SUPPLEMENT TO "SEARCH FRICTIONS AND PRODUCT DESIGN IN THE MUNICIPAL BOND MARKET"

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Appendix A. Construction of Variables in the Data

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

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

The Annual Survey of State and Local Government Finances from the Census provides the local government finance information. A census is conducted every five years, and a sample of local governments is used to collect data in the intervening years. We do not always observe the financial information for every year for local governments, but we find that while the data for county governments are consistently provided over time, other local governments, especially for small ones, are not. Therefore, when necessary, we interpolate the finance information over time. In addition,

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for local governments other than county governments, we use the finance information aggregated over the governments of the same category (city/township, school districts, and other special-purpose governments). As for government revenues and expenditures, we use CPI-adjusted values (where the base year is 2012).

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

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

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

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

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

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

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

a part of an underwriter syndicate, we look for a dealer whose net sales is the highest for each bond within an issue and when there is a tie, we choose one whose first trade of the bond as in the data precedes the other(s). This way, we designate one underwriter per bond within an issue, but there may be multiple underwriters per issue.

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

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

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

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

Appendix B. Revolving-door Regulations

B.1. **State Legislation.** Based on the Ethics and Lobbying State Law and Legislation database by National Conference of State Legislatures, we identify the 14 enactments of state legislation regarding revolving-door practices during the period of our study, 2010-2013. Among them, five pieces of state legislation introduced revolving-door regulations to state or local government officials. Table A2 provides the list of these five pieces of legislation, which provides variation in regulations, which is important in our empirical strategy. The rest, nine pieces of legislation, is to strengthen the existing revolving-door regulations.

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

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

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

Notes: This table reports OLS estimates, based on the negotiated issues of general obligation or revenue bonds with any secondary market trades originated by local governments in 2010–2013. Standard errors are adjusted for clustering at the state level, and are provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. The outcome variables represent each of the complexity features as follows: whether or not an issue consists of multiple bonds (Column (1)); the logarithm of the sum of one and the frequency of a particular bond provision (call option, sinking fund, non-standard interest payment schedule, and variable/floating interest rate) across bonds (Columns (2)–(5), respectively). *a*. See the notes in Table 2 for the details on the control variables.

he receives compensation or other emolument of office." Prior to this new section of the State Code, existing provisions regulating revolving-door practices include 2.2-3104 with regards to certain state officers or employees and 30-103 regarding the members of the general assembly.

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

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

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

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

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

TABLE A4. Heterogeneous Effects of Revolving-door Regulations

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

Notes: This table reports OLS estimates, based on the negotiated issues of general obligation or revenue bonds with any secondary market trades originated by local governments in 2010–2013. Standard errors are adjusted for clustering at the state level, and are provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. For ease of interpretation, we interact a revolving-door dummy variable with the standardized value of a bond or issue attribute, by subtracting its mean and then dividing it by the standard deviation, if the attribute is a continuous variable. *a*. The Herfindahl-Hirschman index associated with a given bond using data on the financial advisors for all municipal bonds issued in the bond's state within three calendar years prior to its issuance. *b*. A dummy variable indicating whether the government issued at least one bond within the three calendar years prior to a given bond issue. *c*. A county where the issuing government of a given bond is located is considered as electorally competitive or "swing" at issuance if the vote margin in the most recent Presidential general election outcome prior to the issuance is less than 5%. *d*. The state government is considered as "divided government" if both chambers in the state legislature are controlled by another party than the governor's. *f*. A dummy variable indicating that there was at least one daily newspaper operating in a given county in 2004, based on Gentzkow et al. (2011, 2014). *g*. We define transactions of bonds with par value less than $100,000 as individual investors'. For a given bond, we look at the fraction of such transactions among all transactions involving the bonds of the same type of security (revenue, limited or unlimited general obligation) issued by local governments in the same state during the year when the given bond was issued. *h*. The notes in Table 2 describe the control variables.

Another factor that may affect the officials' weight for underwriters, ψ, is the political situation that they may face in office. Column (3) of Table A4 shows that the effects of revolving-door regulations on bond design is higher in "swing" or electorally competitive counties.[2] One explanation is that local government officials' turnover rate in these counties can be higher than in other counties, increasing the value of post-government job opportunities and consequently the value of ψ. In addition, Column (4) in the same table shows that the effects of revolving-door regulations for state officials are dampened when the state government is divided (i.e., both chambers in the state legislature are controlled by another party than the governor's). This finding may be explained by the idea that state officials may influence local officials' dealings at bond origination, and that such influence may wane with a divided government, as scrutiny on state officials becomes stronger and thus decreasing ψ. Interestingly, Column (5) shows that the effects of revolving-door regulations are lower when the county is covered by at least one daily newspaper, showing that the local media can serve as a watchdog in the local government dealings with the underwriter.[3]

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

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

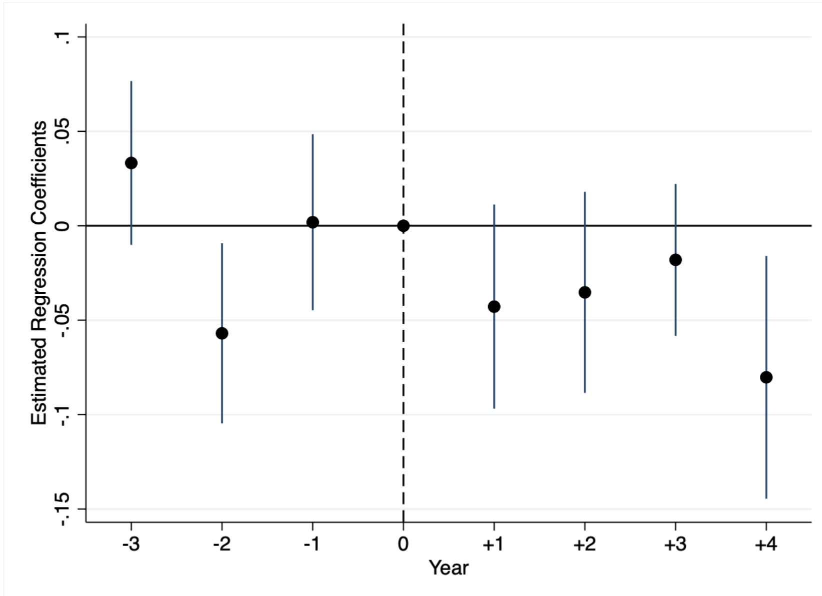
$$\log(s_i + 1) = \sum_{\tau_1=1}^{\tau_1=4} \beta_{\tau,1} d\tau_{1,i} + \sum_{\tau_2=1}^{\tau_2=3} \beta_{\tau,2} d\tau_{2,i} + \gamma \mathbf{X}_i + \kappa_{c(i)} + \theta_{t(i)} + \epsilon_i, \tag{A.1}$$

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

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

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

Figure A1. Effects of Revolving-door Regulations Over Time



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

Figure A1 presents the coefficient estimates for $\beta_{\tau,1}$ (for Year $+1, +2, +3, +4$) and $\beta_{\tau,2}$ (for Year $-1, -2, -3$). There are two notable patterns in the coefficient estimates. First, we do not find evidence that there exists an obvious pre-trend. Second, the effects are higher and statistically significant after the regulations were in place more than three years. This may reflect that it takes time for local governments to plan on a bond issue, select an underwriter (syndicate), and negotiate over terms of issuance.

Appendix C. Methods of Bond Sale

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

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

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

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

where $Negotiated_j$ is a dummy indicating that bond j was negotiated; $\mathbf{x}_j$ includes various observed attributes such as the source of the security (general obligation vs. revenue bond), in addition to (time-varying) issuer-specific attributes; $\pi_{t(j)}$ summarizes semi-annual period fixed effects; $\mu_{i(j)}$ represents issuer fixed effects; and $\phi_{c(j),t(j)}$ represents time-varying county fixed effects, which may capture, among other things, state and local regulations, local primary market conditions, and local investor demand. Table A5 presents the OLS results of this specification (Column 3) and two modified versions (Columns 1–2).

There are two important patterns present in this table regarding the issuers' choice of modality. First, we find that local government attributes, as opposed to bond attributes, explain a large variation in the method of sale. Including issuer attributes alone drastically increases the R^2; the R^2 of Column (2) is 0.713, which is a marked improvement from Column (1), 0.258. The issuer-specific factors may include "*de facto* or *de jure* limitations on the use of negotiated issuance procedures" in local governments (Fruits et al., 2008). For example, we find that the local government's prior experience in bond issuance is positively correlated with the probability of negotiation (Columns (2) and (3) of the table).

Second, the table shows that time-variant local attributes do not move the choice of modality much, once (time-invariant) circumstances faced by each issuer captured by issuer fixed effects are controlled for. Indeed, including county-year fixed effects, in addition to the controls used in Column (2), does not change the R^2 much, from 0.713 to 0.769, and even slightly decreases the adjusted R^2. This pattern is consistent with the fact that among the 5,896 issuers in the sample that issued at least two new-money bonds during 2004–2014, a large majority (83%) of them used a single method only, not both.[5]

C.2. **Effects of Revolving-door Regulations and the Method of Sale.** Having shown that predetermined issuer-specific factors, either observed or not, are key

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

Table A5. Determinants of the Method of Sale

	Negotiated sale (as opposed to auctions)		
	(1)	(2)	(3)
Bond attributes			
Offering amount (log, total)	-0.004 (0.014)	0.004 (0.006)	0.004 (0.006)
Length of maturity (log, average)	0.026 (0.030)	-0.047 (0.029)	-0.047 (0.030)
Limited general obligation bond	-0.076 (0.072)	-0.037* (0.018)	-0.015 (0.014)
Revenue bond	0.236*** (0.038)	0.022 (0.017)	0.029 (0.017)
New-money	-0.121** (0.055)	-0.135*** (0.050)	-0.153*** (0.060)
Issuer attributes			
Issued a bond in the past 5 years		0.023** (0.010)	0.024** (0.010)
Num. of bonds issued (log, past 5 yrs)†		-0.005 (0.013)	-0.017 (0.011)
Num. of underwriters (log, past 5 yrs)†		-0.011 (0.015)	-0.012 (0.009)
Ratio of taxes in the revenue		0.011 (0.043)	0.036 (0.064)
Ratio of government transfers		-0.0314 (0.068)	-0.119 (0.104)
State regulations			
Negotiation sale restricted	-0.405*** (0.055)	-0.140 (0.089)	-0.106 (0.094)
Local officials regulated	0.072 (0.063)	0.011 (0.035)	0.025 (0.039)
State officials regulated	-0.148** (0.065)	-0.030 (0.024)	-0.064 (0.069)
Year-month FE	Yes	Yes	Yes
Issuer FE	No	Yes	Yes
County-year FE	No	No	Yes
Number of observations	55,878	52,393	46,323
R^2	0.259	0.713	0.769
Adjusted R^2	0.258	0.638	0.636

Notes: This table reports OLS estimates, based on all tax-exempt general obligation or revenue bonds issued by local governments in 2004–2014. Standard errors are adjusted for clustering at the state level, and are provided in parentheses; $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. † These two variables are time-varying issuer attributes. Based on the past five years of bond issuance for a given issuer, we compute the number of bonds and the number of unique underwriters that the issuer employed.

determinants for the method of sale, we investigate how our results presented in Section 4.1 may change when we control for issuer fixed effects. Column (1) of Table A6 reprints the results presented in Column (4) of Table 2, and Column (2) of Table A6 presents the regression results of an alternative specification of (1) where the only difference from the original specification is that issuer fixed effects, instead of county fixed effects, are employed. We find that, despite a steep increase in R^2 in Column (2) compared to that in Column (1), the estimated effects of revolving-door regulations are statistically similar in the sense that the 95% confidence intervals of the precisely estimated coefficients for the revolving-door regulations against local

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

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

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

officials, $[-0.088, -0.040]$ and $[-0.066, -0.014]$, largely overlap.[6] In a similar vein, Column (3) shows that the results are robust to using a subsample of negotiated bonds issued by local governments that used negotiation only for all incidences of new-money bond issuance during 2004–2014.[7] This suggests that the issuer-specific factors affecting the method of sale, beyond those captured by county fixed effects, may not be correlated with the error term in (1).

Our study focuses on negotiated bonds because underwriters cannot directly influence bond design at origination for auctioned bonds. We argue that revolving-door regulations reduce conflicts of interest and limit underwriters' pushes for complex bond design in negotiations. As a way to provide additional support for this argument, we show that revolving-door regulations do not negatively affect bond design for auctioned bonds. To see this, we run the same specification of (1) using auctioned

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

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

bonds issued during the same period. Columns (3) and (4) of Table A6 show that revolving-door regulations, if anything, increased complexity, which is the opposite of our findings in Section 4.1.

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

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

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

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

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

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

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

where the vector of $\mathbf{w}$ comprises of the controls used in the specification for Column (3) in Table A5. Note that we control for extra variables that are not used in the estimation of the main model, such as the issuer's past experience of bond issuance and county-year fixed effects, capturing various state and local regulations and market conditions that change over time.[8] Including these extra variables here allows us to take into account some of the correlations between the issuers' preferences in the model and their decision on the method of sale.

C.3.2. *Monte Carlo Simulation: Procedure.* An important factor for the extent of selection bias is the probability that a bond is negotiated, conditional on observed attributes. When the probability is low for a given bond and yet the bond is indeed negotiated, the extent of the role played by ϵ must be big. With that, we first estimate δ (A.3) to match the conditional probability of negotiation for the bonds used for Table A5. Among these bonds, we focus on a bond with a low predicted negotiation probability, to explore a worst-case scenario concerning the role of selection. Specifically, the simulation results presented below are based on a 92-million general obligation bond issued by the city of Chicago, Illinois, in 2010, and the predicted probability of negotiation, given our δ estimates, is 0.244, close to the 25^{th} percentile of the estimated probability of negotiation for bonds in our extended sample, and slightly below the 5^{th} percentile among the negotiated bonds in the sample.

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

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

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

therefore, of the choice of coupon rate and complexity. Given this observation, for Case 1, which focuses on selection driven by ξ_s, we pick a large value for the standard deviation of ξ_s. Instead, for Case 2, which focuses on selection driven by ξ_r, we pick a large value for the standard deviation of ξ_s.[9]

Given our bond, we use the draws $(\epsilon^{(j)}, \xi_s^{(j)}, \xi_r^{(j)})$, together with the estimates of δ, our model parameter estimates, as well as the estimates for the unobserved attributes of the trading market, $\hat{\xi}_M$ to simulate the chosen method of sale and the equilibrium bond design.[10] In doing so, we use the estimates of δ and our model parameter estimates, as well as the estimates for the unobserved attributes of the trading market, $\hat{\xi}_M$. Note that selection bias does not apply to the estimation of the trading market parameters and $\hat{\xi}_M$, because the first-step parameter estimation uses within-bond variation across transactions and the moment conditions used for the second-step estimation are valid given our assumption that ξ_M is uncorrelated with ϵ, conditional on observables. The government preference parameters, however, are subject to selection bias, given the nonzero correlation between ϵ and ξ_G.

C.3.3. *Selection Bias in Estimates and Counterfactual Results.* Table A7 presents the simulation results for both Case 1 and Case 2. Allowing for nonzero correlation between ϵ and ξ_s (ξ_r) results in a much lower (larger) average value of $\xi_s^{(j)}$ ($\xi_r^{(j)}$) for negotiated bonds, -0.592 vs. -0.029 (1.043 vs. -0.018), about one standard deviation of $\xi_s^{(j)}$ ($\xi_r^{(j)}$) away from zero. This translates into a sizeable digression of the marginal financial cost, $c_0^{(j)}$, and its derivative with respect to complexity, $\partial c_0^{(j)}/\partial s$, for the negotiated bonds, compared to all bonds, especially for Case 1 (0.974 vs. 2.165 and -0.459 vs. 0.088). This is by construction, as we choose values for the simulation so that the differences in the resulting $c_0^{(j)}$ (and $\partial c_0^{(j)}/\partial s$) values are as large as possible depending on the method of sale.

Despite the fact that governments with low $\partial c_0/\partial s$ and/or high c_0 would choose to use negotiation, the effects of such selection on the equilibrium bond designs are

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

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

Table A7. Simulation Exercise on Selection Bias

	Case 1		Case 2	
Average values (standard error)	All	Negotiated	All	Negotiated
Marginal financial cost for issuers				
$c_0^{(j)}$	2.165	0.974	2.315	3.368
	(0.040)	(0.060)	(0.037)	(0.055)
$\partial c_0^{(j)}/\partial s$	0.088	-0.459	0.131	0.127
	(0.018)	(0.029)	(0.003)	(0.006)
Unobserved component for c_0				
$\xi_s^{(j)}$	-0.029	-0.592	-0.003	-0.006
	(0.019)	(0.028)	(0.003)	(0.006)
$\xi_r^{(j)}$	-0.007	-0.009	-0.018	1.043
	(0.003)	(0.006)	(0.036)	(0.054)
Equilibrium bond design				
Complexity index ($s^{(j)}$)	1.246	1.382	1.399	1.378
	(0.014)	(0.019)	(0.009)	(0.017)
Coupon rate ($r^{(j)}$, basis points)	348.3	398.8	337.9	309.3
	(3.1)	(5.7)	(3.1)	(5.4)
Number of simulated bonds	1,000	266	1,000	266

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

relatively limited. For example, for Case 1, the average complexity index for negotiated bonds is 1.382, slightly higher than that of all bonds by a margin of 0.136. This difference is about half of the standard deviation of the complexity index in our negotiated bond sample (Table 1). In addition, the average coupon rate for negotiated bonds is 399 basis points, 51 basis points higher than that of all bonds, again about half of the standard deviation in the data, and the magnitude of the equilibrium bond design differences between negotiated and auctioned bonds for Case 2 is even smaller. These patterns reflect the fact that, given our trading market parameter estimates, the equilibrium bond design is much more sensitive to the underwriter's value of the bond, than to issuer costs.

Appendix D. Modelling Revolving-door Regulations

The empirical findings in Section 4.1 and Appendix B.2 imply that revolving-door regulations reduces the use of nonstandard provisions in bonds. Moreover, Table 3 in Section 4.1 provides suggestive evidence that such regulation does not affect the investor demand or the local government behavior in managing credit risk or issuing bonds. This implies that the government cost of paying debt is not directly influenced by the regulations. To explain these findings, we propose that revolving-door regulations may affect the extent to which officials internalize the payoff of the underwriter from trades, V_U, when negotiating over bond design upon its origination.[11] Under an alternative model, the officials may internalize the net payoff of the underwriter, $V_U - F$, under constraints on bond price F. Below, we show that these two models are observationally equivalent in the sense that they both can rationalize the same equilibrium bond design. In addition, we provide comparative statics consistent with our main finding in Section 4.1 and heterogeneous effects in Appendix B.3.

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

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

subject to

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

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

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

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

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

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

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

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

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

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

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

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

subject to

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

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

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

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

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

Rearranging terms in (A.13), we have

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

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

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

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

and the FOC with respect to s becomes

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

Rearranging terms in the above equation, we have

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

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

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

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

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

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

Rearranging terms we have

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

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

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

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

Rearranging terms we have

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

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

Appendix E. Characterizing Equilibrium in the Trading Market

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1. *(i) follows (A.20)–(A.21) subject to (A.22)–(A.23), given (ii)–(iv);*
2. *(ii) satisfies (9), (11), and the terminal values in Section 5, given (i);*
3. *(iii) satisfies (10), given (i)–(ii);*
4. *(iv) satisfies (A.16)–(A.19), given (ii).*

Appendix F. The Estimator

This section provides a more detailed discussion of the first and third steps of the estimation (Appendix F.1 and F.2), of how we construct the bootstrapped standard errors (Appendix F.3), and of the estimation sample and its summary statistics (Appendix F.4 and F.5).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

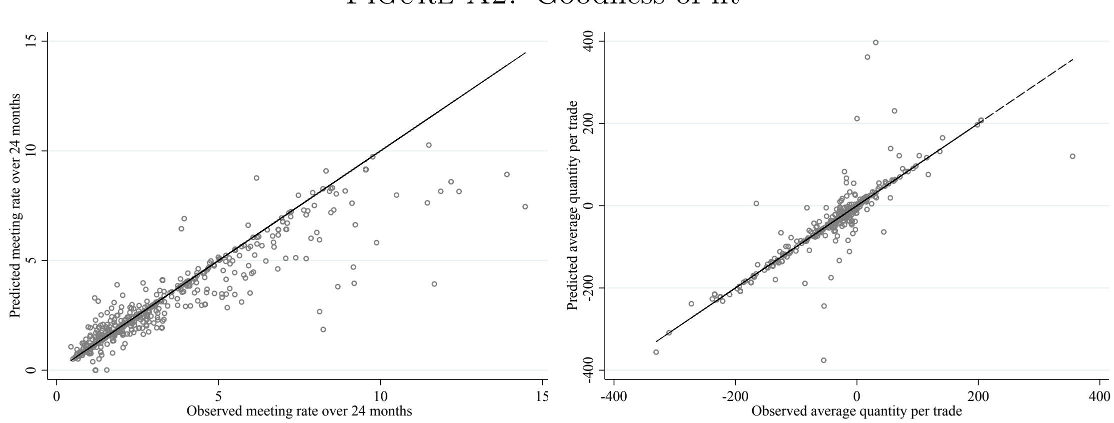
F.2. **Step 3.** We derive the GMM estimator for the government preference parameters, and discuss the implications of our normalization that the officials' weight for their underwriter when revolving-door regulations are in place, $\psi(\mathbf{x}_\psi, 1) = 0$ for all $\mathbf{x}_\psi$.

Table A8. The Distribution of First-Step Parameter Estimates

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

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

Figure A2. Goodness of fit



(A) Meeting Rate (B) Trading Quantity

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

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

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

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

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

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

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

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

$$\mathbb{E}\Big(\xi_s(s,r,\mathbf{x},h,\hat{\xi}_M;\theta_c,\theta_d,\theta_\psi)\,[\mathbf{x}_G,\mathbf{z},h,h\mathbf{x}_\psi]\Big)=0, \tag{A.27}$$
$$\mathbb{E}\Big(\xi_r(s,r,\mathbf{x},h,\hat{\xi}_M;\theta_c,\theta_d,\theta_\psi)\,[\mathbf{x}_G,\mathbf{z},h,h\mathbf{x}_\psi]\Big)=0, \tag{A.28}$$

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

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

$$-c_0'(s^*)A(1+rT) + \theta_d + \{1+\psi(1)\}\frac{\partial}{\partial s}V_U(s^*, r^*) = 0,$$

$$-c_0(s^*)AT + \{1+\psi(1)\}\frac{\partial}{\partial r}V_U(s^*, r^*) = 0,$$

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

$$-c_0(s^{**})AT + \{1+\psi(0)\}\frac{\partial}{\partial r}V_U(s^{**}, r^{**}) = 0.$$

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

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

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

$$\frac{c_0(\cdot)}{1+\psi(1)}, \frac{\theta_d}{1+\psi(1)}, \frac{1+\psi(0)}{1+\psi(1)}.$$

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

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

$$\tilde{c}_0(s, \mathbf{x}_G, \xi_G; \theta_c, \psi_1) = (1+\psi_1)c_0(s, \mathbf{x}_G, \xi_G; \theta_c),$$

$$\tilde{\theta}_d(\theta_d, \psi_1) = (1+\psi_1)\theta_d,$$

$$\tilde{\psi}(\mathbf{x}_\psi, 0) = \psi_1 + (1+\psi_1)\psi(\mathbf{x}_\psi, 0; \theta_\psi),$$

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

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

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

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

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

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

where n_i is the number of transactions for bond i and $\theta_{0,i}$ denotes the true parameter vector. Using the bootstrapped first-step estimates, $\hat{\theta}_i^m$ for $m = 1, ..., 200$, we estimate Σ by employing a maximum likelihood estimator and denote it by $\hat{\Sigma}$.[12]

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

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

matrix by numerically computing the derivative of $\partial V_U(s, r, \mathbf{x}_{M,i}, \hat{\xi}_{M,i}; \hat{\theta}_i)/\partial s$ and $\partial V_U(s, r, \mathbf{x}_{M,i}, \hat{\xi}_{M,i}; \hat{\theta}_i)/\partial r$ with respect to each element of $\hat{\theta}_i$.[13]

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

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

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

For the counterfactual analysis, we draw a stratified subsample from the estimation sample and focus on that sample to understand the overall distribution of the effects of a standardization policy. Although the estimation sample is comparable to the entire sample, we draw the stratified sample to further mimic the latter. To this end, the stratification relies on the distribution of three key bond attributes: coupon rate, complexity index, and transaction frequency. Specifically, we create four bins for each attribute, using the 25th, 50th, and 75th percentiles of the entire sample as cutoffs, and then obtain the probability that a bond in the sample falls into one of the 4×3 bins. Then, based on these probabilities, we randomly draw a subsample from the estimation sample. As a result, Table A9 shows that the 25th, 50th, and 75th percentiles of the three bond attributes used for the stratification are almost identical between the entire sample and the stratified sample. Remarkably, the distribution

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

Table A9. Comparison between the Estimation and the Entire Sample

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

Notes: This table presents the 25th, 50th, and 75th percentile of each variable's distribution among the entire sample of bonds, the estimation sample, and the stratified sample used for the counterfactual analysis. *a*. When an issue contains multiple bonds, we take a simple average across the bonds within the issue. *b*. This index is the simple average number of nonstandard provisions (in terms of call and sinking fund provisions, as well as interest payment frequency and type), plus a dummy indicating that the issue includes multiple bonds. c. The demographic information is at the county level.

of the other variables for which the stratification procedure does not target among the stratified sample resembles the counterpart distribution among the entire sample, more so than the estimation sample.

F.5. **Variables Used in Estimation.** Table A10 presents the mean and the standard deviation of the variables used in the estimation of the model, including the endogenous bond attributes (s, r) and the controls $(\mathbf{x})$, based on the 927 sample bonds. The table also shows summary statistics of our inter-dealer and dealer-to-investor transaction-level data, which are used in the first step of the estimation.

Appendix G. The Effects of Standardization: Sensitivity Analyses

This section looks at the sensitivity of or results to the investors' substitution across different bonds (Section G.1), the choice of auction vs. negotiation (Section G.2), the choice of underwriter (Section G.3), and the role of call options (Section G.4).

Table A10. Summary Statistics of the Variables Used in Estimation

	Mean	SD		Mean	SD
Bond attributes			*Issuer attributes*		
Face value (in \$million)	23.9	67.6	Issuer type		
Maturity (in years)	8.82	4.91	County government	0.08	-
Bond type			City government	0.41	-
General obl., unlimited	0.50	-	School district	0.27	-
General obl., limited	0.20	-	Special district	0.24	-
Revenue	0.30	-	Num. bonds by the underwriter[a]	2.03	3.63
Newly issued (vs. refunding)	0.30	-	At least one bond issued[a]	0.61	-
Complexity index	1.48	0.56	*County attributes*		
Coupon rate (in pp)	3.22	1.07	Median household income (\$K)	52.2	14.0
Inter-dealer trades			Senior population	0.13	-
Unit price (p, \$ per \$100)	89.5	37.7	Poverty rate	0.16	-
Quantity (pq, in \$K)	210	794	Population growth rate (%)	0.51	1.72
Duration (in days)[b]	7.8	43.9	Unemployment rate (%)	8.82	2.03
Dealer-to-investor trades			Num. of local dailies (in 2004)	1.98	1.88
Unit price (p, \$ per \$100)	104	11.1	*Issuer finances*		
Quantity (pq, in \$K)	157	840	Average annual revenues (\$M)[c]	146.2	433.8
Duration (in days)[b]	5.9	45.5	SD annual revenues (\$M)[c]	201.6	281.1
Revolving-door regulations			Frac. of taxes in revenues	0.35	-
Affecting state officials	0.59	-	Frac. of rev. from federal/state	0.39	-
Affecting local officials	0.29	-			

Notes: This table is based on the 927 bonds used in the estimation. *a*. To construct these two variables we look at the bond issuance history of an issuer for the past eight years. *b*. The average number of days for subsequent trades of bonds within an issue. *c*. Based on the government revenues in 2000–2014, measured in 2012 CPI-adjusted dollars.

G.1. **Investor Substitution.** We estimate the demand for each bond separately, holding fixed the value of alternative investment opportunities that an investor may choose from. This does not bias our estimates, but it may warrant some important caveats for the interpretation of the counterfactual policies that we study. Specifically, when we estimate the impact of standardization policy, our approach only allows us to simulate a "partial equilibrium" impact of the policy, where we hold the opportunity cost constant, thus assuming that an investor's alternatives do not respond to the policy. For example, we do not consider a repricing of the bonds in circulation at the time of the announcement, which might impact investor surplus from holding existing bonds. This section explores how our findings may change if we allow all bonds to be simultaneously subject to the policy. Section G.1.1 discusses how our model reflects investors' substitution behavior in a parsimonious way, allowing the opportunity cost of holding a bond $\kappa_{I,i}$ to depend flexibly on the desirability of alternative investment opportunities. If standardization were imposed on all bonds simultaneously, it would

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

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

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

change such a bond-specific opportunity cost; therefore, Section G.1.2 studies how sensitive our counterfactual results are to that parameter.

G.1.1. *Modelling Investors' Substitution.* The municipal bond market is dominated by individual retail investors, largely due to income tax exemption based on residence: municipal bond interest income is exempt from federal and, for in-state residents, state taxes. The local nature of these tax advantages restricts the extent of investors' substitution across bonds; for example, investors looking for federal/state tax savings would primarily look for their home-state bonds.

Our model captures this limited substitution in a parsimonious way allowing an investor's holding of a given bond i in her portfolio to depend on alternative investment opportunities. In particular, the investors' flow utility for holding quantity a_i of bond i includes a bond-specific quadratic cost $-\frac{1}{2}\kappa_i a_i^2$, which reflects the opportunity cost of tying up amount a_i in bond i rather than in alternative investment opportunities. In other words, more desirable alternatives in the market at the issuance of bond i can be reflected by a larger κ_i.

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

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

where $\hat{W}_{-i,t}$ is the value function for the investors, based on our estimates, averaged across investor types, for bond i's close substitutes when they are issued.[14] The state-year fixed effects, $\mu_{sy(i)}$, and the monthly period fixed effects, $\rho_{t(i)}$, reflect the opportunity costs associated with other alternatives specific to the state during the year and all alternatives, regardless of location, available during the month of bond issuance, respectively. As for the bond's substitutes, we include all bonds that were issued in the six months before its issuance, in the same state, by the same government type (county, city, school district, or other special district). We find that the estimate of β is positive and statistically significant, implying that our bond-specific parameter of $\kappa_{I,i}$ is positively correlated with the average value of close substitutes.

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

G.1.2. *Robustness.* If the standardization policy were to be implemented for all bonds, their values to investors would be accordingly adjusted, and the opportunity cost of holding bond i, $\kappa_{I,i}$ would also be affected. Under this scenario, all alternative bonds would be plain vanilla, but they would compete in coupon rate, liquidity, and (exogenous) default risk. Note that here $\kappa_{I,i}$ becomes an equilibrium object, along with the equilibrium coupon rates and liquidity levels of all bonds.

Instead of computing the general equilibrium under this policy scenario, we conduct a sensitivity analysis by simulating the effects of the policy when $\kappa_{I,i}$, as an

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

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

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

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

equilibrium response, increases by 1% compared to the estimated value. Note that given the elasticity estimate for $\kappa_{I,i}$ with respect to the average value of substitutes to investors (0.0208, from Column (2) in Table A11), a 1% increase in $\kappa_{I,i}$ would require a 50% increase in the investor surplus from other bonds in equilibrium.

Table A12 presents the results for the bond studied in Section 8.2 of the paper, a general obligation bond issued in 2012 by a school district in Michigan, as an example.[15] We find that our overall results are robust to a 1% change in the equilibrium opportunity cost of holding a bond. When $\kappa_{I,i}$ increases, reflecting the additional competitive pressure, the decrease in the coupon rate as described in Section 8.2 (or in Column (2) of Table A12) would be slightly offset (−29.7 vs. −26.0 basis points), and so would the increase in liquidity.

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

G.2. **The Choice of Auction vs. Negotiation.** Some issuers in our sample may currently prefer selling their bonds through negotiated deals because they value complexity and this gives them more flexibility in customizing the bond design than auctions. If a standardization mandate were implemented, these issuers might switch to selling bonds through auctions, although such switching behavior may be limited given our discussion in Section 3.1 and Appendix C. Through the lens of the model,

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

Table A13. What if Some Issuers Switch to Auctions?

	Median Change under Standardization			
Fraction of switchers to auctions	None	10%	25%	50%
Interest rate (basis point)	−22.66	−23.65	−26.98	−35.11
Issuer costs				
Interest payment ($K)	−9.0%	−9.4%	−10.2%	−12.5%
Marginal financial cost (c_0)	+5.0%	+5.0%	+5.0%	+5.0%
Total issuer cost ($c_0 A(1 + rT) - d_0 s$, $K)	+10.6%	+10.25%	+10.11%	+9.74%

Notes: This table presents, relative to the current policy, the median interest rate changes and the median percentage changes in issuer costs, under multiple standardization scenarios where nonstandard provisions are allowed at a minimal level, while some issuers switch to auctions. The numbers are based on the 386 stratified sample bonds. When the fraction of such switchers is zero (second column), the results are identical to Table 8. The last three columns present the results when issuers with the 10% (20% and 50%, respectively) lowest $\frac{\partial}{\partial s} c_0(s, \mathbf{x}, \xi)$ switch to auction.

this would imply that issuers with a high value for complexity, hence low $\frac{\partial}{\partial s} c_0(s, \mathbf{x}, \xi)$, might switch to auction following a standardization mandate. In light of this, we next consider an alternative scenario where these issuers may choose auction instead of negotiation under the standardization policy of Section 8.

A challenge in evaluating this scenario lies in determining the coupon rate under an auction. To make inroads, we rely on Cestau et al. (2019), who use panel variation in state-level legislation banning negotiated sales to show that switching from negotiated to competitive sales reduces yields by around 16 basis points. With that, we simulate the equilibrium outcomes when the issuers with the lowest values of $\frac{\partial}{\partial s} c_0(s, \mathbf{x}, \xi)$ (bottom 10^{th}, 25^{th}, and 50^{th} percentile) were to switch to auctions following the standardization mandate, under the assumption that their counterfactual coupon rate would be 16 basis point lower than their negotiated rate under standardization.

The results, in Table A13, show that accounting for selection magnifies the cost savings for the issuers. We find that the median interest payment for the issuers would decrease by as large as 12.5% if a half of the issuers switch to auctions, while the interest payment savings without switchers is 9%.

G.3. **The Choice of Underwriter.** Municipal governments choose their underwriter and can switch underwriters. However, the underwriter-issuer relationship is notoriously persistent (Section 2.2). Moreover, the underwriting market tends to be fairly concentrated. These facts indicate that although the issuers do choose their

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

	Median change from standardization: Does the issuer always choose the low-cost underwriter?	
	No	Yes
	(1)	(2)
Interest rate (basis point)	−22.7	−26.93
Average dealer's meeting rate (yearly)	+33%	+33.74%
Investor surplus	+8.01%	+9.48%

Notes: The numbers are based on the 386 stratified sample bonds. In the first column, we consider the standardization mandate of the main text, Section 8. In the second column, we consider an alternative standardization policy where an issuer selects a dealer with the lowest search cost as the underwriter. The table presents the median (percentage) changes, relative to the market's current outcomes.

underwriter, the scope of their choice is often limited. This motivates us to abstract away from the choice of underwriters in our model.[16] Yet, this decision may have implications for our results. In particular, under a standardization mandate, the government might be less tied to a particular underwriter, and it may switch to low-cost underwriters. As a robustness check, we simulate our counterfactual policy and assume that, when switching to standardization, issuers switch underwriters in favor of a dealer with the lowest search cost. The results, summarized in Table A14, confirm that our results are overall robust although, perhaps unsurprisingly, the improvement in investors' welfare and market liquidity are magnified, and drive a a bigger decline in the coupon rate.

G.4. **The Role of Call Options: An Alternative Standardization Policy.** Among the various nonstandard provisions considered in this study, call options are frequently used: for our sample of 13,118 tax-exempt bonds that are negotiated in 2010-2013, having a call option in a bond issue is common (74%). We find that the revolving-door regulations decrease the extent to which call options are embedded in

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

Table A15. What If Standardization Allows Call Options?

	Median change from standardization: Is a call option allowed? No (1)	Yes (2)
Interest rate (basis point)	−46.88	−38.97
Average dealer's meeting rate (yearly)	+24.8%	+18.67%
Investor surplus	+5.48%	+7.20%
Issuer costs		
Interest payment ($K)	−16.0%	−12.0%
Marginal financial cost (c_0)	+6.07%	+2.94%
Total issuer cost ($c_0 A(1 + rT) - d_0 s$, $K)	+15.08%	+9.35%

Notes: The numbers are based on the 253 stratified sample bonds that have a call option. In the first column, we consider a standardization policy where nonstandard provisions are allowed at a minimal level as in Section 8, and the numbers in this column are not identical to those in Table 8 because a subsample of the stratified sample bonds is used here. In the second column, we consider an alternative standardization policy where only call options are allowed. The table presents the median (percentage) changes, relative to the market current outcomes.

the bond contract (Table A8, Column 3), suggesting that call options may be "over"-used. However, these options can be particularly useful for the issuers, allowing them to lower the interest costs when the market interest rate is falling. For this reason, we explore the role of call options, specifically in driving the counterfactual results in Section 8.

To this end, we simulate the market outcomes under an alternative standardization policy that would restrict the use of all nonstandard provisions except for call options. In implementing this policy, we set the complexity level of a bond issue equal to the observed complexity level determined by the call options in the issue only, so that the counterfactual bond would include the same call option provisions but would not include any other nonstandard provisions. We present the equilibrium outcomes under this counterfactual policy in the last column of Table A15, presenting the median percentage change in these outcomes, compared to those of the baseline scenario. Here we focus on a subset of the stratified sample bonds that have a call option, 253 bonds. This is because for the bonds without a call option even without any standardization mandate, whether or not a call option is allowed in the standardization policy would be most likely irrelevant.

Table A15 shows that mandating a full-fledged standardization would increase the marginal financial cost c_0 by 6.07%, but allowing for call options would only increase the marginal cost by 2.94%, reflecting the benefits of call options to the issuers. With that, the impact of this alternative approach to standardization is more muted, compared to the policy we study in the main text, but the overall results are similar. First, the key trade-off associated with non-standard bond provisions is present: standardization would increase the rate at which transactions occur for all the bonds, with a median percentage equal to +18.7%, but reduce the flexibility in the payment schedule for governments, increasing the marginal financial cost (c_0) and decreasing the long-term benefits of such flexibility on government finances ($d_0 s$). Second, the coupon rate would fall, with the median change in coupon rate by -39 basis points, and thanks to the higher liquidity investors would, in general, benefit from standardization despite the overall decrease in coupon rate, with the median percentage change in the investor surplus +7.2%.

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