NORTH-HOLLAND

The Quarterly Review of Economics and Finance
43 (2003) 191–211

The QUARTERLY REVIEW of ECONOMICS And FINANCE

# Comparative costs of negotiated versus competitive bond sales: new evidence from state general obligation bonds

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**Abstract**

Previous work on the interest cost implications of the municipal bond underwriting method of sale decision has produced results asserting that competitive bid sales result in lower interest costs. However, negotiated offerings still dominate the municipal market. This paper invokes financial certification theory to explain the apparent paradox. After correcting for selection bias which is predicted by the theoretical model, empirical estimates show that for a sample of state general obligation bonds, negotiated offerings have at worst no higher and perhaps lower interest costs.


*JEL classification:* G240, H740

*Keywords:* Municipal bonds; Underwriting; Public finance

## 1. Background

The prevailing wisdom regarding the choice of underwriting method (competitive sale vs. negotiated offering) by municipal issuers has for years recommended competitive sales over negotiated offerings. One recent article summarized the prevailing wisdom: "where municipalities have a choice, they should sell their new bond issues by competitive means" (Simonsen & Robbins, 1996). Most of the empirical work in this area is significantly dated, however. After a period of initial interest in this issue, research has declined to just a handful of articles in the

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1062-9769/03/$ – see front matter 
PII: S1062-9769(01)00124-7

last 10 years. And the municipal bond market is still dominated by negotiated issues (62% of all sales in 1994 were done negotiated (The Bond Buyer, 1987–1999)).

There are advantages and disadvantages with both types of underwriting method. Competitive issues may provide the appearance of a fair and impartial decision regarding which underwriter to use. However, since syndicates bidding on issues may not know if they will be awarded the bonds, there will be less incentive to conduct an exhaustive "search" for the highest level of market demand prior to the sale date. If there is more uncertainty regarding the credit quality of an issuer, it may be difficult to fully subscribe an issue. Also, the issuer has less flexibility to change the timing of a sale once the sale date is announced. If market conditions change adversely, the issuer may not be able to delay an issue. Negotiated underwriters may undertake a higher level of market search prior to issue and it has been suggested that they may be able to time the issue better. However, negotiated sales are perceived to lack competition and may result in charges of patronage to firms that are political insiders. Owing to this perception and the results of previous empirical studies, some states have considered legislation restricting issuers to only use competitive bid sales (Juarez & Bonpua, 1994).

Previous empirical research has concentrated on three main hypotheses regarding differences between interest costs of competitive and negotiated issues. It has concentrated on the perception that lower competition in negotiated sales leads to rent-seeking behavior, that market search is greater under negotiation, and that market uncertainty leads to issuers seeking to maximize issue flexibility through using negotiated offerings. Most of the results have indicated that competitive bid sales result in lower interest costs for issuers. However, the paradox remains that the majority of municipal bond issues are negotiated offers.

This paper offers a different explanation for the choice between negotiated and competitive underwriting. Negotiated underwriting may help to resolve information asymmetries that potentially increase interest costs for all new issues. By accurately certifying the fair price of new issues, negotiated underwriting can assist the municipal securities market in reaching a stable separating equilibrium. Since this is the case, a self-selection is created; issuers that most need to solve information problems are those issuers most likely to use negotiated offering. The problem with past empirical studies is that they have largely ignored selection biases. This paper applies for the first time a technique often used in studies of economic decisions to the question of the relative costs of negotiated offerings and competitive bid sales. This technique allows a clear interpretation of the results while controlling for self-selection problems. The results indicate that issuers rationally choose the underwriting method they use. Issues more likely to need independent certification of value are offered through negotiation. Once selectivity biases are controlled, negotiated offering is shown to produce at worst the same interest cost for issuers that use negotiation and at best lower interest costs.

## 2. Previous empirical literature

The literature on the use of negotiated offerings began in the mid-1960s. It has heretofore centered on three basic hypotheses: the monopsony-pricing hypothesis, the underwriter search hypothesis, and the market uncertainty hypothesis.[1]

### 2.1. Monopsony-pricing hypothesis

Most of the empirical work has been based around the monopsony-pricing hypothesis. Theories of monopsony-pricing have concentrated on the observation that negotiated issues are subject to less competition than competitive issues. Therefore, it is held, negotiated underwriters can extract a monopolistic rent from issuers in the form of an underpriced issue with higher than competitive interest costs. Large underwriters may collude either overtly or covertly through the syndication process to eliminate competitive bidding. In order to sustain the collusion, potential bidders would either have to join the syndicate or refrain from bidding. Since it would not be possible to include all potential bidders in a syndicate, nonmembers who honor the collusion could be rewarded for abstaining from bidding (a concession to not break the cartel). After the syndicate breaks, the bonds can then be resold in the secondary market at a higher price (West, 1967, 1966, 1965). This hypothesis has provided a framework for several other studies that have concluded that new issue bonds sold through competition are priced more favorably than those sold through negotiation (Joehnk & Kidwell, 1979; Simonsen & Robbins, 1996).

An important theoretical foundation for the monopsony-pricing hypothesis is that negotiated underwriters intentionally underprice bonds in the primary market, extracting a monopsonistic rent as the price of the issue rises in the secondary market to its fair price. The empirical evidence on municipal bond underpricing is relatively sparse, with one study supporting the underpricing hypothesis (Ederington, 1976) and another study failing to find evidence of systematic underpricing (Maese, 1985).

### 2.2. Underwriter search hypothesis

Through the underwriting process, underwriters acquire specialized knowledge of what their best customers will pay for a prospective bond issue. If they can employ this knowledge in a competitive environment, they will bid issues at the highest competitive price consistent with normal profits. The underwriter search hypothesis argues that the larger the number of bids submitted, the greater the probability of discovering the underwriter who will offer the most for the bonds. The suggestion is that as the number of bids increases, prices should increase leading to lower reoffering yields (Kessel, 1971).

Some empirical research has supported the notion that both the number of bidders for municipal bonds and the intensity of their search effort reduces interest cost for some issues (Benson, 1979; Leonard, 1999). Other research has suggested that competitive bidding actually produces less “effective” search than negotiated issues. In competitive underwriting, search is duplicated by losing syndicates, making effective search lower than total search, which in turn lowers the offer price for the issue. In addition, bidders may become “trapped” (willing to pay more for the securities than the winning offer price, but excluded from the final offer). Because of the problem of trapped bidders, competing syndicates command fewer high-priced members than possible under negotiation, further weakening the issuer’s offer (Hansen & Khanna, 1994).

### 2.3. Market uncertainty

While the monopsony-pricing and underwriter search hypotheses have received the bulk of the attention in the literature on underwriting, an interesting third hypothesis has emerged.

This hypothesis holds that in times of greater market uncertainty, negotiated underwriting may actually reduce issuance costs by providing more efficient market search and better issue timing. Empirical studies have generally supported the market uncertainty hypothesis (Dyl & Joehnk, 1976; Ederington, 1976; Tallman, Rush, & Melicher, 1974).

## 3. The certification hypothesis

In this section, we develop a new hypothesis regarding the relationship between method of sale and interest costs that draws on existing theory. Securities issues are decisions to buy and sell financial assets. However, in a situation where buyers are unsure of the quality of assets available in the market and sellers are unable to credibly communicate the asset quality, information asymmetry problems occur. In cases where sufficiently high asymmetries are present, markets may fail (Akerlof, 1970). One way to solve the information asymmetry problem is through employing a third party agent to provide certification of financial information. Financial certification agents provide information through their actions (such as underwriting an issue, providing a credit rating or providing bond insurance) to potential purchasers of securities (investors). This information is new information for investors regarding the *ex ante* probability that an issuer will default on its debt obligations. Given that bonds are priced by investors according to the market rate of interest adjusted by investors' estimates of default probability (Bierman & Hass, 1975) and marketability (Fisher, 1959), an action which reduces the *ex ante* probability of default should increase the price the bond receives in the market and therefore reduce its interest cost to borrowers.

The theory of financial certification was developed by Booth and Smith (1986), working from a basis of reputational signaling models (Klein & Leffler, 1981). According to this theory, financial certification agents reveal information to investors by putting their reputational capital on the line when they provide certain services to issuers. This reputational capital is realized through future financial returns to the reputation of the agent. As long as investors view the amount of reputational capital placed in jeopardy as greater than the potential one-time transfer of wealth created by "cheating" and providing false certification (e.g., taking an action which indicates that a high default risk issuer is a low default risk issuer), the investor will accept the certification as true and adjust their *ex ante* probability that the issuer will default downward (Booth & Smith, 1986; Kriz, 2000; Megginson & Weiss, 1991).

Certification agents thus help resolve the problem of adverse selection in the municipal securities marketplace by providing information through observable actions. However, there are costs that the issuer must pay in order to purchase certification. In fact, if purchasing the certification were costless, the problems of adverse selection would not be mitigated (Megginson & Weiss, 1991).

The choice to use any single certification agent therefore reduces to the balancing of interest cost savings from the provision of certification and additional interest costs from obtaining that certification. In general, we would expect that issuers with greater initial uncertainty regarding repayment should seek to use services provided by certification agents because they will recognize a higher net certification benefit.

The question that remains to be answered is whether negotiation provides a differential certification benefit beyond that offered by simply using an underwriter. Smith (1987) finds

evidence that negotiated sales provide high levels of certification value. In his sample of public utility bonds, issues with greater *ex ante* uncertainty regarding their credit quality were more likely to issue negotiated. The interest cost benefits from negotiation that he finds in lower rated bonds are higher than those for lower rated bonds, indicating the presence of certification benefits of negotiation.

The intuition behind this finding can be thought of in terms of the timing of contracts in the negotiated offering. After the contract is finalized with a negotiated underwriter and before the issue is made, the underwriter obtains access to inside information regarding default risk of the issue and issuer.[2] At the time of sale, the underwriter effectively faces a decision whether to take an issue to market. Given that underwriters are penalized by a loss of market share if they underwrite bad credits, a negotiated underwriter is unlikely to place reputation on the line by taking an overly risky issue to market. Competitive bid sales are by their nature a short-term relationship, releasing little new information to the market. In competitive bid sales, underwriters act as traders, buying a commodity from one party and reselling it to another.[3] They stand at arm's length from the issuer. Because they do not gain access to inside information, they put little reputational capital at stake by underwriting an issue. Negotiated offering therefore offers a higher level of certification and we expect that issuers who need more certification will use negotiated offerings and realize a benefit from them. At least two studies have suggested the presence of greater certification value for negotiated underwriting (Smith, 1987; Sorensen, 1979).

Based on this theory and evidence, we can develop hypotheses about the use of negotiated offerings and the interest cost effect of that decision. We expect that certification will become more valuable as uncertainty regarding the true value of the issue increases. Therefore, issuers most in need of financial certification should choose to issue negotiated. Given this decision, the effect should be to reduce issuer interest costs below the level that their bond issues would otherwise incur.

## 4. Data and empirical analysis

In order to test the hypotheses generated in the last section, an empirical model of bond issuance was derived and tested on a sample of state government issued general obligation (GO) bonds. State GO bonds were chosen for two reasons. First, the state GO market has the largest issues in the municipal market, made by issuers that are relatively well known to the market. This should produce a certain bias to not rejecting the null hypothesis of no difference in interest costs.[4] Second, from a practical standpoint, the state GO market contains the largest quantity of reliable information for modeling. Finally, almost all of the existing studies of the decision to issue negotiated have used samples of local bonds from one state. Ours is one of the first truly national studies of this question. The sample period chosen for this research is the period 1990–1997. This sample period was chosen because it provides coverage of two important threats to validity. First, there was a short recession during the period from late in 1990 until midyear 1992. Second, interest rates fell during this period, however they increased relatively sharply during the period from October 1993 to November 1994. Because macroeconomic shocks can have serious effects on the pricing of GO bonds, it was important to gather data that spanned these two potential events.

Initially, an attempt was made to gather information on all state GO bonds during the 1990–1997 period. Data was gathered on the issues using several sources. There are three primary sources of information regarding the bond issues. First was the MUNI-IRIS® database, produced by DPC Data, Inc. The second source was the MuniStatements.com© database (available online at http://www.munistatements.com/), produced by Thomson Financial Services. These databases are part of the Nationally Recognized Municipal Securities Information Repository (NRMSIR) system established by SEC Rule 15c2–12. As a last resort, issue information was obtained using the competitive issuance calendar and negotiated issuance calendar features from the Bloomberg© financial information system. In the event that the third option was used, an attempt was made to reconcile the information obtained from Bloomberg with data from the first two sources. If the data could not be reconciled, the issue was deleted from the database. An estimate of the population size during the sample period is 708 issues.[5] However, several bond issues could not be obtained and data on several additional issues was not available. The resulting final sample size used for this study is 521 bonds. If the population estimate is accurate, then the sample accounts for 73% of the population.

### *4.1. Data and descriptive statistics*

Table 1 lists all of the variables used in this research along with the sources used to gather the data. The variables have been broken down into groups representing the socioeconomic and financial condition of the issuer, market conditions at the time of the bond issue, experience of the issuer and characteristics of the issue. Most of these variables are common to other studies and need no further discussion. Socioeconomic condition is broken down into demographic variables and economic condition variables. Regional variables were included as controls because at least one study has indicated that the interest cost implications of the use of bond ratings (another source of financial certification) differs across geographic regions (Rivers & Yates, 1997).

Economic condition in our sample is captured through two variables. Unemployment rates are a common measure of economic distress and condition. This variable has been used in such a manner in a large number of studies across a wide array of topics. To this variable, we added state per capita income as a measure of the robustness of the underlying state economy. State per capita income is used by several rating agencies as a measure of fiscal capacity (Standard & Poor's, 1999).

Financial condition of issuers in our sample is captured through seven variables that can be broken down into three categories: revenue variables, expenditure variables, and debt variables. Revenue variables measure the ability of an issuer to raise funds that may be used to service debt (Capeci, 1991, 1994). Expenditure variables may capture economic distress as per capita expenditures may increase during an economic downturn (Liu & Thakor, 1984). Debt variables are included to measure competing claims against the revenue of the jurisdiction. A state with a large amount of debt outstanding prior to a bond issue can devote less of its financial resources toward servicing debt payments on the current issue (Capeci, 1994).

Market characteristics are captured in this research using four variables. The first variable is used in order to measure the "market" rate of interest at the time of issue. Previous studies of municipal bond issuance have used several different variables to capture the market rate of interest. The variable that seems to be used in most often in recent literature is the Bond

Table 1
Variables used in the empirical analysis

| Variable name | Description | Source |
|---|---|---|
| Socioeconomic (SOCEC) variables | | |
| LOGPOPN | Total resident population (in logs) | U.S. Census Bureau; *Population estimates* |
| NEREG | Indicator variable for issuer being in the Northeast region of the U.S. | Adapted from U.S. Bureau of Economic Analysis classifications |
| MWREG | Indicator variable for issuer being in the Midwest region of the U.S. | Adapted from U.S. Bureau of Economic Analysis classifications |
| SOREG | Indicator variable for issuer being in the South region of the U.S. | Adapted from U.S. Bureau of Economic Analysis classifications |
| WESTREG | Indicator variable for issuer being in the Western region of the U.S. | Adapted from U.S. Bureau of Economic Analysis classifications |
| UNEM | State-wide unemployment rate | U.S. Bureau of Labor Statistics; *Local area unemployment* |
| PCI | State per capita income | U.S. Bureau of Economic Analysis; *Survey of current business* |
| Financial condition (FINAN) variables | | |
| GENREV | Per capita general revenue | U.S. Bureau of Census; *State government finance estimates* |
| INCTAX | Per capita income tax revenue | U.S. Bureau of Census; *State government finance estimates* |
| IGREV | Per capita intergovernmental revenue | U.S. Bureau of Census; *State government finance estimates* |
| GENEXP | Per capita general expenditures | U.S. Bureau of Census; *State government finance estimates* |
| STDEBT | Per capita short-term debt outstanding | U.S. Bureau of Census; *State government finance estimates* |
| DEBT | Per capita long-term debt outstanding | U.S. Bureau of Census; *State government finance estimates* |
| DSERV | Per capita state debt service | U.S. Bureau of Census; *State government finance estimates* |
| Market characteristics (MARKET) variables | | |
| BBI20 | The Bond Buyer 20 Bond Index for the week of the issue | Securities Data Company; *The Bond Buyer* |
| VOL8 | Eight-week standard deviation of The Bond Buyer 20 Bond Index | Calculated from *The Bond Buyer* |
| VOL12 | Twelve-week standard deviation of The Bond Buyer 20 Bond Index | Calculated from *The Bond Buyer* |
| T30RESQ | Residuals from the projected 30 year constant-maturity Treasury bond series | Calculated from U.S. Federal Reserve Board of Governors; *Statistical release H.15* |

Table 1 (*Continued*)

| Variable name | Description | Source |
|---|---|---|
| Issuer experience (EXPER) variables | | |
| MGMT | Number of years that state treasurer has been in office | Official statement (OS), State records |
| Issue characteristics (ISSUE) variables | | |
| MATURE | Final maturity in 365-day years | Calculated from OS |
| LNMAT | Final maturity in log of 365-day years | Calculated from OS |
| LONG | Indicator for long-term bond issue (final maturity greater than 10 years) | Calculated from OS |
| SHORT | Indicator for short-term bond issue (final maturity less than or equal to 10 years) | Calculated from OS |
| SHORTMAT | Interactive variable for the final maturity of a short-term bond (short∗mature) | Calculated from OS |
| CALL | Indicator variable for callable bond | OS |
| PAR | Par value (in logs) | OS |
| TAX | Indicator variable for bond interest subject to federal taxation | OS |
| TIC | True interest cost of the issue | Calculated from OS |
| CRATE | Ordinal variable for the highest credit rating from Moody's, S & P or Fitch | OS |
| THRATE | Indicator variable for the use of three credit ratings | OS |
| NEGOT | Indicator variable for use of negotiated offering method of sale | OS |
| REPUT | Market share of underwriter (as percentage of total issues) | Calculated from database of all state-issued GO bonds |
| REPUT2 | Indicator variable for use of high reputation underwriter (market share greater than 4% of total) | Calculated from database of all state-issued GO bonds |
| INS | Indicator variable for the use of private bond insurance | OS |

Buyer 20 Bond Index (BBI20). This variable, gathered by the publishers of The Bond Buyer trade journal, is a weighted average yield for a representative sample of 20 long-term general obligation bonds. In order to capture interest rate volatility in this market (and to measure the market uncertainty hypothesis for underwriting), two traditional measures of interest rate uncertainty were employed, the 8-week (VOL8) and 12-week (VOL12) standard deviation of BBI20. Another variable was created to capture unexpected changes in long-term interest rates. This variable was constructed in two steps. First, an ARIMA (1,0,0) model was estimated on a time series of 30 year Treasury constant-maturity yields. Next, the residuals from that estimation were saved as the variable (T30RESQ) used in the empirical analysis. The interpretation of this variable is that this is the unexpected component of the long-term interest rate series. A similar methodology has been employed elsewhere in creating time series of expected tax rates (Long, 1990).

Issuer experience is somewhat difficult to capture in the market for state issued bonds. The reason is that while most previous studies have used the number of previous bond issues (Bland, 1985), states are frequent issuers of general obligation bonds. Most states in our sample have in excess of five issues during the sample period. Therefore, most of the returns to issuer experience should have dissipated prior to a bond issue included in the sample.[6] The hypothesis of issuer experience could be extended to capture the experience of the chief financial officer of the jurisdiction. In most states, the chief financial officer is the state treasurer. Therefore, we include a variable that measures the experience of the state treasurer. Since most state treasurers are elected (or are appointed by the governor, an elected official) and serve 4-year terms, the experience of the state treasurer is likely related to the number of terms that he or she has served. Therefore, issuer experience variable is captured as an ordinal variable for the number of terms that the issuer's treasurer has served where 0 is a treasurer in their first term.

Maturity is captured in our study in several ways. Past studies have used different functional forms to capture the effects of the term structure of interest rates on bond pricing, with some studies using average maturity (Capeci, 1994) or its log (Capeci, 1991) and some studies using final maturity (Johnson & Kriz, 1998) or its log (Hsueh & Kidwell, 1988). We include three different specifications of maturity: final maturity, the log of final maturity, and a new specification that creates a spline function. This spline function estimates the yield as being an increasing function of maturity for bonds with a final maturity of less than 10 years. For all bonds with final maturities 10 years or more, a single coefficient is obtained with an indicator variable.[7] The estimator that is used in the final model was determined through the fit of the estimations.

Another issue characteristic that may affect interest costs is the presence and strength of call provisions in the bond issue. These provisions may increase the risk for a bondholder. Call options therefore may increase an issuer's interest costs. However, the extent of this increase depends on investors' expectations of future interest rates (Spivey, 1989). In our research, we include a dummy variable representing the presence of a call option provision. We also include the par value of the bond issue (in logs). The last issue characteristic that must be controlled for is the tax status of interest received from the bond issue by investors. Municipal bond yields are in general lower than corporate bond yields of similar risk and issue characteristics. The extent of the difference between corporate bond yields (and other market yields) and municipal bond yields is determined at least in part by the effects of the tax exemption on municipal

Table 2
Descriptive statistics for continuous variables

| Variable | Mean | Median | Standard deviation | Kurtosis | Skewness | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| LOGPOPN | 15.167 | 15.271 | 0.887 | −0.092 | 0.085 | 13.248 | 17.290 |
| UNEM | 5.966 | 5.800 | 1.357 | −0.455 | 0.299 | 2.800 | 9.400 |
| PCI | 18.396 | 18.341 | 3.220 | −0.400 | 0.216 | 12.253 | 27.898 |
| GENREV | 1.688 | 1.664 | 0.465 | 27.340 | 2.884 | 0.845 | 6.809 |
| INCTAX | 0.540 | 0.555 | 0.315 | −0.635 | −0.114 | 0.000 | 1.372 |
| IGREV | 0.725 | 0.695 | 0.177 | 0.669 | 0.654 | 0.300 | 1.521 |
| GENEXP | 2.266 | 2.139 | 0.677 | 9.193 | 2.116 | 1.099 | 7.395 |
| STDEBT | 0.017 | 0.001 | 0.035 | 10.997 | 3.169 | 0.000 | 0.249 |
| DEBT | 0.699 | 0.440 | 0.675 | 1.648 | 1.550 | 0.028 | 3.167 |
| DSERV | 0.119 | 0.090 | 0.079 | 2.070 | 1.346 | 0.027 | 0.587 |
| BBI20 | 6.127 | 6.050 | 0.564 | −0.802 | 0.392 | 5.200 | 7.560 |
| VOL8 | 0.099 | 0.087 | 0.049 | 3.934 | 1.086 | 0.025 | 0.267 |
| VOL12 | 0.124 | 0.110 | 0.057 | 5.347 | 1.473 | 0.041 | 0.356 |
| T30RESQ | 0.007 | 0.004 | 0.010 | 17.890 | 3.162 | 0.000 | 0.089 |
| MATURE | 18.139 | 19.597 | 6.740 | −0.242 | −0.106 | 1.545 | 31.945 |
| LNMAT | 2.805 | 2.975 | 0.480 | 2.686 | −1.473 | 0.435 | 3.464 |
| SHORTMAT | 0.774 | 0.000 | 2.214 | 6.676 | 2.803 | 0.000 | 9.973 |
| PAR | 17.545 | 17.740 | 1.553 | −0.171 | −0.598 | 12.983 | 20.986 |
| REPUT | 0.057 | 0.047 | 0.049 | −0.266 | 0.931 | 0.002 | 0.153 |
| TIC | 5.690 | 5.611 | 0.859 | 1.055 | 0.623 | 3.042 | 8.890 |

Period = 1990–1997; $N = 521$.

debt interest. While there have been discussions of which tax rate (corporate or personal) is appropriate in the pricing of municipal debt (Fortune, 1988), there is little doubt that municipal bonds whose interest is subject to federal or state income taxes will have higher yields and interest costs than similar bonds whose interest is not subject to the taxes.

Tables 2 and 3 list the descriptive statistics for the sample. The summary statistics show that our sample captures a wide range of bond issues and states with different demographic,

Table 3
Descriptive statistics for categorical variables

| Variable | Number of issues with this attribute | | Variable | Number of issues with this attribute | |
|---|---|---|---|---|---|
| NEREG | 121 | 23.22% | NEGOT | 184 | 35.32% |
| MWREG | 81 | 15.55% | REPUT2 | 277 | 53.17% |
| SOREG | 169 | 32.44% | FGIC | 30 | 5.76% |
| WESTREG | 150 | 28.79% | MBIA | 12 | 2.30% |
| LONG | 458 | 87.91% | AMBAC | 20 | 3.84% |
| CALL | 376 | 72.17% | FSA | 2 | 0.38% |
| TAX | 49 | 9.40% | OTHERINS | 0 | 0.00% |
| THRATE | 274 | 52.59% | INS | 57 | 10.94% |

Period = 1990–1997; $N = 521$.

economic and financial conditions. Most of the variables are normally distributed with the exception of the uncertainty variables, some financial condition variables and some issue characteristics variables. However, the skewness and kurtosis of all variables is not excessive enough to compromise multivariate normality.

Here some interesting patterns emerge that indicate the nature of the market. The first four variables in Table 3 are variables indicating the region of the country in which the issuer is located. The sample is representative of the nation, with slightly higher representation in Southern and Western states and slightly lower representation from Midwest regional issuers. The reason for this is that several Midwestern states (Indiana, Iowa, Kansas, Nebraska, North Dakota and South Dakota) do not permit states to issue general obligation debt.

Tables 2 and 3 taken together provide an excellent picture of the state bond market. It is a relatively long-term market, with the average final maturity of 19 years and the vast majority of bonds with final maturities greater than 10 years. Just over 35% of the sample was issued using a negotiated sale method. This is considerably below the figure for the municipal bond market as a whole. Given that we predict that the use of financial certification should be positively related to the ratio of private information to public information, we should expect that a market containing large relatively well-known issuers should have lower rates of negotiated underwriting. The lower rate of negotiated offering is in accordance with the certification theory.

The nature of underwriter participation in this market is indicated by the underwriter reputation variables. High reputation underwriters with a national orientation underwrite over 50% of the issues in this sample. The average underwriter market share is over five percentage. This is interesting in that high levels of underwriter reputation are not as predicted by the theory of financial certification. The theory predicts that underwriters with higher reputation should be employed in situations where their reputational capital is most needed. That would employ a somewhat lower level of underwriter reputation in the state market, with its large, stable issuers. However, what is missing in the theory of financial certification is underwriter's strategy. If underwriter compensation is not solely a function of the provision of more reputation, but also based on some other factor (such as issue size), then higher reputation underwriters will likely seek more profitable markets. Since state bond issues are larger in size and have lower levels of uncertainty, it makes sense that underwriters should seek to compete in this market.

Slightly over 50% of the sample has three ratings. This is interesting from the standpoint that one might reasonably expect a slightly smaller percentage of state bonds to receive three ratings. This percentage is smaller than that found in an earlier study of three ratings (Johnson & Kriz, 1998). However, the early 1990s saw most of the issuers receiving two ratings as Fitch's was just starting to compete. By the middle 1990s (the earlier sample was 1994–1997), Fitch had better established their presence in the state municipal market. The last variables in Table 3 present figures on the use of bond insurance. Not surprisingly given our theory, the incidence of insured issues (11%) is below the average for the municipal market as a whole (27%).

The rating profile of the sample is shown in Table 4. This is obviously a market dominated by high quality issuers, as indicated by the large number of AA or better-rated issues. Interestingly, Moody's tends to have slightly higher ratings than Standard & Poor's in the middle range of the credit quality scale. This is shown in panel (a) of the table. The lightly shaded cells of the table indicate areas where the ratings of the two agencies are equal, so the bulk of the issues on the lower left of the shaded areas indicate higher Moody's ratings. Similarly, panel (b) shows

Table 4
Ratings distribution for the sample

Panel (a) Standard & Poor's versus Moody's

| | Standard & Poor's rating | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | BBB | A− | A | A+ | AA− | AA | AA+ | AAA | Total |
| Moody's rating | | | | | | | | | |
| Baa2 | 3 | | | | | | | | 3 |
| A2 | | 7 | 8 | 1 | | | | | 16 |
| A1 | | | 1 | 1 | 5 | 3 | | | 10 |
| Aa3 | | | | | 3 | 1 | 3 | | 7 |
| Aa2 | | | | 3 | 138 | 143 | 17 | | 301 |
| Aa1 | | | | | | 1 | 20 | | 21 |
| Aaa | | | | | | | 30 | 133 | 163 |
| Total | 3 | 7 | 9 | 5 | 146 | 148 | 70 | 133 | 521 |

Panel (b) Fitch's versus Moody's

| | Fitch's rating | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | NR | A | A+ | AA− | AA | AA+ | AAA | Total |
| Moody's rating | | | | | | | | |
| Baa2 | | 3 | | | | | | 3 |
| A2 | 15 | 1 | | | | | | 16 |
| A1 | 2 | | 1 | 4 | 3 | | | 10 |
| Aa3 | 3 | | | | 4 | | | 7 |
| Aa2 | 172 | | | | 86 | 42 | 1 | 301 |
| Aa1 | 10 | | | | 2 | 6 | 3 | 21 |
| Aaa | 45 | | | | | | 118 | 163 |
| Total | 247 | 4 | 1 | 4 | 95 | 48 | 122 | 521 |

Panel (c) Fitch's versus Standard & Poor's

| | Fitch's rating | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | NR | A | A+ | AA− | AA | AA+ | AAA | Total |
| Standard & Poor's rating | | | | | | | | |
| BBB | | 3 | | | | | | 3 |
| A− | 7 | | | | | | | 7 |
| A | 8 | 1 | | | | | | 9 |
| A+ | 2 | | 1 | | 2 | | | 5 |
| AA− | 75 | | | 4 | 47 | 19 | 1 | 146 |
| AA | 90 | | | | 38 | 20 | | 148 |
| AA+ | 31 | | | | 8 | 9 | 22 | 70 |
| AAA | 34 | | | | | | 99 | 133 |
| Total | 247 | 4 | 1 | 4 | 95 | 48 | 122 | 521 |

that Fitch's rates issues higher than does Moody's when they are called on the rate an issue and they also seem to rate higher than Standard & Poor's (panel (c)).

## 5. Empirical analysis

The existing literature on this question has generally assumed that the relationship between interest costs of bonds issued competitively and through negotiation can be modeled using traditional OLS methods. As a starting point, we estimate such a model:

$$\text{TIC} = \alpha_0 + \alpha_1\text{SOCEC} + \alpha_2\text{FINAN} + \alpha_3\text{MARKET} + \alpha_4\text{EXPER} + \alpha_5\text{ISSUE} + \varepsilon_1 \quad (1)$$

where the dependent variable is TIC, the true interest cost of the bond issue,[8] SOCEC is a matrix of socioeconomic condition variables, FINAN is a matrix of financial condition variables, MARKET is a matrix of market condition variables, EXPER is a vector of experience variables and ISSUE is a matrix of issue characteristics variables and $\varepsilon$ is an iid error term uncorrelated with the regressor matrix. TIC is the interest rate that represents the cost of a bond issue to the issuer on a present value basis; it is the internal rate of return of the bond issue and equates the net proceeds of the bond issue to future debt service payments. Therefore, TIC captures all issuance costs in present value terms and has been advocated as superior to other measures of issuance costs (net interest cost, underwriter spread and reoffering yield). The model was estimated using a backward elimination approach, first entering all of the variables into the equation and then removing variables using the following guidelines:

- In order to remove a variable, the appropriate test statistic (*t* statistic for linear models, *z* statistic for probit models) must be less than 1; and
- Removal of the variable cannot result in a decrease in the adjusted $R^2$ statistic for linear models or the likelihood ratio index (a measure of goodness of fit) for the probit models.

The results of the OLS estimation are listed in Table 5. We are able to effectively model interest costs using the OLS estimation. The model is successful in predicting almost 78% of the variation in TIC. The *F*-statistic is significant at the 1% level. The coefficients all have expected signs and make intuitive sense. States with higher per capita income tax revenues pay lower interest costs on their bond issues. Since higher revenues signal better ability to repay debt, this coefficient seems reasonable. The debt variables have positive coefficients but are not significant. This also makes sense. High levels of debt may be a sign of fiscal instability and may affect repayment probabilities. The coefficients for the Bond Buyer Index and taxable interest variables are the sign and magnitude predicted by previous research. The maturity variables are positive and significant as expected. The variable for credit rating is positive and significant indicating that a better credit rating reduces interest costs approximately 9 basis points per ratings notch.[9] The bond insurance indicator variable is positive and significant. Given our coding, the coefficient indicates that insured bonds are priced somewhere between AA− and A+ rated issues, which is comparable to the results of previous research.

With respect to the variable of interest, we find that the sign of NEGOT is negative as predicted by the certification hypothesis but not significant. This indicates that even before taking into account potential threats to the OLS model, interest costs of negotiated issues are

Table 5
Results of OLS estimation of true interest cost (TIC)

| Variable | Coefficient | Standard error | $t$ | Significance |
|---|---|---|---|---|
| Constant | −1.929 | 0.297 | −6.496 | 0.000 |
| INCTAX | −0.181 | 0.063 | −2.894 | 0.004 |
| DEBT | 0.009 | 0.032 | 0.289 | 0.773 |
| STDEBT | 0.868 | 0.534 | 1.626 | 0.104 |
| BBI20 | 0.999 | 0.034 | 28.983 | 0.000 |
| TAX | 1.328 | 0.063 | 21.202 | 0.000 |
| CALL | 0.017 | 0.051 | 0.340 | 0.734 |
| LONG | 1.332 | 0.183 | 7.264 | 0.000 |
| SHORTMAT | 0.097 | 0.025 | 3.826 | 0.000 |
| NEGOT | −0.002 | 0.045 | −0.047 | 0.963 |
| REPUT2 | −0.040 | 0.039 | −1.023 | 0.306 |
| THRATE | 0.115 | 0.042 | 2.759 | 0.006 |
| INS | 0.298 | 0.067 | 4.467 | 0.000 |
| CRATE | 0.091 | 0.019 | 4.725 | 0.000 |
| $N$ | 521 | | | |
| $F$ | 140.29 | | | |
| Significance | 0.000 | | | |
| Adjusted $R^2$ | 0.777 | | | |

not significantly different from interest costs of competitive issues. This immediately calls into question previous results.

The ordinary least squares estimates indicate that certification effects on interest costs may be less than our theory suggests. However, there are reasons to doubt the robustness of these results. OLS techniques make several assumptions about regressors and error terms. The assumption that reduces the usability of Eq. (1) is that the error term is uncorrelated with the regressors in the equation. Our theoretical model suggests that the demand for certification is based on some of the same variables that appear on the right-hand side of (1). This situation can cause a significant bias in the estimates of the effects of the certification variables.

A general structural model of OLS estimation using dummy variables to measure differences in interest costs can be defined as follows (Maddala, 1983):

$$\text{Interest}_{1i} = X_i\beta_1 + \xi_{1i} \quad \text{(for issuers who use negotiated offering)}$$
$$\text{Interest}_{2i} = X_i\beta_2 + \xi_{2i} \quad \text{(for issuers who use competitive bid)}$$
$$\text{Negotiation}_i = Z_i\lambda + \varepsilon_i \quad \text{(decision to use negotiated offering)}$$
$$\text{negot}_i = 1 \quad \text{iff Negotiation}_i > 0 \qquad \text{negot}_i = 0 \quad \text{iff Negotiation}_i \leq 0$$

The structural formulation states that the interest cost depends on a matrix of regressors $X$ and an error term for each of two groups, one that uses negotiation and one that issues bonds competitively. The choice to use negotiation is modeled as a function of a set of regressors $Z$ and an error term. The choice to use a particular rating certification such as three ratings will be made if the function exceeds some threshold level. The observed counterpart to the interest rate construct is TIC. We can write the relationship between the observed and latent interest

cost as:

$$\begin{array}{ll} \text{TIC}_i = \text{Interest}_{1i} & \text{iff NEGOT}_i = 1 \\ \text{TIC}_i = \text{Interest}_{2i} & \text{iff NEGOT}_i = 0 \end{array} \qquad \text{Cov}(\xi_{1i}, \xi_{2i}, \varepsilon_i) = \begin{bmatrix} \sigma_{11} & \sigma_{12} & \sigma_{1\varepsilon} \\ \sigma_{12} & \sigma_{22} & \sigma_{2\varepsilon} \\ \sigma_{1\varepsilon} & \sigma_{2\varepsilon} & 1 \end{bmatrix}$$

Evaluating the benefit of negotiation using OLS estimation with dummy variables is a test of the difference between the expected value of interest cost under a choice to use negotiation and the expected value of interest cost under a choice to issue competitively, controlling for other variables $X$:

$$E(\text{TIC}_i|\text{NEGOT}_i = 1) - E(\text{TIC}_i|\text{NEGOT}_i = 0) = X_i(\beta_1 - \beta_2) + \varepsilon_i$$

where the error term $\varepsilon_i$ is iid. However, as one can see from our discussion of the structural model, the iid assumption is unlikely to be met. The difference in interest costs is biased by a term representing the covariance between the error terms. The model must be rewritten taking into account this covariance:

$$E(\text{TIC}_i|\text{NEGOT}_i = 1) - E(\text{TIC}_i|\text{NEGOT}_i = 0) = X_i(\beta_1 - \beta_2) + (\sigma_{2\varepsilon} - \sigma_{1\varepsilon})\frac{\phi(Z_i\lambda)}{\Phi(Z_i\lambda)} \tag{2}$$

There are different empirical methods for producing an unbiased estimate of the benefits of negotiated underwriting using the framework developed in Eq. (2). Most of these methods involve the use of two-step estimators developed to examine labor market decisions and the effects of public programs.[10] At least one previous study has used a similar technique. Smith (1987) uses a model that estimates TIC separately for each group incorporating the selectivity term (the second term on the right-hand side of (2)) for each group. Then comparisons of interest costs are made. However, this separate equation approach effectively ignores the covariance between errors of the decisions and only takes into account the correlations. The last term on the right-hand side of (2) (the inverse Mills ratio, which we call LAMBDA) is estimated separately. This formulation is appropriate for cases where an exogenous variable determines the split into groups (a switching regression model). A more efficient alternative in the case of endogenous self-selection is to use all of the observations in the calculation of the selectivity term. Thus, our estimation strategy will be to use a two-stage estimation model, where the first stage is the estimation of a probit model for the choice of underwriting method and the second stage is the estimation of Eq. (2) using all observations and incorporating the variable LAMBDA into the equation in place of the error term:

$$\begin{aligned} \text{negot} &= \beta_0 + \beta_1\text{SOCEC} + \beta_2\text{FINAN} + \beta_3\text{MARKET} + \beta_4\text{EXPER} + \beta_5\text{ISSUE} + \xi_1 \\ \text{TIC} &= \alpha_0 + \alpha_1\text{SOCEC} + \alpha_2\text{FINAN} + \alpha_3\text{MARKET} + \alpha_4\text{EXPER} + \alpha_5\text{ISSUE} \\ &\quad + \alpha_6\text{LAMBDA} + \varepsilon_1 \end{aligned} \tag{3}$$

Results from the estimation of the first stage of Eq. (3) are listed in Table 6. The model was estimated using a probabilistic estimator (probit). We are able to effectively model the choice of using negotiated offerings. The likelihood ratio test statistic (a measure of goodness of fit) is significant at the 1% level and we are able to predict over 79% of the decisions (though

Table 6
Results of probit estimation of the decision to use negotiated offer method of sale (NEGOT)

| Variable | Coefficient | Standard error | $z$ | Significance |
|---|---|---|---|---|
| Constant | 3.105 | 1.492 | 2.081 | 0.037 |
| LOGPOPN | −0.533 | 0.094 | −5.676 | 0.000 |
| UNEM | 0.221 | 0.057 | 3.884 | 0.000 |
| DEBT | 0.566 | 0.126 | 4.508 | 0.000 |
| STDEBT | 8.986 | 2.029 | 4.429 | 0.000 |
| T30RESQ | 17.730 | 8.589 | 2.064 | 0.039 |
| CALL | −1.481 | 0.185 | −8.011 | 0.000 |
| CRATE | 0.711 | 0.103 | 6.889 | 0.000 |
| LONG | 1.465 | 0.783 | 1.872 | 0.061 |
| SHORTMAT | 0.121 | 0.111 | 1.095 | 0.273 |
| INS | 0.895 | 0.306 | 2.927 | 0.003 |
| THRATE | 1.099 | 0.192 | 5.713 | 0.000 |
| MWREG | 1.443 | 0.308 | 4.687 | 0.000 |
| SOREG | 0.741 | 0.257 | 2.880 | 0.004 |
| WESTREG | −0.001 | 0.196 | −0.055 | 0.956 |
| $N$ | 521 | | | |
| $\chi^2$ | 231.773 | | | |
| Significance | 0.000 | | | |
| % Predicted correctly: | | | | |
| 0 | 88.4% | | | |
| 1 | 62.0% | | | |
| Overall | 79.1% | | | |
| McKelvey–Zavoina $R^2$ | 0.639 | | | |

the percentage of correctly predicted negotiated offerings was lower than the percentage for competitive bid sales). These results compare favorably with those reported in Leonard (1996) and Smith (1987).

The results are also interesting in that the various explanatory variables indicate that for the most part, larger more stable issuers use competitive bid sales while smaller issuers with greater uncertainty tend to use negotiation. This is evident with the negative coefficient for the population variable. Larger issuers are more likely to use competitive bid. The positive coefficients for unemployment, debt, short-term debt and credit ratings support the notion that uncertainty about issuer's ability to pay is a factor in the decision to issue negotiated. Unemployment is a sign of economic instability and short-term debt may be a sign of short-term fiscal instability. Short-term debt is issued in some cases to provide interim financing while awaiting revenues from a specific source. However, larger balances indicate that states may be using short-term borrowing to fund operations, indicating endemic budget balance problems. Higher levels of outstanding debt can affect future repayment through competition for scarce revenues. Finally, bonds that will receive lower credit ratings (the credit ratings variable is coded so that lower ratings have a higher ordinal number) are more likely to be issued through negotiation. These bond issues are more likely to have greater uncertainty associated with their repayment.

The market uncertainty variable, T30RESQ, has a positive and significant coefficient (the high value of the coefficient is due to the scale of the variable). This supports the market uncertainty hypothesis that negotiation is used in an attempt to "time the market." In a negotiated sale, issuers can work with underwriters to sell the bonds at the best possible time. We therefore would expect that issuers would be more likely to use negotiation during periods of relative uncertainty. The positive coefficient for the maturity variables and negative coefficient for callability of the issue are related. First, maturity and callability are positively correlated. Next, both relate to the uncertainty of the issue, but in opposite ways. A bond with a longer term to maturity will have more potential events that can positively or negatively affect the probability of full repayment. So a longer-term bond has greater uncertainty. Callability shortens the effective term to repayment, and will especially affect the perceived term of the bond issue in a falling interest rate environment such as in the sample period.

With regard to the other issue characteristics, the purchase of bond insurance and the decision to obtain a third rating both increase the probability that a bond will be issued through negotiation. This indicates that issues more likely to need certification (bond insurance (Kidwell, Sorensen, & Wachowicz, 1987) and additional credit ratings (Johnson & Kriz, 1998; Thompson & Vaz, 1990) are other sources of financial certification) are issued negotiated which conforms to our theory. Finally, issuers in the Western and Northeastern regions are less likely to use negotiation, with Midwest issuers the most likely to issue negotiated. This is likely due to the presence of large underwriter networks in the West and East coast financial centers. If issuers perceive that their issues are more likely to be sold at a lower interest cost through competition,

Table 7
Results of selectivity estimation of TIC

| Variable | Coefficient | Standard error | *t* | Significance |
|---|---|---|---|---|
| Constant | −1.988 | 0.297 | −6.704 | 0.000 |
| INCTAX | −0.175 | 0.062 | −2.808 | 0.005 |
| DEBT | 0.040 | 0.035 | 1.134 | 0.257 |
| STDEBT | 1.222 | 0.568 | 2.149 | 0.032 |
| BBI20 | 0.997 | 0.034 | 29.387 | 0.000 |
| TAX | 1.337 | 0.061 | 21.745 | 0.000 |
| CALL | −0.086 | 0.070 | −1.226 | 0.220 |
| LONG | 1.478 | 0.197 | 7.485 | 0.000 |
| SHORTMAT | 0.111 | 0.026 | 4.170 | 0.000 |
| NEGOT | −0.245 | 0.120 | −2.045 | 0.041 |
| REPUT2 | −0.044 | 0.038 | −1.154 | 0.248 |
| THRATE | 0.147 | 0.045 | 3.285 | 0.001 |
| INS | 0.311 | 0.068 | 4.582 | 0.000 |
| CRATE | 0.121 | 0.024 | 5.079 | 0.000 |
| LAMBDA | 0.163 | 0.074 | 2.208 | 0.027 |
| *N* | 521 | | | |
| *p* | 0.397 | | | |
| *F* | 131.640 | | | |
| Significance | 0.000 | | | |
| Adjusted $R^2$ | 0.779 | | | |

they will likely forego negotiation. A large underwriter network may increase competition for competitively bid issues, reducing interest costs.

The results of the estimation of the second stage of the selection model are listed in Table 7. There are obviously some important results in terms of significant predictors of interest costs from these models. There are two changes of note in the control variables from the OLS results. First, the sign of callability becomes negative. The coefficient remains insignificant, however. Second, the short-term debt variable becomes significant and the coefficient increases. The direction of the sign is as expected by theory.

The impact of selection bias is noticeable. LAMBDA is statistically significant and positive, indicating that OLS estimates will be biased upward by 16 basis points. Controlling for this selection bias, negotiated offering method of sale is predicted to reduce interest costs by 24 basis points relative to competitive bid sales for those issuers that actually used negotiated offering.

## 6. Conclusions

The results presented for the underwriting decision suggest that municipalities make a rational choice in choosing the type of offering. These results are consistent with some previous findings (Leonard, 1996). The interest cost results suggest that the monopsony rent hypothesis can be positively rejected for our sample and the certification hypothesis is supported. Interest costs are lower for those issues that used negotiated offering, when the endogenous issuers' choice of underwriting method is taken into account. These results contradict the prevailing wisdom, but are consistent with studies that control for selection biases using other methods (Leonard, 1996; Smith, 1987).

The certification hypothesis is supported both by the results of the negotiated/competitive decision model and the interest cost model. The results of the interest cost model indicate a positive interest cost benefit for the use of negotiated offers by issuers subject to information asymmetry. The fact that issuers that should be more likely to issue negotiated (smaller issuers with more economic uncertainty and higher debt burdens that will receive lower ratings) suggests that issuers in this sample are making choices of underwriting method in order to minimize interest costs. The interest cost model results indicate that once information asymmetries are resolved, issuers appear to be successful in minimizing these costs. Also, the market uncertainty hypothesis is supported in our model. The positive and significant coefficient on the T30RESQ variable in the probit model of the choice to issue negotiated suggests that issuers facing more interest rate uncertainty tend to increase their use of negotiated offering. Thus, issuers do seem to employing negotiated offering more frequently during periods of market uncertainty. The policy implications of these findings cannot be overstated. Therefore, any effort to restrict issuers to one type of method would impose costs on those issuers who were making an efficient choice of the other underwriting method. The drive to restrict issuers seems to be based on a fear that municipalities are being "taken" by underwriters. The research presented in this paper suggests otherwise.

The analysis of method of sale has come a long way since its initial studies. This paper is just one more step in the process. Further research should be conducted on underwriting decisions,

using different samples to test the various hypotheses. An interesting area of potential research is the relationships between underwriting and other certification decisions (e.g., credit ratings, reputation, bond insurance). It has been shown that these decisions are related (Kriz, 2000). It would be interesting to estimate a systems model of the issuance process in order to measure the effects of all of the relationships in a more formal manner.

## Notes

1. For an excellent review of the literature see Leonard (1994).
2. For example, according to the Wisconsin Legislative Audit Bureau (1997): "[In a negotiated offering] The State negotiates with the lead underwriter to determine the structure of the bonds . . . " This implies that the negotiated underwriter is made privy to information impacting prospective cash flows supporting the bond issue.
3. The Wisconsin Legislative Audit Bureau (1997) discusses competitive issues as: "In sales that are bid competitively, the State performs the various tasks associated with issuing bonds, such as seeking bond counsel, obtaining a bond rating, preparing legal documents, and printing the bond prospectus. To solicit sealed bids from bond underwriters who wish to purchase the bonds, the State places a notice of sale in a national trade publication." This implies an arm's length transaction.
4. Thanks go to an anonymous referee for suggesting this.
5. Population size was determined as the union of the MUNI-IRIS and MuniStatements databases for all state GO issues. All searches were performed in the following manner. First the issuer was defined as "State of" (with the exception of Texas, whose general obligation bonds are often issued by the Texas Public Finance Authority). The results were then refined through defining the sample period and non-GO debt along with bonds that were escrowed to maturity.
6. Bland finds that there are significant interest cost savings realized with each bond issue up to the fourth bond issue. After that point, there are no additional gains to experience.
7. The location of the "knot" in the spline function was determined through visual examination of a graph of final maturity versus interest cost.
8. TIC is calculated here as an "all-inclusive" measure, meaning that all costs of issuance are captured in the interest cost used in our models.
9. One reviewer pointed out that the jump in credit quality may not be linear, therefore the 9 basis point per notch may not be true for a given jump in quality. To ensure the absence of bias, estimations were made entering the credit rating of the issue as a set of indicator variables. The results for these estimations are qualitatively the same.
10. This model has been called a "treatment effects" model (Greene, 1993).

## Acknowledgments

The author wishes to thank his dissertation committee members: Craig Johnson, Sreenivas Kamma, Ted Miller, Barry Rubin, Larry Schroeder and Kurt Zorn for their time and effort in reviewing this paper and for their insightful comments.

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