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DETERMINANTS OF MUNICIPAL BOND YIELDS

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Since World War II, the significance of the municipal bond market has increased dramatically with state and local government debt growing much more rapidly than public and private debt, federal debt, or the gross national product. Between 1960 and 1970, the annual value of new issues of state and local government bonds increased 110 percent,[1] and there is every indication that the total will continue its rapid rise. In 1969 and 1970, the values of state and local government bond new issues were second only to those of the corporate bond market.[2] Despite the size of the state and local bond market, investors and researchers have devoted their attention to the markets for corporate and U.S. government securities; the interest in these markets has tended to overshadow activity in the municipal bond market.

This article is concerned with one aspect of this growing market: the yields of general obligation bonds of local governments, hereafter referred to as municipal bonds. It describes the factors that determine the structure of municipal bond yields and presents the empirical results of tests used to measure the impact these factors have on municipal yields. In order to determine statistically the impact of these factors, we will study the relative differences in municipal yields. We are concerned with why, for example, Paducah, Kentucky's bonds have yielded 25 basis points more than Columbus, Ohio's bonds, and 30 basis points less than New York City's bonds.

Before we examine the results of the study, it is important to understand the interaction of factors that determine municipal bond prices, and consequently,

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**Boise Cascade Corporation.* *The author is greatly indebted to Richard West and Seymour Smidt for their helpful suggestions. The study was completed in 1969 while the author was a Ph.D. candidate at Cornell Graduate School of Business.*

[1]Total new issues increased from $7.2 billion in 1960 to $15.2 billion in 1970. *Moody's Municipal and Government Manual* (February 1971), p. a20.

[2]In 1970, the $15.2 billion of new issues of state and local bonds compared with $14.8 billion of new issues of U.S. government securities, $30.3 billion of corporate bonds, and $7.3 billion of corporate equities.

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their yields. Therefore, we will first discuss the *a priori* reasoning that would suggest the economic relationships between various factors and yields and, secondly, we will discuss the results and implications of the study.

I. Theoretical Relationships

In general, the municipal bond investor seeks to maximize his after-tax yields subject to two types of factors -- those factors that affect the estimate of default risk and those that affect the estimate of marketability.

Default Risk

Traditionally, bond analysis has been conducted from a pessimistic point of view. Since the investor's return is limited by the coupon rate and the maturity payment, he is especially concerned about the issuer's ability to meet its debt service. In assessing the risk of default, the investor is concerned with estimating the probability that the debt service will not be paid as scheduled. The rational investor's estimation of these probabilities must be derived from the limited information available to investors. There are three types of measures that may be relevant to assessing the default risk of a municipality: 1) measures that consider relative debt burden, 2) measures that consider the city's economic base, and 3) measures that consider the municipality's default history.

Relative Debt Burden. Under normal economic circumstances, the probability that a municipality will default is very small. However, under conditions of unusual local or national economic decline, some municipalities may experience difficulty in servicing their debt. In the case of general obligation bonds, a local government's ability to tax its residents determines the availability of revenue to service the debt. Presumably, the lower the existing debt burden, the greater the ability to tax. Consequently, it is suggested that municipalities with a high debt burden will be more likely to default than will those with relatively low debt burdens. As a measure of relative debt burden, this study uses overall debt as a percent of the true value of taxable property (overall debt/true value).[3]

[3]Overall debt rather than net debt is used because it considers the debts of overlapping jurisdictions, and therefore, it is a more effective measure of the resident's total debt burden. The true value of taxable property is preferred to assessed value because it is a more accurate indicator of the community's ability to pay. Since assessed valuation is determined by a wide range of percentages of full value, it would be difficult to compare the differences in ability to pay by using this factor. In addition, overall debt/true value is desirable because it recognizes the importance of property taxes as the principal source of local government revenue.

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Economic Base. By itself, overall debt/true value is not an effective measure of the total risk of default; it measures only the current ability to meet the debt service by utilizing property values. Because most payments on the bonds will be made in the future, we must estimate future ability to pay as well as present ability. In estimating future ability to pay, we must be concerned with the potential stability of income and property values.

Under conditions of unusual national or local economic decline, municipalities that are economically well diversified will be less susceptible to declining property values and incomes than will less diversified cities; therefore, they may also be less susceptible to default. As a result, economic diversity may serve as a plausible indicator of the potential stability of property values. The "minimum requirements approach" has been selected as the measure of economic diversity.[4]

While economic diversification may be one measure of the soundness of the economic base, it does not consider the fact that some industries have a more stabilizing effect than others. We would like to have a measure of stable industries, but stability is very difficult to quantify, and relevant information is almost impossible to obtain. In addition, it is not enough that a particular industry is located in a city, but it must also be large enough to exert a significant influence on the local economic base. As a result, a proposed measure must consider not only the existence of the industry, but also its relative importance to the community.

In order to examine the effect of highly stable industries, it was decided to test the effect of one industry which is considered to be a significant stabilizing influence. Since it is widely accepted that universities are an important stabilizing factor in the economic base of cities, the university industry was chosen for this study. In order to recognize the university's relative importance to the city, the factor is measured by the number of college students as a percent of the city's population.

Default History. The preceding factors measure ability to pay, but they do not consider the municipality's "willingness to pay" or its past reliability in meeting its obligations. Investors are undoubtedly more wary of municipalities

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[4]The "minimum requirements approach" develops an index which approximates the minimum percentage of the labor force that is required by various sectors of the city's economy in order to maintain economic viability. When the minimum percentage is subtracted from the actual employment in a particular sector, we have the excess employment of the sector. The measure of economic diversity is a weighted average of the excess employment in each sector. A city with a low value of the measure will be described as more diversified than a city with a large value. See Edward Ullman and Michael F. Dacey, "The Minimum Requirements Approach to the Urban Economic Base," *Papers and Proceedings of the Regional Science Association*, Volume 6 (1960), p. 176.

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that have defaulted in the past, regardless of their present ability to pay. Therefore, bonds with a default-free record might be accorded a lower estimate of default risk than would bonds with a default in their history. As an additional measure of default risk, the default history of municipalities has been included. A bond is described as defaulted if, after 1930, it failed to meet any principal or interest payments promptly.

Marketability

Marketability is concerned with the price that buyers pay and sellers receive when they wish to alter their holdings. If an investor is certain that he will not need to liquidate his investment prior to maturity, he is not concerned with marketability. Or, if the market for municipal bonds were "perfect," or highly efficient, marketability would be of no concern.[5] However, because the principal investors in the municipal bond market do have a potential need to liquidate their holdings prior to maturity and because the market is not highly efficient, marketability may be an important determinant of municipal yields. There are three types of measures that are relevant for assessing the marketability of a municipality's bonds: measures of block marketability, measures of issuer marketability, and measures that predict future marketability.

Block Marketability. Larger blocks of bonds may attract premium prices or lower yields for several reasons. The costs of analyzing, acquiring, and servicing one large block may be less than the costs of analyzing, acquiring, and servicing several smaller blocks of the same value. These cost advantages may enable institutional investors or large individual investors to pay higher prices for larger blocks and still be better off than they would be if they bought several smaller blocks. In light of these expectations, it is hypothesized that block size is one measure of marketability. The impact of this factor is interesting for another reason. The activity of large institutional investors has increased during the last decade and is expected to increase in the future. If the impact of block trading has increased over the time period studied, this study may indicate future developments in the municipal market.

Block size marketability considers the marketability of specific holdings of bonds, regardless of the issuer. This is marketability over which the buyers and sellers exert some control. In contrast, the aspect of marketability to be discussed next, "issuer marketability," is a characteristic of a whole bond issue,

[5]A perfect or highly efficient market is, among other things, a market in which the buyer or seller has no effect on the market price; no matter how few or how many bonds the investor wants to buy or sell, the market will absorb them without affecting the price of the security.

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irrespective of the size of the holdings. A specific investor has no control over this aspect of marketability.

Issuer Marketability. The marketability of an issuer is usually discussed in terms of the thinness of the market for *that particular issue*. One measure of issuer marketability might be the size of the issuer's net debt outstanding.[6]

The argument used to support net debt outstanding as a good measure of marketability is the following: all other things equal, the smaller the number of bonds outstanding, the fewer the transactions we should expect to take place; the less frequently transactions occur, the thinner the market; the thinner the market, the more uncertain the price and the less marketable the issuer's bonds.[7] This view of marketability suggests that larger issues are more marketable than smaller issues.

On the other hand, some investors tend to view the marketability of an issuer's bonds as it relates to their own portfolio. If a specific issue already represents a significant portion of an investor's portfolio, the issue may be acceptable only if the yields rise relative to the rest of the market. This view suggests that the yields of larger issuers may be higher than those of otherwise comparable issuers; it suggests that the bonds of smaller issuers may be more marketable than those of larger issuers.

Future Issuer Marketability. If an investor does not expect to sell his bonds immediately, he is more interested in future than in present marketability. If the current total debt is a measure of current marketability, then future total debt should be a measure of future marketability.

Since the local citizenry determines which facilities and services are required, the future demands of the residents would be an indicator of future debt outstanding. One possible measure of future demands is past population growth. Past population growth is preferred to current population growth, because it is a better estimate of the changing demand for capital expenditures -- the major use of borrowed capital. As the population grows, so do the demands for schools, roads, and other public services requiring large capital outlays, but these demands tend to lag behind actual changes in population. These capital outlays are usually made only after existing facilities have become

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[6]Lawrence Fisher used total debt outstanding as the measure of marketability of corporate bonds. Lawrence Fisher, "Determinants of Risk Premiums on Corporate Bonds," *Journal of Political Economy*, Volume 57 (June 1959), pp. 217-237. Lerner and Carleton used debt outstanding as a measure of marketability in their study of municipal bond ratings. W. T. Carleton and E. M. Lerner, "Statistical Credit Scoring of Municipal Bonds," *Journal of Money, Credity and Banking*, Volume 1 (November 1969) pp. 750-764.

[7]Fisher, "Determinants of Risk Premiums," p. 229.

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overcrowded and the citizenry has expressed its demands. For these reasons, past population growth appears to be the best measure of future demands for capital expenditures, and, in turn, for future increases in debt.

As in the case of current issuer marketability, future marketability can be discussed from two apparently conflicting viewpoints. According to one argument, an increase in total debt would reduce the thinness of the market for the issuer's bonds and would enhance the bonds' marketability. Following the second argument, an increase in total debt would increase the amount of the issuer's bonds relative to the total market, thereby impairing the bonds' marketability. The two views of issuer marketability tend to suggest opposite conclusions regarding the effect of current and future debt outstanding. If the empirical results are to be meaningful, they should confirm the validity of one of these two views.

Term to Maturity. This study is not directly concerned with measuring the effect of term to maturity on municipal yields. Because the secondary market for municipals is not active, it is not possible to study a sample of bonds with a common maturity date; thus, a segment on the term structure was selected in order to obtain a sufficiently large sample. For our study, the cross sections of bonds are taken from the 15- to 25-year segment of the term structure. This segment was chosen because it is relatively active; moreover, in this segment, the effect of term to maturity on yields tends to be more linear and smaller than the effect in earlier segments (i.e., the term structure tends to be more horizontal).

The operational hypothesis of this study is as follows: municipal bond yields are a function of eight variables: overall debt/true value, default history, economic diversification, college students/population, block size, net debt, population change, and term to maturity.

II. Empirical Model

The equation to be tested is as follows:

$$X_y = a_* + a_o X_o + a_d X_d + a_e X_e + a_c X_c + a_s X_s + a_n X_n + a_p X_p + a_t X_t$$

where:

X_y = bond yield: measured in basis points per annum, compounded semiannually, after capital gains taxes;

X_o = overall indebtedness as a percent of full value of taxable property;

X_d = municipal default: dichotomous variable -- 1 if default, 0 if no default;

X_e = economic diversification: pure number using minimum requirements

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approach;

X_c = number of college students as a percent of the city's population;

X_s = logarithm of block size of bonds offered for sale;

X_n = total outstanding direct debt: measured in 100 millions of dollars;

X_p = population change: ratio of last census date to previous census date;

X_t = term to maturity: measured in 100's of months;

a_* = constant term; and

a_i = the reduced form coefficients of the specific variables.

Form of the Function. If an independent variable's effect on yields depends upon the size of all of the other independent variables, a nonlinear function is required. On the other hand, if the effect of an independent variable is independent of the magnitude of the other independent variables, then a linear function may be appropriate.

While neither assumption is totally descriptive of our relationships, it was decided that a linear function is the most appropriate. For example, the effect of a default on yields is not dependent upon the relative number of college students in a city nor upon the size of the block offered for sale. By the same token, the effect of overall debt burden is not dependent upon the size of the block offered for sale. Similarly, the effect of economic diversity is not dependent upon the rate of population change.

While *a priori* reasoning may suggest that some multiplicative relationships are reasonable, preliminary testing indicated that a "better fit" could be obtained by using the linear form. Moreover, an examination of the regression residuals failed to reveal any second-order relationships except in the size of the block offered for sale. In addition, at least one variable has the potential of taking nonpositive values.[8] If a simple multiplicative relationship were assumed and if logarithms were employed to permit the use of multiple regression techniques, the measure of the nonpositive variables would have to be changed, the variables taking nonpositive variables would have to be dropped, or the observations taking nonpositive values would have to be dropped. None of these alternatives is acceptable. Consequently, ordinary least squares is used to estimate the coefficients of a restricted reduced form equation.

Selection of Cross Sections. Traditionally, the two major suppliers of funds (demanders of bonds) have been individual investors and commercial banks. While commercial banks have been an important source of funds in recent years, they are erratic investors. As a result, dominance of the market seems to alternate between commercial banks and individuals. Consequently, it was decided to determine whether the factors used to assess the risk of municipal

[8]College students/population frequently takes zero values.

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bonds have the same importance to both investors.

The hypothesis on the determinants of municipal bond yields was tested by least squares regressions for cross sections of municipal bonds in five different periods:[9] the last seven business days of March 1957 and the last five business days of March of the following years: 1960, 1963, 1965, and 1967.[10] These periods were chosen to test the hypothesis under varying circumstances. Commercial banks were active in the market during the periods including the 1963 and 1967 cross sections; individuals were active during the periods including the 1957 and 1960 cross sections; and both individuals and commercial banks were active during the period of the 1965 cross section.[11]

III. Summary of the Results

The equations (1) - (5) in Table 1 show the coefficients of the regression equations that were used to test the hypothesis and to estimate municipal yields for each of the five cross sections. All of the coefficients have the hypothesized signs, including the positive coefficients of net debt and population change and the negative coefficients of log of block size. It should be noted that the regression coefficients are not stable over all of the cross sections. However, when the cross sections are divided into periods of either commercial bank dominance or individual investor dominance, the coefficients are considerably more stable. Based on this stability, the cross sections from 1967 and 1963 and from 1960 and 1957 were pooled together. This allows us to obtain a single set of "best" estimates of the coefficients under the two types of investor dominance. The resulting regression equations are shown as equations (6) and (7) in Table 2.

Since the coefficients for overall debt/true value (a_o) and economic diversification (a_e) were not stable between the 1967 and 1963 cross sections,

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[9]The observations in each cross section contain all noncallable, general obligation municipal bonds listed in the *Blue List* that have maturities between 15 and 25 years and that were new quotations during the cross sections. Old quotations were not considered. Since most municipal general obligations are serial bonds, more than one quotation may appear for a single municipality. So that the larger issuers would not swamp our sample, no more than five quotations of a single issuer appear in any cross section. If more than five observations appeared in the initial sample, five observations were randomly selected for study.

[10]Seven days were used for 1957 to obtain a comparable sample size.

[11]In the first six months of 1963 and 1967, commercial banks, holdings of state and local government bonds increased $3.2 billion and $5.9 billion respectively. In the first six months of 1957 and 1960, commercial banks' holdings increased $0.5 billion and decreased $0.2 billion respectively.
Source: *Assets and Liabilities and Capital Accounts - Commercial and Mutual Savings Banks, Federal Deposit Insurance Corporation*. Washington, D.C.

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TABLE 1

REGRESSION EQUATIONS FOR ESTIMATING MUNICIPAL BOND YIELDS -
LINEAR FUNCTION OF OVERALL DEBT/TRUE VALUE, DEFAULTS, DIVERSIFICATION, COLLEGE STUDENTS,
LOG OF BLOCK SIZE, NET DEBT, POPULATION CHANGE, AND TERM TO MATURITY (t-VALUES)

Equation	Date	No. of Observations	R^2	O.D. True a_o	Default a_d	Diversity a_e	Students a_c	Log Block a_s	Net Debt a_n	Pop. Change a_p	Term a_t	Constant a_*
(1)	1967	143	.747	+6.108	+10.49	+8.488	-0.477	-12.82	+0.397	+0.275	+20.74	+277.8
				(8.68)°	(2.33)°	(8.08)°	(2.51)°	(4.37)°	(2.00)*	(0.56)	(4.76)°	
(2)	1963	141	.550	+2.048	+5.962	+2.507	-0.827	-5.911	+0.175	+2.143	+34.50	+215.2
				(3.44)°	(1.78)*	(2.72)°	(2.33)°	(2.62)°	(0.78)	(2.47)°	(9.53)°	
(3)	1960	137	.240	+0.247	+17.19	+1.896	-2.202	-8.948	+0.732	+3.769	+7.200	+342.8
				(0.79)	(3.41)°	(1.68)*	(1.94)*	(2.12)*	(2.06)*	(2.47)°	(1.57)'	
(4)	1957	109	.596	+0.786	+18.27	+1.360	-2.345	-5.539	+0.932	+49.60	+8.437	+231.8
				(0.86)	(2.59)°	(2.13)*	(3.96)°	(1.08)	(1.96)*	(8.28)°	(1.50)'	
(5)	1965	114	.272	+1.067	+15.26	+0.766	-0.461	-12.65	+0.294	+1.904	+1.143	+325.6
				(1.85)*	(4.01)°	(0.89)	(2.74)°	(4.69)°	(1.09)	(1.14)	(1.78)*	

° = significance at .01 level or below

* = significance at .05 level

' = significance at .10 level

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TABLE 2

POOLED REGRESSION EQUATIONS FOR ESTIMATING MUNICIPAL BOND YIELDS (t-VALUES)

Pooled Regressions: Changing Slope Coefficients

	Commercial Banks		R^2	a_{o63}	a_{o67}	a_d	a_{e63}	a_{e67}	a_c	a_s	a_n	a_p
(6)	1967-1963	284	.860	+2.202 (3.62)°	+6.291 (9.91)°	+7.979 (2.88)°	+2.830 (2.99)°	+8.809 (9.10)°	-0.540 (3.35)°	-8.831 (4.81)°	+0.312 (2.11)*	+0.637 (1.54)'
									a_{t63} +35.10 (8.82)°	a_{t67} +20.11 (4.99)°	a_{*63} +217.9	a_{*67} +272.3
	Individuals			a_o		a_d	a_e		a_c	a_s	a_n	
(7)	1960-1957	246	.654	+0.301 (1.07)		+16.93 (4.34)°	+1.410 (2.72)°		-2.353 (4.40)°	-8.010 (2.53)°	+0.809 (3.02)°	
							a_{p57} +49.95 (8.69)°	a_{p60} +3.811 (2.70)°	a_{t57} +8.692 (1.43)'	a_{t60} +7.407 (1.74)*	a_{*57} +286.5	a_{*60} +346.2

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TABLE 2 (cont)

Pooled Regressions: Common Slope Coefficients

Commercial Banks			R^2	a_o	a_d	a_e	a_c	a_s	a_n	a_p	a_{t63}	a_{t67}
(6a)	1967-1965	284	.838	+4.687 (10.0)°	+10.53 (3.59)°	+6.499 (9.13)°	-0.520 (3.02)°	-10.28 (5.27)°	+0.326 (2.06)*	+0.686 (1.57)'	+34.10 (8.01)°	+22.65 (5.27)°
											a_{*63} +197.9	a_{*67} +283.7
Individuals				a_o	a_d	a_e	a_c	a_s	a_n	a_p	a_{t57}	a_{t60}
(7a)	1960-1957	246	.564	+0.549 (1.76)*	+13.09 (3.02)°	+1.531 (2.63)°	-2.364 (3.95)°	-9.184 (2.59)°	+0.598 (2.00)*	+6.328 (4.11)°	+5.987 (0.88)	+7.333 (1.54)'
											a_{*57} +306.1	a_{*60} +346.1

° = significance at .01 level or below

* = significance at .05 level

' = significance at .10 level

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separate coefficients were estimated when the two cross sections were pooled. Similarly, separate coefficients were estimated for population change (a_p) when the 1957 and 1960 cross sections were pooled. (The use of separate coefficients and the tests of stability are discussed in more detail at the end of this section.)

In equations (6) and (7), all the coefficients have the hypothesized signs. While the results confirm some of the market's conventional beliefs, they raise questions about, and perhaps disprove, others.

Default Risk

Overall Debt/True Value. The coefficients for overall debt/true value (a_o) are as hypothesized. Cities with larger ratios must pay higher yields. The larger magnitudes of the coefficients during periods of bank dominance suggest that, when banks dominate the market, municipalities are penalized more for their debt burden.[12]

Default History. The positive coefficients of the default variable (a_d) indicate that higher yields are demanded from issuers that have defaulted since 1930. Further examination suggests that the "penalty" for a past default is larger during periods of individual investor dominance; during these periods, the bonds of issuers that had defaulted after 1930 yielded approximately 17 basis points more than the bonds of otherwise comparable issuers that did not default. Translated into dollar costs, cities with past defaults pay $1,693 more in interest annually for every million dollars of bonds outstanding.[13] During periods of commercial bank dominance, the "penalty" is slightly less than half that amount.

Economic Diversification. Under both types of dominance, the more "undiversified" a city is, the larger the yield is. However, the variable's coefficient (a_e) and significance are larger under periods of bank dominance. This may reflect the more sophisticated and thorough analysis that can be conducted by commercial banks. Information on economic diversification may be relatively difficult for the individual to obtain and analyze. This may explain why the market appears to "penalize" undiversified cities less when individuals are dominant and more when banks are dominant.

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[12] Overall debt/personal income (X_{oi}) was tested in place of overall debt/true value (X_o). In 1965, the coefficient for X_{oi} had the wrong sign while the coefficients for X_o had the correct sign in all cross sections. Moreover, when X_{oi} was substituted for X_o, the range of estimated coefficients for the other seven independent variables was larger in every case.

[13] See equation (7) in Table 2.

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College Students/Population. The negative signs of the coefficients of the college student/population variable (a_o) and their relatively high significance confirm in part the belief that the presence of universities enhances a city's economic stability and should reduce the cost of borrowing. Individuals apparently are more willing to pay higher prices (accept lower yields) on the bonds of "university towns" than commercial banks are.

The theoretical relationships between bond yields and each of the four variables measuring default risk are slightly different. There is a more direct theoretical relationship between bond yields and overall debt/true value (X_o) and between bond yields and economic difersification (X_e); that is, X_o and X_e are more sound economic variables. On the other hand, default history and college student/population (X_d and X_c) are more "emotional" variables; that is, while these two variables may help to determine the size of bond yields, there is less sound theoretical justification for the relationship. If we can assume that banks are able to conduct a more sophisticated and more thorough analysis, the coefficients of X_o and X_e should be more significant during periods of bank dominance than during periods of individual dominance. Similarly, the coefficients of X_d and X_c should be more significant when individuals are dominant. The results shown in Tables 1 and 2 confirm this hypothesis.

Marketability

Block Size. The estimates of the coefficients for log of block size (a_s) indicate the growing importance and significance of block trading. The coefficients indicate that larger blocks of bonds sell at higher prices or lower yields. The significance of the logarithm of block size stresses the nonlinear effect of offer size on yields; increasing the block size offered from $5,000 to $50,000 has a significant effect on yields, while increasing the block size from $200,000 to $300,000 has relatively little effect.[14]

New Debt. In all five cross sections, the sign of the coefficient for net debt (a_n) is positive -- the larger the net debt, the larger the yield. While

[14] In addition, two other specifications of block size were tested. The results of substituting block size (X_{bs}) for log of block size (X_s) yielded the correct sign, but the R^2s and t-values were significantly larger only in one out of the five cross sections. In addition, when X_{bs} is used in place of X_s, the ranges of the coefficients of the other seven independent variables were larger. The results of substituting block size (X_{bs}) and block size squared ($(X_{bs})^2$) in place of X_s yielded the hypothesized signs. However, the adjusted coefficient of multiple determination (adjusted R^2) was lower in four out of five cross sections. Moreover, X_s is significant at the .025 level in four out of five cross sections; X_{bs} and $(X_{bs})^2$ are significant at the .025 level in three out of five cross sections, respectively.

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not all of the coefficients are highly significant, the results tend to dispute the argument that small cities are discriminated against because of their size. On the other hand, they lend support to the belief that there is an "oversupply" of some large issuers' bonds.

In their study of municipal bond ratings, Lerner and Carleton suggest that net debt is a proxy for marketability and economic diversification.[15] According to their reasoning and empirical results, the bonds of a city with a large net debt would have high marketability while small cities would suffer from thin markets and relative obscurity. Although these results are exactly the opposite of ours, there may be a logical explanation for these differences. Lerner and Carleton did not include a separate variable that specifically measured economic diversity, and there is a difference between the large size of a city (measured by net debt or population) and economic diversification. Detroit, Michigan, is a large city but it is not well diversified. Thus, it is highly likely that Lerner's and Carleton's positive relationship between net debt and "quality" may have resulted mainly from the positive relationship between net debt and economic diversity. This would suggest that some large cities may enjoy lower interest costs not because their bonds are more marketable but because the cities are usually more diversified. It would be interesting to test the effect of net debt in Lerner's and Carleton's work when a separate measure of economic diversity is used.

The magnitude and significance of the coefficients for net debt indicate that larger issuers are "penalized" more when individuals dominate the market. These results seem to be reasonable when we consider net debt as a measure of the current supply of bonds relative to the purchasing power of active investors. Because individuals' portfolios tend to be smaller, we would expect the penalty to be larger when individuals are dominant than when banks are dominant. Tables 1 and 2 confirm this reasoning.

Population Change. The results of testing the effect of population change (X_p) were in line with those from testing net debt. They support the viewpoint that there is an "oversupply" of some large issuers' bonds; that is, the coefficients of X_p indicate that marketability decreases when population growth has been high.

The magnitude and significance of the population change variable vary from cross section to cross section. In all equations, however, the more rapidly the city has grown, the more interest the city is forced to pay. The significantly larger size of the 1957 coefficient possibly results from the fact that X_p for 1957 is measured by the rate of population change of the 1940s; the measures for the later cross sections use the rate of change for the 1950s.

[15]Lerner and Carleton, "Statistical Credit Scoring," p. 154.

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Term to Maturity. The results of this study indicate that the term structure of municipal bonds may be significantly affected by the type of investor who dominates the market. The larger coefficient under bank dominance indicates that the term structure has a steeper slope when banks are dominant. This is reasonable because of commercial banks' demand for short- or intermediate-term bonds; this demand increases the price and decreases the yields for shorter maturities. At the same time, the demand for longer maturities is smaller; as a result, these yields will increase. On the other hand, when individuals are dominant, the demand for bonds may be spread more evenly along the term structure. This would cause a flatter term structure and, therefore, a smaller coefficient for the term to maturity variable. The lower t-values for the coefficients under individual dominance tend to support Roland Robinson's point that yield arbitrage becomes more erratic when commercial banks withdraw from the market. He suggests that the yield-maturity relationships are more rational when commercial banks are active.[16]

R^2. Table 1 indicates that the variance in yields, as explained by the regression equation, varies from cross section to cross section. A possible economic explanation of the lower R^2 in 1965 and 1960 may be that the cross sections represent periods of adjustment[17] and that the "offered" yields have not yet fully adjusted to recent events.

If transaction yields could have been determined, the R^2s might have been more consistent among the cross sections. Offered yields are those that appear in the *Blue List of Current Municipal Offerings*; transaction yields are those that result from actually buying the bond and holding it until maturity. Clearly, it would have been more desirable to use transaction yields for this study. However, information on transaction yields is not available in the municipal bond market, and therefore, offered yields have been used. When offered yields are used in analysis of periods of adjustment, the regression equations may not have highly explanatory powers (high R^2s). First, the offered yield on some

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[16]Roland Robinson, *Postwar Market for State and Local Government Securities*. (Princeton, N.J.: Princeton Press for the National Bureau of Economic Research, 1960), p. 185.

[17]As a result of the November 1964 change in Regulation Q, yields on municipal bonds declined about 20 basis points between October and February 1965. During the month of the cross section (March 1965), the yields regained most of what they had lost over the preceding five months. U.S. Board of Governors, *Federal Reserve Bulletin*, Volume 51 (August 1965), p. 1058.

The period of adjustment in 1960 was not as unusual. Moody's Aaa municipal bond index cropped 19 basis points in the first four months of 1960, and yields on state and local governments declined more than those outstanding corporate issues of similar quality. *Federal Reserve Bulletin*, Volume 46 (December 1960), p. 1325.

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bonds may respond more quickly to new factors than the offered yield on other bonds. Secondly, no matter how quickly offered yields respond, we would expect *a priori* that the difference between offered yields and transaction yields would be greater during periods of instability. Both factors would contribute to lower R^2s.

If we assume that our hypothesis has some economic rationale for determining yields, the low R^2 may indicate that the market is not fully adjusted and that the market has a number of "good" and/or "bad" buys. If this is true, the model presented here may have some value as a screening device in the analysis of municipal bonds.

Stability of Coefficients

In order to determine the stability of the coefficients, a statistic was calculated to test the significance of the differences in the coefficients among the cross sections.[18] Table 3-A shows the results when this test is applied to the partial regression coefficients in Table 1. As a result of this stability, the cross sections from 1967 and 1963 (commercial bank dominance) were pooled together as were the cross sections from 1960 and 1957 (individual dominance). The regression equations which result from this pooling are shown as equations (6) and (7) in Table 2.

Because the effect of population change (X_p) was not stable between 1957 and 1960, two variables were used to measure the effect of population change

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[18] In order to determine the stability of the coefficients within the periods, the following statistic was calculated:

$$y = \sum_{t=1}^{T} \frac{(b_{it} - b_i^*)^2}{s_{it}^2}$$

where:

$$b_i^* = \frac{\sum_{t=1}^{T} (b_{it}/s_{it}^2)}{\sum_{t=1}^{T} (1/s_{it}^2)} ,$$

b_{it} = the estimated partial regression coefficient for the i^{th} variable in the t^{th} cross section, and

s_{it} = the standard error of the estimate - b_{it}.

This test for stability was suggested by Lawrence Fisher. According to Fisher, the statistic, y, has approximately the χ^2 distribution with T - 1 degrees of freedom. Therefore, a high value of the statistic is reason for rejecting the hypothesis that all of the partial regression coefficients are estimates from the sample population. See Lawrence Fisher, "Determinants of Risk Premiums on Corporate Bonds," *Journal of Political Economy*, Volume 57 (June 1959), p. 229.

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TABLE 3-A

TEST OF THE STABILITY OF REGRESSION COEFFICIENTS

Commercial Bank Dominance - 1967 and 1963

Coefficient	y	Probability of Obtaining as Large a χ^2	Accept the hypothesis that 1967 and 1963 samples have the same coefficients?
a_o	19.40	0.00	No
a_d	0.65	0.40	Yes
a_e	18.30	0.00	No
a_c	0.76	0.40	Yes
a_s	3.48	0.07	Yes
a_n	0.55	0.45	Yes
a_p	3.50	0.06	Yes

Individual Investor Dominance - 1960 and 1957

Coefficient	y	Probability of Obtaining as Large a χ^2	Accept the hypothesis that 1960 and 1957 samples have the same coefficients?
a_o	0.314	0.55	Yes
a_d	0.016	0.90	Yes
a_e	0.170	0.60	Yes
a_c	0.012	0.90	Yes
a_s	0.262	0.65	Yes
a_n	0.124	0.70	Yes
a_p	55.000	0.00	No

Pooling All Five Cross Sections

Coefficient	y	Probability of Obtaining as Large a χ^2	Accept the hypothesis that all the samples have the same coefficients?
a_o	59.88	0.00	No
a_d	5.93	0.20	Yes
a_e	40.00	0.00	No
a_c	12.16	0.02	No
a_s	5.76	0.20	Yes
a_n	3.24	0.50	Yes
a_p	73.00	0.00	No

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when individual investors are dominant. Thus, X_{p57} measures the effect of population changes on 1957 yields and X_{p60} measures the effect on 1960 yields. Similarly, the stability tests indicate that the effects of overall debt/true value (X_o) and economic diversity (X_e) are not stable between 1963 and 1967. Thus, two variables are used to measure the impact of each of these factors on their respective yields. (If separate variables are not used in these cases, equations (6a) and (7a) would result.)

As discussed above, this study is not concerned with factors that affect the general level of municipal bond yields. Since these factors vary from year to year, we would not expect the constant term to be the same for each cross section. Therefore, two constant terms are included in both pooled regressions.

The preceding statistics were calculated to test the stability of each individual variable. In addition, another set of statistics was calculated to confirm the pooling suggested by the previous tests.[19] The results of these tests are shown in Table 3-B. The test rejects the hypothesis that all five cross sections have the same coefficients. However, it accepts the hypothesis that 1957 and 1960 have the same coefficients except for a_p and that 1963 and 1967 have the same coefficients except for a_o and a_e. In other words, it leads us to the same conclusion as the previous tests.

IV. Conclusion

This study indicates that municipal bond yields are a function of the bond's default risk and the bond's marketability. Default risk can be estimated

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[19] The following F-test was suggested by Gregory Chow to test the equality between sets of coefficients:

$$F\ (v_1, v_2) = \frac{(SSR_s - SSR_d)/v_1}{SSR_d/v_2}$$

where:

SSR_s = the sum of squared residuals based on the hypothesis that the coefficients are the same for all cross sections,

SSR_d = the sum of squared residuals based on the hypothesis that all of the coefficients are different for all cross sections,

v_2 = degrees of freedom on the first hypothesis (coefficients are the same for all cross sections), and

v_1 = degrees of freedom on the first hypothesis minus the degrees of of freedom on the second hypothesis.

See Gregory C. Chow, "Tests of Equality between Sets of Coefficients in Two Linear Regressions," *Econometrica*, Volume 28 (July 1960), pp. 591-605; and Shaul Ben David and William Tomak, "Allowing for Slope and Intercept Changes in Regression Analysis" (unpublished paper, Cornell University, November 1965).

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TABLE 3-B

Hypothesis:	F-Test	Accept the hypothesis?
Pooling All Five Cross Sections		
The coefficients for all five cross sections are the same.*	F(28,590) = 8.64	No
Pooling 1963 and 1967 Commercial Bank Dominance		
The coefficients for the 1963 and 1967 cross sections are the same.*	F(7,266) = 7.58	No
The coefficients for the 1963 and 1967 coefficients are the same except for a_o and a_e.*	F(5,266) = 1.91	Yes
Pooling 1957 and 1960 Individual Dominance		
The coefficients for the 1957 and 1960 cross sections are the same.*	F(7,228) = 8.54	No
The coefficients for the 1957 and 1960 cross sections are the same except for a_p.*	F(6,228) = 0.04	Yes

*Separate constant and term to maturity were always used.

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by four factors: overall debt to true property values, default history, economic diversification, and college students as a percent of the issuer's population. Marketability can be estimated by three factors: size of the block offered, net debt of the issuer, and past population growth. The relative significance of these factors varies depending upon the dominance of the market. When commercial banks are dominant, factors such as overall debt to true value, economic diversification, and block size are the most important. When individuals are dominant, population growth, college students, and default history are the most important.

The increased significance of block size indicates the growing importance of block trading. Since the activity of institutional and large individual investors is expected to increase in the future, the results suggest that smaller cities may wish to facilitate the acquisition of larger blocks of bonds.

The results indicate that larger issuers are penalized rather than helped by their size. While this conflicts with traditional thinking and with other bond studies, the difference may be attributed to this study's use of a separate variable to measure economic diversification; other bond studies have not included such a measure. The positive relationship between net debt and yields suggests that large cities may face a crisis in borrowing costs as they seek financing in order to solve the complex problems of the inner city.

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