal financial cost, $\hat{c}_{0,i}$, conditional the unemployment rate during the year of the bond origination in the county where the issuing government is located.

government revenues from local taxes and fees and an increase in government expenses for those in need. In addition, it may negatively affect the conditions for future borrowing.

Lastly, we find evidence that conflict of interests exists in the sense that the issuing government directly cares about the payoff of the underwriter: both the weight parameters with and without revolving-door regulations, ψ_1 and ψ_0 respectively, are positive. In particular, the estimate of ψ_0 is 0.035, and ψ_1 substantially lower, estimated at 0.005. This implies that revolving-door regulations effectively reduce the incentives of the government officials to give favors to private interests.

In the existing literature, Goldberg and Maggi (1999), an empirical investigation of the model of Grossman and Helpman (1994) in the context of trade protection, provide an estimate of a parameter similar to our ψ. Their counterpart parameter of our ψ is $(1-\beta)/\beta$, and its point estimate ranges from 0.014 to 0.019, depending on the specifications. Although β is precisely estimated in Goldberg and Maggi (1999), the standard error of $(1-\beta)/\beta$ is large (greater than 24 across all three specifications), so comparing these estimates with our ψ estimates is limited. With that caveat, the estimate of the weight parameter absent revolving-door regulations (ψ_1) is higher than the estimate of Goldberg and Maggi (1999), possibly reflecting differences in federal vs. local politics.

6.4. **Counterfactual Policies.** Given our estimates of the model, we study how bond design affects search frictions and welfare, and investigate the effects of the dual role of underwriters as a bond designer and a dealer. In doing so, we consider three counterfactual scenarios. First, we quantify the consequences of a policy mandating standardization of the bond provisions. Second, we study the impact of policies to reduce underwriters' incentives to distort the bond design 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 the last two counterfactual scenarios will be presented in the next version of the paper.

On standardization, we specifically consider a policy requiring that the number of special bond provisions be at most one, which is the current 25^{th} percentile value. The average number of special provisions in our sample is 1.64, thus the reduction in the frequency of such provisions in the market is at least 39%. In this exercise, we consider a bond with the median value of all exogenous bond attributes, both observed and unobserved ones, $(\mathbf{x}, h, \xi)$. Note that revolving-door regulations are prevalent in our sample (Table 1); the median value for h is one, i.e., such regulations are in place.

Table 9 shows that this standardization policy increases liquidity in the market. An average dealer's meeting rate would increase from 0.22 investors per year to 0.24, which is an increase of 7.1%. Despite this increase in the meeting rate, the average search cost decreases by 3.8%, suggesting that a sizeable impact of this policy on search frictions. It is notable, however, that these overall effects on search frictions are relatively muted for the underwriter: the meeting rate increases by 0.6% and average search cost would decrease by 0.9%. This is because the competitive advantage from exclusive initial sales is reduced due to the standardization policy.

The decrease in the number of special provisions, as mandated by the policy, directly affects search costs, investor demand, and the government's marginal cost of paying debt.

Table 9. Bond Standardization and Search Frictions

	Current	Mandate	Change (%)
Average dealer's search cost	$10,105	$9,722	−3.8
Underwriter's search cost	$8,147	$8,073	−0.9
Average dealer's meeting rate	0.22	0.24	+7.1
Underwriter's meeting rate	0.23	0.23	+0.6

Notes: The numbers presented in this table are based on a bond with the median value of exogenous attributes, $(\mathbf{x}, h, \xi)$, evaluated at the average parameter estimates. The "Current" column provides average search costs and meeting rates for the underwriter and an average dealer when there is no regulation on bond design. The "Mandate" column provides the equilibrium average search costs and meeting rates under a standardization policy mandating that the number of special provisions are set at or below one, which is the 25^{the} percentile value in the data.

In addition, it indirectly affects them through a change in the negotiated coupon rate. To distinguish the direct and the indirect effects, Figure 5 presents the welfare impacts of the policy for two scenarios: (i) the coupon rate is set at the current level (the "fixed coupon" case) and (ii) the coupon rate is negotiated between the issuing government and the underwriter, cognizant of the policy (the "negotiated coupon" case). We find under the policy, the coupon rate decreases by 25bp. This decrease is mainly driven by the fact that the policy increases c_0 by 7% (from 1.75 to 1.87; Figure 3), raising the government's financial burdens of increasing the coupon rate.

Figure 3 shows the cost of financing the median bond, associated with paying interests and the principal, will increase by 5.5%. It is notable that the financing cost increases despite the decrease in the negotiated coupon rate. This is due to the increase in the marginal cost of paying the debt, c_0, triggered by the limited use of special provisions. As discussed earlier, c_0 is convex in the number of special provisions, but the standardization policy considered here strips the issuers of the ability to introduce flexibility in the debt payment schedule, reducing their financial costs. If the coupon rate were set at the current level, the financing cost would increase by 7% instead.

Our estimates indicate that the average investors are the winner of this policy, despite the decrease in the coupon rate. First, the decrease in the number of special provisions directly increases the average investor valuation of the bond (Table 8, Column (3)). Although some investors looking for a niche bond decreases their valuation of the bond as a result of the policy, an average investor increases his valuation. Second, the increase in liquidity (Table 9) benefits investors. Overall, the investors' surplus from trades increases by 10.3%, and we find that the 25bp decrease in the coupon rate makes only a small dent in the investor

Figure 5. Welfare Effects of Bond Standardization

Notes: This graph presents the effects of the bond standardization policy, where the number of special provisions in a bond is mandated to be at most one. The purple bars show the changes in the government cost of paying debt and the value from trades for investors, dealers, and underwriters, when the coupon rate is set at the current scenario where such a policy is not implemented. The yellow bars, on the other hand, show the changes when the coupon rate is negotiated between the issuing government and the underwriter under this policy.

surplus, 0.8%, which is represented by the difference between the purple and the yellow bars for investors in Figure 5.

This large increase in the investor surplus comes with a decrease in the surplus of dealers, including the underwriter. This finding is consistent with the literature that search frictions benefit producers (Diamond, 1971; Ellison and Wolitzky, 2012). Figure 5 shows that the surplus from trades for average dealers decreases by 2.7%. More importantly, the underwriter's surplus is hit more severely than other dealers; her surplus decreases by 5.9%.

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 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. In addition, we quantify the role of the vertical integration in the municipal bonds market in that underwriters participate in both the primary and the secondary markets.

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.

Albrecht, James, Guido Menzio, and Susan Vroman, "Vertical Differentiation in Frictional Product Markets," Technical Report, National Bureau of Economic Research 2022.

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.

Bar-Isaac, Heski, Guillermo Caruana, and Vicente Cuñat, "Search, design, and market structure," *American Economic Review*, 2012, *102* (2), 1140–60.

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.

Célérier, Claire and Boris Vallée, "Catering to investors through security design: Headline rate and complexity," *The Quarterly Journal of Economics*, 2017, *132* (3), 1469–1508.

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.

Diamond, Peter A, "A model of price adjustment," *Journal of economic theory*, 1971, *3* (2), 156–168.

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 Alexander Wolitzky, "A search cost model of obfuscation," *The RAND Journal of Economics*, 2012, *43* (3), 417–441.

_______ **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.

Ghent, Andra C, Walter N Torous, and Rossen I Valkanov, "Complexity in structured finance," *The Review of Economic Studies*, 2019, *86* (2), 694–722.

Goldberg, Pinelopi Koujianou and Giovanni Maggi, "Protection for sale: An empirical investigation," *American Economic Review*, 1999, *89* (5), 1135–1155.

Grossman, Gene M. and Elhanan Helpman, "Protection for Sale," *The American Economic Review*, 1994, *84* (4), 833–850.

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," *mimeo*, 2019.

Johnson, Justin P and David P Myatt, "On the simple economics of advertising, marketing, and product design," *American Economic Review*, 2006, *96* (3), 756–784.

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.

Menzio, Guido, "Optimal Product Design: Implications for Competition and Growth under Declining Search Frictions," Technical Report, National Bureau of Economic Research 2021.

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.

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 during the period of our study, 2010-2013. Among them, five pieces of state legislation introduced revolving-door regulations to state or local government officials. Table A1 provides the list of these five pieces of legislation, which provides the variation in regulations. The rest, nine pieces of legislation, is to strengthen the existing revolving-door regulations.

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

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.