Bond Ratings and New Issue Municipal Bond Pricing: Path Analysis Results

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Abstract

Although research on municipal debt pricing has included both the bond rating and economic information as exogenous variables, other information is often of little value to investors due to lack of both timeliness and reliability. This study employs path analysis to resolve the role of the bond rating in the context of such economic data. The results suggest that the bond rating assumes considerable importance in the pricing of municipal debt.

Introduction

Bond pricing research and the comments of practitioners attest to the importance of the bond rating as a means of measuring credit quality both for corporate and municipal debt issuers. Ingram, Brooks, and Copeland (1983) suggest that the rating takes on particular importance in the pricing of municipal debt due to the lack of timely, reliable public information in some standardized format for municipalities. Robbins, Apostolou, and Strawser (1985) conclude that the financial statements of municipalities are inadequate when considered in the context of investor needs. Thus, investors may rely heavily on the bond ratings in lieu of economic data if the cost of securing and interpreting those data is excessive.

Although Liu and Thakor (1984) provide a model for examining this relationship between economic information and municipal bond pricing, their methodology is limited in its ability to measure the marginal effects. It is unclear from the Liu and Thakor analysis specifically how the economic variables affect new issue yields, given the existence of bond ratings. As Cranford and Stover (1988) observe, the Liu and Thakor model examines merely the total effects of economic information rather than deciphering the direct effect and the indirect effect via rating. Therefore, an empirical model is required to decompose the total relationship between economic information and new issue debt pricing into direct and indirect effects. The indirect effects are those influences of the exogenous variables on new issue debt pricing through the formers' respective effects on the bond ratings given to the new issues.

Path analysis (Goldberg and Duncan, 1973) is employed to quantify this distinction between the total effect of economic variables on debt pricing and

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their indirect effects via the bond rating. Based on two separate samples of initial municipal bond offerings, the path analysis results provide a more complete measure of the relationship between economic information and new issue bond pricing. The goal of path analysis is to provide plausible explanations of observed correlations by constructing a model of cause-and-effect relations among the variables. The observed relationships then are decomposed into a sum of path coefficient terms representing the direct and indirect paths. This explicit measure of indirect effect is missing from the Liu and Thakor's (1984) analysis.

In particular, the model quantifies the relative roles of economic information and bond rating. Based on the results, it is suggested that state administrators and the investment community could rely extensively on the bond rating in examining new issue municipal debt pricing. Thus, administrators could place more emphasis on ratings as a means of avoiding average quality pricing due to an adverse selection problem. The investment community could reduce its search costs. The direct effects of economic variables specifically on new issue pricing are relatively inconsequential in the pricing of municipal debt new issues.

Empirical Methodology

General Path Model

Based on m economic variables and n bonds, the Liu and Thakor model is stated as:

(1) $R = \lambda \underset{\sim}{1} + Z\pi + \xi$

(2) $Y = \alpha \underset{\sim}{1} + \sigma R + Z\beta + \epsilon$

where:

$\underset{\sim}{1}$	= an n dimensional column vector of ones;
R	= an n dimensional vector of ratings;
Z	= an n x m matrix of economic variables;
Y	= an n dimensional vector of yields;
λ, α, and σ	= scalar coefficients;
π and β	= m dimensional column vectors of regression coefficients; and
ξ and ϵ	= n dimensional column vectors of stochastic error terms.

The path analysis format easily is extracted from the model described in equations (1) and (2). Equation (1) indicates that each of the variables has an effect on rating, and equation (2) indicates that these variables, in addition to rating, have an effect on new issue debt yields. Based on path analysis, the decomposition of the total effect of a variable on yield is found by:

$$(3)\quad \text{Total Effect of } Z_i \text{ on } Y = \underbrace{\beta_i}_{\text{(Direct effect)}} + \underbrace{\pi_i\sigma}_{\text{(Indirect effect)}}$$

where β_i, π_i, and σ are the regression coefficients from equations (1) and (2). The direct effects of the economic variables and rating are given by the estimation of β and σ in equation (2). The indirect effects are given by the product of the estimates of π_i in equation (1) for each variable and the estimate of σ in equation (2). The total effect is the sum of the direct and indirect effects for a particular variable. See the appendix for a further description of path analysis.

Sample Descriptions

Two distinct samples of new municipal debt offerings are utilized to examine the robustness of the path analysis results. Each sample is composed of different forms of municipal debt as well as unique sets of exogenous variables. The first sample, hereafter referred to as Sample I, is the sample used by Liu and Thakor (1984).[1] The use of this sample provides the opportunity to draw direct comparisons with the results of Liu and Thakor. This sample consists of offerings by 28 states as reported in the February 1977 *Standard & Poor's Blue List of Current Municipal Offerings*. Liu and Thakor restricted the sample to those general obligation bonds maturing within two years of 1990.

Sample II consists of a sample of general obligation bonds issued during the 1984-1985 period according to *Moody's Bond Survey*. General obligation bonds are examined because their full faith and credit backing can be related directly to certain economic characteristics. Revenue bonds, limited general obligation bonds, drainage, school district bonds, and port authority bonds are not considered. Housing authority bonds also were excluded because they carry a federal government guarantee. Other bonds were eliminated because they were dependent on the revenue-producing ability of a specific underlying asset or project. A total of 170 issues survived this set of decision criteria. The sample then was diversified geographically to avoid the effects of concentrated economic factors. No two issues from the same municipality were included. Certain of the general obligation bonds had to be excluded due to incomplete information, particularly demographic data, over the observation period. A total of 58 issues form the final sample. No issues with Moody's rating below Ba appear in the

[1]The Liu and Thakor (1984) sample was provided upon request from the editors of the *Journal of Money, Credit and Banking*.

sample. This restriction was not a major factor, however, given the limited number of issues below the Ba rating. A majority of the issues were in the A rating category which is consistent with the finding of Carlton and Lerner (1969) that Moody's exhibits a tendency to rate bonds in the medium range.

The exogenous variables for both samples are defined in Table I. The variables for Sample I have been explained in Liu and Thakor (1984). In Sample II, the set of variables was selected from previous municipal debt rating and pricing research. Similar to Ederington, Yawitz, and Roberts (1987), there is no assurance that the set of chosen rating determinants is exhaustive. In addition, the evidence from previous municipal bond rating prediction models Cranford and Stover, 1988; Michel, 1977; Raman, 1982) provides no systematic approach for selecting exogenous variables. According to the *Handbook of Fixed Income Securities*, the credit analysis of general obligation bonds issued by states, counties, and municipalities requires the collection and assessment of distinct categories of information. The variables for Sample II were selected to conform to these categories as closely as possible.[2]

In their examination of the rating effect in the municipal bond market, Liu and Thakor (1984) selected bonds with almost identical maturity structures at a specific point in time. No attempt was made to similarly restrict Sample II, and a set of variables is included to control for debt instrument differences in the sample. These variables are the market level of interest rates (MKTINT), measured as the long-term U.S. Treasury bond rating in the offering week, the issue size (SIZE), average maturity (MAT), and the possible existence of a call feature (CALL). Previous municipal bond pricing research provides extensive discussion of the role of these variables and their suggested effect on new issue yields.

The first category of economic variables focuses primarily on taxing authority. Both current tax collections and the historic average collection percentage are available measures for taxing authority. The current collection variable (TAX), employed by Carlton and Lerner (1969), was used, although there is a high correlation between the two. The next category includes information on the issuer's debt structure to determine the overall debt burden. The debt burden normally is measured in terms of either direct (or overlapping) debt per capita or as a percentage of real estate valuation. The variables for this study include both direct debt per capita (PCDEBT) and direct debt as a

[2]The selection of variables was limited to publicly available information. One category listed in the *Handbook of Fixed Income Securities* (1987) was the issuer's ability and political discipline for maintaining sound budgetary operations. The focus of this category did not lend itself to proxy variables from available sources and was not included in the model.

percentage of real estate valuation (DEBTVAL). Carlton and Lerner (1969), Liu and Thakor (1984), and Michel (1977) use similar measures.

The final category provides variables that gauge the socioeconomic environment of the issuing municipality. Measures of environment used in this study are an index of cash flow stability (ECON1, ECON2) as well as population (POP) and population trend (POPTR). The cash flow stability variables measure the ability of the municipality to generate cash flows during adverse business cycle movements and to withstand the loss of specific industries within the community. This form of variable is difficult to quantify, given the limited information in municipal annual reports (see Robbins, Apostolou, and Strawser, 1985). Therefore, based on text terminology by *Moody's Bond Manual* of proposed municipal bond offerings, ECON1 and ECON2 were defined as follows. Both ECON1 and ECON2 are dichotomous variables. ECON1 differentiates between the desirable (ECON1=1) and less desirable categories (ECON1=0) based on the following terms: desirable--diversified or noncyclical economy, high income/wealth per capita, and broad tax base; less desirable--fairly diverse economy, moderate income/wealth level per capita, and a stable tax base. A broad and high income base typically will increase the likelihood that the municipality will be able to maintain tax collections and revenue generation during adverse times. A wealthier population also reflects greater potential for generating higher tax revenue. ECON2 includes the undesirable category (ECON2=0) described as cyclical/vulnerable economy, low income/wealth per capita, and small tax base. Again, ECON2=1 refers to the less desirable category.

Both Carlton and Lerner (1969) and Horton (1969) also conclude that population is related positively to the economic diversity of the community. POP reflects the enhanced marketability of the debt of a large municipality. The population trend (POPTR) was measured as an annual percentage change in the municipality's population through the last census date.

The reoffering yield, YIELD, is employed in both Samples I and II.[3] The exact reoffering yield reported by Liu and Thakor (1984) in terms of maturity was not specified. For Sample II, although the six and ten year reoffering yields were examined, only the results using the ten year reoffering yields are presented.[4] The bond ratings are based on Moody's letter rating system. A continuous measure, however, was necessary for path analysis. Therefore, the

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[3]Although Ingram, Brooks, and Copeland (1983) and Liu and Thakor (1984) admit that the reoffering yield is not ideal, both studies use it.

[4]The entire data analysis of this study using the six year reoffering yield is available from the author. The results are substantially the same as the reported results used in the study based on the ten year reoffering yield.

ratings, RATING, are represented as the average ten year reoffering yield for each rating class as in Liu and Thakor.

Path Analysis Models for Samples I and II

Path analysis assumes a linear recursive system and employs maximum likelihood estimates. The recursive path models can be represented by the following sets of structural equations:

Sample I

(4) RATING $= p_{51}BURDEN + p_{52}PCDEBT + p_{53}UNEMP + p_{54}HOME + e_1$

(5) YIELD $= p_{61}BURDEN + p_{62}PCDEBT + p_{63}UNEMP + p_{64}HOME + p_{65}RATING + e_2$

Sample II

(6) RATING $= p_{12,5}TAX + p_{12,6}DEBTVAL + p_{12,7}PCDEBT + p_{12,8}ECON1 + p_{12,9}ECON2 + p_{12,10}POP + p_{12,11}POPTR + e_3$

(7) YIELD $= p_{13,1}CALL + p_{13,2}MKTINT + p_{13,3}SIZE + p_{13,4}MAT + p_{13,5}TAX + p_{13,6}DEBTVAL + p_{13,7}PCDEBT + p_{13,8}ECON1 + p_{13,9}ECON2 + p_{13,10}POP + p_{13,11}POPTR + p_{13,12}RATING + e_4$

where

p_{ij} = the path coefficient from jth variable to ith variable;
e_i = the error term associated with the ith dependent variable.

The direct effects are symbolized by path coefficients. For example, p_{62} in Sample I is the direct effect of variable X_2 (PCDEBT) on X_6 (YIELD). The total association between X_6 (YIELD) and X_2 (PCDEBT) can be written as:

(8) $r_{62} = p_{62} + p_{65}r_{25} + p_{61}r_{12} + p_{63}r_{13} + p_{64}r_{14}$.

The total effect is given by the zero order correlation between the two variables. In this example, the components of the total association can be categorized into the direct effect, r_{62}, the indirect effect, $p_{65}r_{25}$, and the noncausal effects ($p_{61}r_{12}$ + $p_{63}r_{13}$ +$p_{64}r_{14}$). In equation (8), the impact of PCDEBT, consisting of both direct and indirect effects, measures the total change in YIELD resulting from PCDEBT, regardless of how that change occurs. The direct effect is that part of the total effect of the dependent variable that is not transmitted via a mediating variable (in this case, RATING). The indirect effect represents change in the dependent variable that is caused indirectly through a mediating variable. In the above example, $p_{65}r_{25}$ measures the effect of PCDEBT on YIELD through the mediating variable, RATING. The remaining component, the noncausal effects, consists of associations between YIELD and PCDEBT that result from common causes, from correlations among these causes, and from unanalyzed correlation.

Empirical Results

Figure 1 illustrates the path diagrams for both samples.[5] For path models, a statistic analogous to R^2 in ordinary least squares regression is calculated as (Goldberg and Duncan, 1973):

(9) $M = 1 - (1-R_1^2)(1-R_2^2) \dots (1-R_N^2)$

where

R_i^2 = the ordinary squared multiple correlation coefficient for the ith equation in the model.

For Sample I, the M is .919, indicating that the recursive model employed is able to explain 92 percent of the interissue variation in YIELD. For Sample II, the M is slightly lower at .795, which is due primarily to the sample selection process in which a wider variation of issue characteristics was permitted. The results compare favorably with the explanatory power of previous municipal bond pricing models.

The path coefficients illustrated in Figure 1 are measured as standardized regression coefficients.[6] Each coefficient measures change in terms of deviation from each respective mean rather than original units. These standardized

[5]The Linear Structural Relations (LISREL) approach based on the maximum likelihood estimation was employed to estimate each path coefficient.

[6]The typical format for path analysis is to use the standardized form. The nonstandardized results are available from the author.

coefficients are appropriate because of the simplicity of the decomposition of the correlation matrix and because of the ease of comparison among paths.

The significant direct paths are generally as expected in both samples. Most important, none of the direct paths of the exogenous variables on YIELD in Sample I is significant. This result apparently contrasts with the results of Liu and Thakor (1984). Liu and Thakor, however, relied on the total effects rather than the direct effects reported in Figure 1. This indicates that the only influence the exogenous variables have on YIELD is through their respective effects on RATING. All of the coefficients of these variables in the RATING paths are significant at the 5 percent level. In Sample II, only the financial variables, market level of interest rates (MKTINT) and the issue maturity (MAT), exhibit significantly direct paths for YIELD. In contrast, the economic variables are again only significant in the RATING paths. Only POP appears to exhibit an effect on rating, contrary to expectations. Given their robustness in two separate samples with different securities and different exogenous variables, these results suggest that the bond rating incorporates virtually all that public economic information used in previous studies on municipality credit quality for new issue municipal debt offerings.

Table 2 illustrates this decomposition of the total correlation into the direct effect and indirect effects for both samples.[7] The residual column is small relative to the total correlations. This confirms the results of the M statistic that the empirical model is specified correctly. Comparing the direct and indirect effect columns highlights the relative magnitude of the latter. Only TAX and ECON2 exhibited lower indirect effects. The significant total effects of these variables on yield are due to their significant effect on bond rating and, in turn, rating's strong influence of the new issue yield. When differences in coefficient signs occur between the direct and total effects of a variable or yield, it is due to the large indirect effect. Liu and Thakor (1984) suggest that the market makes an independent assessment of borrower risk classes above that depicted by the ratings. These results tend to refute that conclusion. The relative magnitude of the direct and indirect effects illustrated in both Figure 1 and Table 2 indicate that the market relies heavily on the ratings.

[7]To illustrate the relationship between the results in Figure 1 and Table 2, examine the total effect of BURDEN on YIELD. From Figure 1, coefficient of the direct path of BURDEN to YIELD (.099) corresponds to the direct effect in Table 2. The indirect effect in Table 2 (.377) corresponds to the product of the BURDEN-RATING path (-.555) and the RATING-YIELD path (-.680). The sum of the direct and indirect paths equals the total correlation less any spurious or unanalyzed effects.

Conclusions

There appears to be general agreement that the bond rating measures credit risk for a specific debt offering. Therefore, an empirical model was developed to examine the effect of economic information on new issue pricing both directly and through the bond rating as a mediating variable. The results of this study suggest that the market for new issues of municipal debt does not appear to make a significant independent determination of credit quality. None of the direct effect coefficients for the economic variables were significant. Further, the sum of the indirect effects of these variables through ratings was considerably greater than the direct effects.

These results provide confirmation of the premise that the municipal securities market may be unique, at least in terms of the new issue market. Given a lack of consistently accurate and timely information, it is likely that the new issue municipal bond market would come to rely on a signal of credit quality. The bond rating appears to fulfill the informational need. Therefore, information costs are reduced for both issuers and investors. The model presented in this study was capable of explaining a high degree of the variation in yields on new issues of various forms of municipal debt.

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Table 1
Selected Exogenous Variables for
Path Model of Municipal Debt Pricing

Sample I

A.	BURDEN (X_1)	= Total net direct burden of the state ($ billions)
B.	PCDEBT (X_2)	= Per capita debt ($ thousands)
C.	UNEMP (X_3)	= State unemployment rate
D.	HOME (X_4)	= Median home value ($ thousands)

Sample II

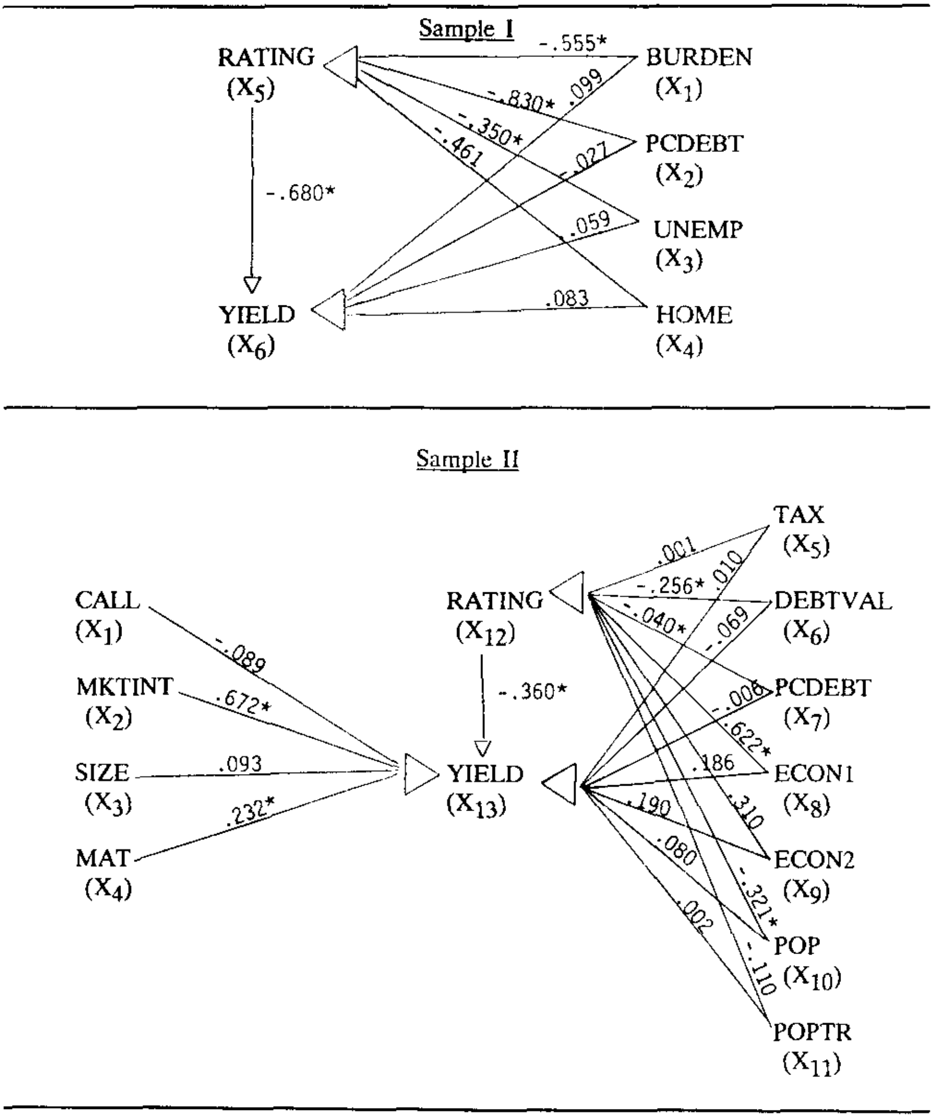
A.	Financial variables	
	1. CALL (X_1)	= Call feature (1=yes, 0=no)
	2. MKTINT (X_2)	= Market average interest rate level
	3. SIZE (X_3)	= Issue size
	4. MAT (X_4)	= Average maturity of issue
B.	Economic variables	
	5. TAX (X_5)	= Current % tax collection record
	6. DEBTVAL (X_6)	= Total direct debt as % of real estate valuation
	7. PCDEBT (X_7)	= Per capita direct debt ($ thousands)
	8. ECON1 (X_8)	= Desirable vs. less desirable economic base
	9. ECON 2 (X_9)	= Less desirable vs. undesirable economic base
	10. POP (X_{10})	= Total population
	11. POPTR (X_{11})	= Population growth trend

Table 2
Decomposition of Effects of Independent Variables on Yield

Dependent Variable	Independent Variable	Total Correlation	Direct Effect	Indirect Effect	Spurious/ Unanalyzed	Residual
			Sample I			
YIELD	BURDEN	.475	.099	.377	-.001	.000
	PCDEBT	.452	-.027	.564	-.085	.000
	UNEMP	.382	.059	.238	.085	.000
	HOME	.323	.083	-.313	.553	.000
	RATING	-.763	-.680	–	-.083	.000
			Sample II			
YIELD	CALL	.021	-.089	–	.132	-.022
	MKTINT	.663	.672	–	.006	-.015
	SIZE	.102	.093	–	.034	-.025
	MAT	.290	.232	–	.048	.010
	TAX	.058	.010	-.001	.049	.000
	DEBTVAL	.091	-.069	.092	.059	.000
	PCDEBT	.117	-.006	.014	.109	.000
	ECON1	-.149	.186	-.224	-.111	.000
	ECON2	.172	.190	-.112	.094	.000
	POP	.205	.080	.116	.009	.000
	POPTR	.009	.002	.040	-.033	.000
	RATING	-.329	-.360	–	.009	.022

Figure 1

Recursive Path Results for Role of Bond Rating in Municipal Bond Pricing



* Significant at 5% level of significance

Appendix A

Path analysis was initially developed to examine the indirect as well as the direct relationships between causal and other variable as specified by an *a priori* model. The path diagram below, although not essential to the description of path analysis, provides a useful means of observing the relationships.

Variables 1 and 2 are considered exogenous or caused by factors outside the model. No attempt is made to explain the variation in these variables. Variables 3 and i are endogenous. As illustrated by the path diagram, Variable 3 is considered both a dependent and independent variable. For an overidentified model, as in the model in this paper, certain paths have been deleted because of the basic model of municipal bond pricing.

Assuming the unidirectional relationships among the variable 1 through i, the following structural equations correspond to the model depicted in the diagram:

(1) $X_1 = e_1$
(2) $X_2 = e_2$
(3) $X_3 = \beta_{31}X_1 + \beta_{32}X_2 + e_3$
(4) $X_i = \beta_{i1}X_1 + \beta_{i2}X_2 + \beta_{i3}X_3 + e_4$

The estimation of the structural equations consists of ordinary least squares regression analysis. The βs are the standardized partial regression coefficients that represent the path coefficients; e's are the disturbance terms; and Xs are the variables defined by the model. See Pedhazur (1982) for an explanation of the assumptions that are basic to path analysis.

Based on the above regression results, the total association between two variables measured as the zero-order correlation can be decomposed into the following components:

(5) Total Association	=	Direct Effect	+	Indirect Effect	+	Unanalyzed Association

For variables 1 and 3 in the path diagram, the total association, (r_{13}), consists of two parts: the direct effect of 1 on 3 or the path coefficient (p_{31}) and the indirect effect that is due to the correlation of 1 with any other causes of 3, in this case variable 2. This is measured as $r_{12}p_{32}$. The noncausal component, that part of the r_{13} that is due to correlated causes, is r_{13}-p_{31}. This latter component is unanalyzed because the model does not provide an interpretation of that relationship.

Figure A1