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CREDIT RISK, CREDIT RATINGS, AND MUNICIPAL BOND YIELDS: A PANEL STUDY

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ABSTRACT

This paper uses a panel data set of general obligation bond issues to examine the channels through which a municipality's credit quality affects its borrowing rate. The paper considers both the direct effect of changes in credit quality on changes in borrowing rates and the indirect effect that operates through changes in credit ratings. Both credit ratings and borrowing rates respond to fiscal indicators in ways that are consistent with the view that credit markets can impose some discipline on municipal fiscal behavior. The estimated effects of rating changes are large in magnitude, but statistically insignificant.

IN the past few years, debt markets have seen a heightened concern over the credit quality of municipalities. The 11-year period from 1972 to 1983 witnessed only 118 cases of municipal default (ACIR (1985)); by contrast, there were 280 such cases in 1986 and 1987 alone (Bond Investor's Association (1989)). The municipal bond market provides a natural barometer of the financial health of towns and cities, by virtue of the fact that there are several participants in the market who monitor the performance of the issuers: most notably, rating agencies and bond investors. Insofar as poor fiscal performance is translated into higher costs of borrowing (either directly or indirectly through changes in ratings), the credit market can serve to impose some discipline on the financial behavior of local governments.

This paper uses a panel data set of new issues by 136 municipalities in 1982 and 1987 to investigate how the market reacts to changes in credit quality, both directly, and indirectly through changes in credit ratings. The distinction between the direct and indirect effect of changes in credit quality is an important one, since it can affect the manner in which the "market based discipline" of interest rate changes will function. In a world where rating agencies are the primary monitors of credit risk, a municipality may undergo a substantial alteration of its fiscal position before its borrowing rate changes, by virtue of the discrete nature of the ratings. Furthermore, for many investors, secondary market price information is more costly to obtain than credit ratings; therefore, it is worthwhile to examine whether prices and credit ratings respond to the same set of underlying credit "fundamentals."

By contrast with the literature on corporate bond prices, existing empirical studies of municipal borrowing costs generally conclude that variation in the credit rating has a substantial impact on the borrowing rate. In most studies, however, it is difficult to determine whether the cost of borrowing is influenced by the rating itself or by the market's independent assessment of the issuer's credit risk. Many cross sectional studies, for example, control for cross-community differences in credit risk entirely through the inclusion of credit rating variables. Cook (1982) reviews much of this literature.

Jantscher (1970) and Ingram, Brooks, and Copeland (1983) focus on instances of rating changes, and both papers report abnormally high (low) yields for communities that have experienced downgradings (upgradings); however, neither study correlates changes in borrowing rates with changes in the underlying fiscal characteristics that may occur around the time of the rating change. Insofar as rating changes are triggered by events that are publicly observable, the yield movements that follow the rating changes could be a direct response to the events themselves. Since high frequency price quotations are difficult to obtain, rating change studies are often forced to look at price changes that occur over fairly long periods of time

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(such as one month or longer), making it difficult to attribute the entire change to the credit rating. Indeed, Jantscher finds that borrowing costs differ among communities in the same rating category in a way that is consistent with *future* changes in ratings, as one might expect in a world where the market moves independently of the ratings.

1. The Credit Ratings vs. the "Market" Rating

Studies that control for both credit ratings and fiscal characteristics of the issuer generally find that the ratings have a substantial independent effect (Benson, Marks and Raman (1986, 1988), Ingram and Copeland (1982), Liu and Thakor (1984), Rubinfeld (1973), Sorensen (1980), Wallace (1981), and Wilson and Howard (1984)). In order to maintain these conclusions, however, one must be fairly confident that the empirical model used to explain the cost of borrowing includes an exhaustive set of credit-related variables. If the estimated equation for the borrowing rate excludes any variables that affect the issuer's credit worthiness, then the estimated impact of the credit rating will likely be biased. Such omitted characteristics may have both a direct effect on the borrowing rate as well as an indirect effect via the credit rating; in general, a correlation between the credit rating of the community and the error term of the yield equation will result, and biased inferences will be drawn.

Following the notation of Liu and Thakor (1984), suppose that R_i represents a cardinal scaling of the issuer's credit rating, and that R_i can be modeled as a linear function of a set of variables (Z_i) that are observable to the rating agencies, the credit markets, and the econometrician. These will include characteristics of the municipality, the bond issue, and the bond market at the time of the sale. Suppose also that the yield to maturity on the bond (Y_i) can be modeled as a linear function of both the credit rating and the vector of variables (Z_i):

$$R_i = \lambda + Z_i'\Pi + \xi_i \quad (1)$$

$$Y_i = \alpha + \sigma R_i + Z_i'\beta + \varepsilon_i. \quad (2)$$

Equation (2) can be viewed as a linear approximation to a nonlinear relationship between the promised interest rate on the municipal bond (Y) and fiscal variables that affect the probability of default (See Capeci (1990)).

As long as the error term ε_i is uncorrelated with R_i and Z_i, ordinary least squares estimates of σ will be unbiased. To the extent that market participants and rating agencies base their credit evaluations on a broader range of information than that contained in Z, the error terms ξ_i and ε_i may be correlated via common sets of omitted characteristics. Suppose that f_i represents a vector of K omitted variables that are related to the issuer's ability to repay its debts and that the error terms ξ_i and ε_i are linear functions of f_i:

$$\xi_i = f_i'c + u_i \quad (3)$$

$$\varepsilon_i = f_i'd + e_i \quad (4)$$

where c and d are constant vectors, and u_i and e_i are uncorrelated components of the error term.

For purposes of illustration, suppose that the components of f_i are mutually uncorrelated, and that every component of f_i is uncorrelated with every component of Z_i. In this case, the covariance between the credit rating variable and the error term of the yield equation can be written as $Cov(R_i, \varepsilon_i) = \Sigma_k c_k d_k \sigma_{fk}^2$, where σ_{fk}^2 equals the variance of the k'th omitted variable. One would expect that c_k and d_k have opposite signs, since any variable that enhances the issuer's ability to repay its debts is likely to raise its credit rating and lower its borrowing rate; consequently, we would expect to see a negative correlation between the credit rating and the error term of the yield equation and a downward bias in the estimated coefficient (σ) that would tend to exaggerate the effect of the rating. In more general cases, the direction of bias is unclear.

In fact, market participants do not observe a cardinally scaled "credit quality" variable like R_i, but only observe which of several ordered categories (ratings) the credit quality falls into. In this case, the yield equation is written:

$$Y_i = \alpha + RAT_i'\Sigma + Z_i'\beta + \varepsilon_i \quad (5)$$

where Σ is a vector of coefficients and RAT_i denotes a vector of rating indicator variables, the jth element of which is given by:

$$RAT_{ij} = 1 \quad \text{if} \quad k_{j-1} \leq R_i < k_j,$$
$$0 \text{ otherwise,} \quad (6)$$

for some pair of cutoff points k_{j-1} and k_j. Here RAT_{ij} will still be correlated with ε_i, as long as ε_i is correlated with ξ_i. As a result, biased estimates of Σ are likely.

The most direct way around the omitted variable problem is to include regressors that capture the entire information set available to both the rating agencies and bond investors. Implementing such an estimation strategy, however, poses enormous data requirements. Given the large quantity of information that is available to both rating agencies and the underwriting houses that purchase new issues, it is unlikely that any econometric study will capture all of the relevant sources of variation in credit risk without exhausting degrees of freedom. Furthermore, there are some considerations relevant to credit analysis that are difficult to quantify in an econometric study. For example, the willingness of a state to intervene on behalf of a bankrupt municipality may affect the perceived security of the municipality's bonds.[1]

An alternative estimation approach concentrates on variation in borrowing rates within communities. Many of the issuer characteristics that affect its credit worthiness change little over a period of five years. For example, the identities of major employers and the mix of income sources across industries are likely to remain stable over the period of a few years. Similarly, the types of tax instruments that the state makes available to local governments will not change much over time, but may vary greatly from jurisdiction to jurisdiction (e.g. access to sales or income taxation). On the expenditure side, socioeconomic differences between communities may give rise to regional differences in the cost of providing public services that compete with debt service for local revenues (Hamilton (1983)).[2] For example, the cost of providing a minimum level of public safety may be higher in an inner city ghetto than in a suburb.

If the omitted characteristics of the issuer do not change over time, the rating and yield equations can be rewritten:

$$R_{it} = \lambda + Z_{it}'\Pi + \xi_{it}$$
$$= \lambda + Z_{it}'\Pi + f_i'c + u_{it} \quad (7)$$

$$Y_{it} = \alpha + RAT_{it}'\Sigma + Z_{it}'\beta + \varepsilon_{it}$$
$$= \alpha + RAT_{it}'\Sigma + Z_{it}'\beta + f_i'd + e_{it}. \quad (8)$$

Under the null hypothesis that the omitted variables in (8) are uncorrelated with both the credit quality variable (R) and the included characteristics (Z), all of the right-hand-side variables in (8) are uncorrelated with the error term, and ordinary least squares applied to the pooled sample will give consistent estimates. Furthermore, the random effects generalized least squares procedure suggested by Maddala (1971) will provide estimates that are both consistent and efficient relative to OLS. If the omitted fixed effect is correlated with the included regressors, then fixed effects estimates based on first differences will provide consistent coefficient estimates:

$$\Delta Y_{it} = \Delta RAT_{it}'\Sigma + \Delta Z_{it}'\beta + \Delta\varepsilon_{it}$$
$$= \Delta RAT_{it}'\Sigma + \Delta Z_{it}'\beta + \Delta e_{it}. \quad (9)$$

Since $\Delta f_i = 0$, no correlation arises between the credit rating indicator variables and the error term in the yield equation.

Section 3 estimates and compares both types of specifications. Community specific characteristics must still be included, insofar as they vary across time. The variables included in the estimation are described in the next section.

2. The Sample

The data set matches information on the results of competitively-issued general obligation bond auctions with economic and fiscal characteristics of the issuing municipalities. Information about the auctions is taken from the Bond Buyer's Post-Sale Worksheets microfiche service, which compiles data on the results of competitive bond issues. An unavoidable sample selection is introduced because the microfiche service only keeps track of issues with $1 million or more in principal.[3] Financial and economic data on the issuers are taken from the 1982 Census of Governments, 1981, 1986, and 1987 Survey of Governments, and the Census of Population and Housing for 1970 and 1980.

The selected issues represent general obligations of city, town, and county governments that issued bonds in competitive auctions during both 1982 and five fiscal years later in 1987. Borrowing costs are then matched with financial data that pertain to the most recently completed fiscal year as of the sale date.[4] The resulting sample consists of 136 municipalities from 31 states. The sampling procedure results in a bias toward large municipalities; an appendix containing a list of the included municipalities is available from the author by request.

Cost of Borrowing Across Credit Ratings

The upper panel of Table 1 shows the changes in credit ratings that occurred between 1982 and 1987 for the communities in the sample. The credit rating variable used in this study is based on the Moody's rating assigned to the issuer's general obligations, as listed in Moody's *Bond Record* during the month of the bond sale. In most cases, this rating is identical to the issue specific rating. One notable exception occurs in the 1987 subsample, where privately-insured issues are automatically assigned a Aaa rating. The rating associated with the observation is the rating on the issuer's *uninsured* general obligations; a separate indicator variable is included in the specification which indicates the presence of private insurance coverage.[5] This approach allows for yields on insured issues to vary according to the credit quality of the underlying municipality, a condition that is consistent with the common perception that issues which achieve their Aaa rating through insurance tend, as a group, to have higher yields than "natural" Aaa issues. Notice from Table 1 that there are a substantial number of both upgrades (16.2 percent of the sample) and downgrades (13.2 percent of the sample).

The lower panel of Table 1 gives summary statistics on two measures of risk premia, sorted by credit rating category. The first of these is the difference between the yield to maturity on the bond issue and the "after-tax" Treasury bond yield: (1-t)YT, where YT is taken to be the before-tax yield on a Treasury bond of similar maturity to the average maturity of the municipal issue, taken from the *Wall Street Journal* on the day of the municipal auction.[6] The tax rate used in creating the after-tax Treasury yield series is the implicit tax rate that equates Salomon Brother's Prime Grade general obligation yield index during the month of the bond sale with the after-tax value of Salomon Brother's Treasury Bond yield index during the sale month.[7,8] Since a substantial portion of the observations (59 percent) are issues that contain some callable bonds, the second risk premium variable that is shown is the spread between the yield to first call date on the bond issue and the after-tax Treasury bond rate.[9]

As one would expect, both risk premia measures tend to be larger among lower-rated bonds than among higher-rated bonds, with an average difference of about 1.5 percentage points between the Aaa and Baa categories. The right half of the lower panel looks at *changes* in risk premia sorted by *changes* in rating status. While

TABLE 1
RATING CHANGES AND COST OF BORROWING BY RATING CATEGORY

BREAKDOWN OF RATING CHANGES[1]

Rating in 1987

Rating in 1982		Aaa	Aa1	Aa	A1	A	Baa1	Baa
	Aaa	10 7.4%	0 0.0%	3 2.2%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
	Aa1	0 0.0%	5 3.7%	1 0.7%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
	Aa	0 0.0%	2 1.5%	37 27.2%	2 1.5%	0 0.0%	0 0.0%	0 0.0%
	A1	1 0.7%	0 0.0%	4 2.9%	18 13.2%	8 5.9%	0 0.0%	0 0.0%
	A	0 0.0%	0 0.0%	0 0.0%	8 5.9%	21 15.4%	2 1.5%	1 0.7%
	Baa1	0 0.0%	0 0.0%	0 0.0%	0 0.0%	3 2.2%	2 1.5%	1 0.7%
	Baa	0 0.0%	0 0.0%	1 0.7%	0 0.0%	1 0.7%	2 1.5%	3 2.2%

YIELD SPREADS BY RATING CATEGORY[2]

Variable	Rating	Mean	Std. Dev.	Variable	Rating	Mean	Std. Dev.
Yield to	Aaa	0.44%	0.66%	ΔSpread	Upgrade	-0.90%	1.25%
Maturity	Aa1	0.61	0.49		No Change	-0.56	0.76
-After	Aa	0.40	0.58		Downgrade	-0.58	1.25
Tax	A1	0.82	0.62				
Treasury	A	0.77	0.74				
Spread	Baa1	1.04	0.94				
	Baa	1.99	1.33				
Yield to	Aaa	0.61%	0.97%	ΔSpread	Upgrade	-0.77%	1.47%
First	Aa1	0.66	0.57		No Change	-0.53	0.91
Call	Aa	0.45	0.62		Downgrade	-0.56	1.25
-After	A1	0.81	0.69				
Tax	A	0.71	0.83				
Treasury	Baa1	0.89	1.35				
Spread	Baa	2.15	1.45				

[1]Each cell displays the number of observations in each category, along with the fraction of total observations contained in the category.
[2]Columns on left show yields by rating category. Columns on right show changes in yields by rating change category.

there was a general decline in the risk premia across all rating categories between 1982 and 1987, there seems to have been a larger decline among those communities that experienced rating upgrades. This finding is consistent with the view that ratings affect the yield; however, in order to disentangle the separate effects of the rating change and the changes in economic characteristics, a multivariate analysis is required.

Other Characteristics

Several variables that reflect the credit worthiness of the issuer are included directly into the yield equation. These are listed in Table 2. As in Capeci (1990), variables are selected which reflect both the municipality's ability to raise revenues, and its commitments to other creditors. To reflect a municipality's debt burden, its total per capita debt is included, along with the per capita quantity of debt issued on the day of the auction. Furthermore, to reflect the possibility that the municipality could be adversely affected by fiscal difficulties in neighboring communities, the per capita level of all outstanding municipal debt in the resident county (excluding the issuer's debt) is included. The issuer's general revenues, assessed valuation, and personal income are included to reflect its revenue generating capacity. The share of general revenues accounted for by intergovernmental grants is intended to measure reliance on outside fiscal aids. As in Benson, Marks, and Raman (1986), this variable is intended to capture the city's fiscal dependency on other levels of government. One final variable that is included is the percent of the population that is non-white, a variable which has had substantial discriminatory power in previous rating studies (See Aronson and Marsden (1980)).

A variety of issue characteristics are also included to control for the marketability of the issue, the degree of bidding competition, the maturity structure, and the presence of special tax treatment or bond covenants; these are a standard set of regressors that have been used in many previous studies (see Cook (1982), for a summary).

Finally, the after-tax Treasury bond rate is included to measure the marginal investor's opportunity cost of investing in municipal bonds. This variable, together with a year dummy will capture much of the variation in municipal yields attributable to macroeconomic changes (such as changes in Fed policy and tax reform). Summary statistics on the data set are given in Table 3.

3. Results

Ordered probit estimates of the credit rating equation (based on the rating categories shown in Table 1) are shown in the first column of Table 4. A significant positive relationship emerges between a municipality's tax revenue base (as measured by per capita income and assessed value) and its rating. The estimates also imply a negative relationship between the quantity of debt issued and the rating. Surprisingly, however, per capita debt outstanding enters insignificantly. This result might reflect an endogenous increase in the stock of outstanding debt that is encouraged by an improvement in a city's bond rating, leading to a possible positive bias in the debt coefficient. If so, this suggests that a similar bias should arise in the estimate of the debt coefficient in the equation explaining the cost of borrowing, an anomaly which is tested below.

Columns (2) through (5) of Table 4 display variants on the yield equation estimated on the pooled data set, using the yield to maturity and the yield to first call as the two dependent variables. The specifications which include the credit rating indicators find a substantial independent effect of rating changes (Columns 3 and 5). The estimates suggest that an upgrade from Baa (the lowest investment grade rating) to Aaa is associated with a reduction in the borrowing rate of approximately 1.5 percent, which equals the difference in average yields across these two groups.

The estimates also suggest that the ratings explain the vast majority of credit related variation in yields; all of the variables reflecting issuer specific fiscal conditions are insignificant.[10] Surprisingly, the issuer characteristics are insignificant, even when the ratings are dropped. This seems at odds with the previous results, which suggest that issuer charac-

TABLE 2
DEFINITIONS OF VARIABLES

Aaa,Aa1,Aa,A1,A, Baa1,Baa	Indicator variables for Moody's rating. Missing category is Baa.
Debt	Par value of total outstanding debt per capita in \$82. Equals debt at the end of the most recent fiscal year plus bonds issue in the current fiscal year prior to the auction date that are listed in the Bond Buyer Worksheets. Includes full faith and credit, non-guaranteed, and short term credit.
Debt Issued	Per capita debt issued on the day of the bond auction, in \$82.
Other County Debt	Par value of outstanding local government debt in the resident county, excluding debt of the issuer, scaled by county population, in \$82.
General Revenue	Per capita general revenue of the issuer during the most recent fiscal year, in \$82.
Aid Share	Intergovernmental aid receipts as a fraction of total general revenues, most recent fiscal year.
Assessed Value	Per capita assessed valuation in 1982, 1987.
Income	Per capita income in 1982, 1987 in \$82. Imputed from the '74, '79 and '85 per capita income, assuming constant annual growth rate.
Population	Population in 1982 and 1987, imputed from '75, '80, and '86 population, assuming constant annual growth rate.
% Non-white	% of population classified as non-white in the 1970 and 1980 census.
Issue Size	Total principal in \$82.
Bids	Number of bidding syndicates in the auction.
Average Maturity	Average maturity of issue, each maturity weighted by principal.
Insured	Dummy variable indicating private insurance.
Callable	Call provision dummy variable.
Sinking Fund	Dummy indicating mandatory redemption requirements.
AMT	Dummy variable indicating that interest payments are counted as a preference item for purposes of calculating Alternative Minimum Tax liability.
Bank Qualified	Dummy variable indicating that the issue qualifies for the 80% deduction by banks on the interest expense incurred in holding the bond.
T-Bond Yield	After tax treasury bond yield of equivalent maturity to municipal issue (see text)
<u>Instruments</u>:	
ΔLagged Debt	Based on census 5 years prior to sale year.
Δ% Owner Occupied	Change in % of occupied households owner occupied, 1970-1980.
ΔMedian Age	Change in Median Age, 1970-1980.
Δ% 65 or Older	Change in % of population over 65, 1970-1980.
Δ% 5 or Younger	Change in % of population under 5, 1970-1980.
Δ% 18 or Younger	Change in % of population under 18, 1970-1980.

TABLE 3
MEANS OF VARIABLES
(STANDARD DEVIATIONS IN PARENTHESES)

Variable	1982	1987	Pooled	Change
Yield to Maturity	9.78%	6.60%	8.19%	-3.18%
	(1.39)	(0.98)	(1.99)	(1.62)
Yield to First Call	9.77%	6.64%	8.21%	-3.13%
	(1.52)	(1.09)	(2.05)	(1.78)
Aaa	0.10	0.08	0.09	-0.01
	(0.30)	(0.27)	(0.28)	(0.17)
Aa1	0.04	0.05	0.05	0.007
	(0.21)	(0.22)	(0.21)	(0.149)
Aa	0.30	0.34	0.32	0.04
	(0.46)	(0.47)	(0.47)	(0.31)
A1	0.23	0.21	0.22	-0.02
	(0.42)	(0.41)	(0.43)	(0.41)
A	0.24	0.24	0.24	0.007
	(0.43)	(0.43)	(0.43)	(0.413)
Baa1	0.04	0.04	0.04	-0.01
	(0.21)	(0.21)	(0.21)	(0.21)
Debt Outstanding ($000/capita)	0.81	1.20	1.01	0.39
	(0.70)	(1.50)	(1.18)	(1.13)
Debt Issued ($000/capita)	0.10	0.11	0.11	0.01
	(0.11)	(0.14)	(0.12)	(0.10)
Other County Debt ($000/capita)	0.96	1.42	1.19	0.47
	(0.80)	(1.71)	(1.35)	(1.08)
General Revenue ($000/capita)	0.59	0.68	0.63	0.09
	(0.31)	(0.33)	(0.32)	(0.24)
Aid Share	0.32	0.25	0.29	- 0.066
	(0.14)	(0.14)	(0.14)	(0.095)
Assessed Value ($000/capita)	11.63	15.68	13.65	4.05
	(12.31)	(16.34)	(14.58)	(9.68)
Income ($000/capita)	10.93	11.12	11.02	0.20
	(2.74)	(2.96)	(2.85)	(1.25)
Population (millions)	0.21	0.22	0.21	0.010
	(0.37)	(0.39)	(0.38)	(0.033)
% Non-white	7.84%	11.70%	9.77%	3.86%[1]
	(12.12)	(14.65)	(13.56)	(3.92)
Issue Size ($000)	7420	8450	7935	1029
	(9978)	(11848)	(10945)	(8850)
Bids	4.32	6.30	5.31	1.98
	(1.87)	(2.52)	(2.43)	(2.52)

TABLE 3 (continued)

Variable	1982	1987	Pooled	Change
log(Bids)	1.37 (0.45)	1.76 (0.43)	1.56 (0.48)	0.39 (0.45)
Average Maturity (years)	7.90 (2.67)	8.31 (3.05)	8.10 (2.87)	0.41 (3.05)
Log(Avg. Maturity)	2.00 (0.38)	2.05 (0.37)	2.03 (0.38)	0.05 (0.40)
Insured	0.09 (0.28)	0.12 (0.32)	0.10 (0.30)	0.03 (0.36)
Callable	0.53 (0.50)	0.65 (0.48)	0.59 (0.49)	0.12 (0.46)
Sinking Fund	0.00 (0.00)	0.01 (0.12)	0.01 (0.10)	0.01 (0.12)
AMT	0.00 (0.00)	0.01 (0.01)	0.005 (0.061)	0.01 (0.09)
Bank Qualified	0.00 (0.00)	0.40 (0.49)	0.20 (0.40)	0.40 (0.49)
T-Bond Yield	8.78 (1.27)	6.22 (0.80)	7.50 (1.66)	-2.56 (1.52)
Instruments:				
Debt Outstanding (previous census)	0.75 (0.46)	1.00 (1.03)	0.83 (0.81)	0.35 (0.87)
% Owner Occupied	64.22% (14.40)	62.86% (13.96)	63.54% (14.17)	-1.36%[1] (4.88)
Median Age	27.78 (4.43)	30.04 (3.54)	28.91 (4.16)	2.26[1] (2.38)
% 65 or Older	9.52% (3.97)	10.98% (4.16)	10.25% (4.13)	1.47%[1] (1.80)
% 5 or Younger	8.66% (2.27)	6.88% (1.62)	7.77% (2.16)	-1.78%[1] (2.02)
% 18 or younger	34.20% (5.59)	26.92% (4.53)	30.56% (6.25)	-7.28%[1] (3.10)

NOTES:
[1]The changes in these variables are the changes between the 2 most recent census of population years, 1970 and 1980.

teristics affect the ratings and that the ratings affect the yield.

The first column of Table 5 shows the generalized least squares (random effects) estimates of equation (8), which account for the non-scalar nature of the variance covariance matrix for the error term ε_{it}. The rating coefficient is hardly changed, and the independent effects of the issuer's fiscal environment are still negligible.

TABLE 4
CREDIT RATING AND YIELD EQUATIONS FROM THE POOLED DATA SET

Dependent Variable:	Moody's Rating	Yield to Mat.	Yield to Mat.	Yield to Call	Yield to Call
Estimation Method:	Ordered Probit	OLS	OLS	OLS	OLS
Variable					
Constant	0.66	1.87*	2.15*	1.28*	1.73*
	(0.56)	(0.48)	(0.47)	(0.55)	(0.55)
Aaa	-	-	-1.54*	-	-1.49*
			(0.27)		(1.32)
Aa1	-	-	-1.31*	-	-1.50*
			(0.29)		(0.34)
Aa	-	-	-1.54*	-	-1.58*
			(0.23)		(0.27)
A1	-	-	-1.12*	-	-1.24*
			(0.22)		(0.26)
A	-	-	-1.14*	-	-1.32*
			(0.21)		(0.25)
Baa1	-	-	-0.80*	-	-1.06*
			(0.26)		(0.31)
Debt ($000)	0.052	0.018	0.028	0.012	0.021
	(0.070)	(0.045)	(0.042)	(0.052)	(0.050)
Debt Issued ($000)	-4.22*	0.66	0.22	0.48	0.13
	(0.66)	(0.43)	(0.41)	(0.50)	(0.49)
Other County Debt($000)	0.024	-0.019	-0.030	-0.021	-0.031
	(0.053)	(0.032)	(0.031)	(0.038)	(0.036)
General Revenue($000)	-0.12	-0.15	-0.11	-0.14	-0.11
	(0.23)	(0.15)	(0.14)	(0.18)	(0.17)
Aid Share	-0.015	0.29	0.53**	0.23	0.41
	(0.543)	(0.34)	(0.32)	(0.40)	(0.38)
Assessed Value($000)	0.022*	-0.0014	0.0010	-0.0002	0.0017
	(0.005)	(0.0035)	(0.0033)	(0.0040)	(0.0039)
Income ($000)	0.098*	-0.0058	0.014	-0.013	0.0063
	(0.026)	(0.0164)	(0.016)	(0.019)	(0.0189)
Population (millions)	0.73*	-0.10	0.049	-0.13	-0.018
	(0.21)	(0.15)	(0.150)	(0.18)	(0.178)
% Non-white	0.0030	0.0012	0.0012	0.0019	-0.00008
	(0.0056)	(0.0034)	(0.0034)	(0.0042)	(0.00407)
Issue Size ($millions)	-	1.9	3.3	4.8	5.9
		(5.2)	(4.9)	(6.0)	(5.8)
log(Bids)	-	-0.30*	-0.057	-0.31*	-0.097
		(0.14)	(0.103)	(0.12)	(0.122)

TABLE 4 (continued)

	Moody's Rating	Yield to Mat.	Yield to Mat.	Yield to Call	Yield to Call
log(Average Maturity)	0.16 (0.20)	0.35* (0.14)	0.40* (0.13)	0.61* (0.16)	0.66* (0.15)
Insured	-	0.41* (0.14)	0.0036 (0.1491)	0.44* (0.17)	0.061 (0.176)
Callable	-0.0005 (0.1525)	0.033 (0.097)	-0.036 (0.092)	-0.054 (0.113)	-0.12 (0.11)
Sinking Fund	1.33 (0.84)	-0.22 (0.48)	-0.31 (0.46)	1.43* (0.56)	1.35* (0.54)
AMT	-	0.65 (0.67)	0.81 (0.62)	0.53 (0.78)	0.68 (0.75)
Bank Qualified	-	-0.23** (0.13)	-0.28* (0.12)	-0.22 (0.15)	-0.27** (0.14)
T-Bond Yield	-	0.86* (0.04)	0.89* (0.04)	0.89* (0.05)	0.92* (0.05)
Year = 1987	-0.094 (0.138)	-0.77* (0.16)	-0.72* (0.16)	-0.70* (0.19)	-0.62* (0.18)
Sample Size:	272	272	272	272	272
R^2	-	0.90	0.92	0.87	0.89
log likelihood	-401.20				

*Significant at 5% level **Significant at 10% level
(Standard Errors in Parentheses)

Allowing for Issuer Specific Fixed Effects

The second column of Table 5 presents the fixed effects version of the model, which is estimated in first differences (equation 9). Notice that the rating coefficients are generally smaller in magnitude in the fixed effects model than in the random effects model. The estimated yield decline from a Baa to Aaa upgrade is 33 basis points smaller in the fixed effects model than in the random effects model (−1.15 vs. −1.48). Furthermore, the ratings are jointly insignificant in the fixed effects case, although the large standard errors leave open a wide range of plausible interest rate responses. The random effects and fixed effects estimates also differ considerably with regard to direct impact of variations in the issuer's economic and fiscal condition on the cost of borrowing. In the fixed effects estimates, for example, the interest savings associated with maintaining high assessed valuation stands out noticeably. A one standard deviation increase in the per capita assessed valuation (an increase of $13.65) is associated with a 34 basis point reduction in the cost of borrowing, holding the credit rating fixed.

Under the null hypothesis that there are no missing fixed effects which are correlated with independent variables of the yield equation, both the random effects model and the fixed effects model will provide consistent estimates of the yield equation parameters. Furthermore, since the random effects estimates are efficient under the null, the two sets of estimates

TABLE 5
YIELD EQUATIONS: RANDOM EFFECTS & FIXED EFFECTS ESTIMATES

Dependent Variable:	Yield to Call	Yield to Call	Yield to Call	Yield to Call
Estimation Method:	GLS Random Effects	OLS Fixed Effects	OLS Fixed Effects	2SLS Fixed Effects
Variable				
Constant	1.42*	-0.55*	-0.62*	-0.53*
	(0.46)	(0.26)	(0.25)	(0.27)
Aaa	-1.48*	-1.15	-	-1.18
	(0.33)	(0.73)		(0.79)
Aa1	-1.44*	-1.10	-	-1.20
	(0.36)	(0.80)		(0.88)
Aa	-1.54*	-1.07**	-	-1.18*
	(0.28)	(0.57)		(0.60)
A1	-1.18*	-0.74	-	-0.70
	(0.27)	(0.50)		(0.54)
A	-1.28*	-0.80**	-	-0.88**
	(0.26)	(0.46)		(0.49)
Baa1	-1.06*	-0.70	-	-0.87
	(0.31)	(0.47)		(0.55)
Debt ($000)	0.013	-0.018	0.0055	-0.12
	(0.052)	(0.093)	(0.0814)	(0.24)
Debt Issued ($000)	0.18	0.072	0.25	-2.74
	(0.51)	(0.937)	(0.82)	(2.93)
Other County Debt($000)	-0.016	0.12	0.13**	0.11
	(0.039)	(0.08)	(0.07)	(0.09)
General Revenue($000)	-0.14	-0.61	-0.62	-0.32
	(0.18)	(0.42)	(0.41)	(0.71)
Aid Share	0.46	0.18	-0.07	0.23
	(0.40)	(0.92)	(0.07)	(1.07)
Assessed Value($000)	0.0004	-0.025*	-0.031*	-0.018
	(0.0041)	(0.010)	(0.010)	(0.014)
Income ($000)	0.0041	-0.00011	-0.00013**	-0.13
	(0.0206)	(0.00007)	(0.00007)	(0.09)
Population (millions)	0.013	3.9	4.0	3.4
	(0.193)	(2.9)	(2.7)	(3.4)
% Non-white	0.00012	0.0095	0.0067	0.0098
	(0.00445)	(0.0239)	(0.0232)	(0.0255)
Issue Size ($millions)	4.6	-0.45	-0.085	5.4
	(6.0)	(10.63)	(10.369)	(35.9)
log(Bids)	-0.15	-0.41**	-0.34**	-0.55*
	(0.13)	(0.21)	(0.20)	(0.28)

TABLE 5 (continued)

Estimation Method:	GLS Random Effects	OLS Fixed Effects	OLS Fixed Effects	2SLS Fixed Effects
log(Average Maturity)	0.67*	0.84*	0.94*	0.89*
	(0.16)	(0.27)	(0.25)	(0.28)
Insured	0.017	-0.47**	-0.53*	-0.27
	(0.176)	(0.28)	(0.26)	(0.37)
Callable	-0.10	-0.12	-0.11	-0.0073
	(0.11)	(0.21)	(0.20)	(0.2533)
Sinking Fund	1.41*	1.33**	1.30**	1.35**
	(0.53)	(0.69)	(0.69)	(0.73)
AMT	0.82	1.28	0.94*	1.31
	(0.73)	(0.98)	(0.25)	(1.10)
Bank Qualified	-0.27**	-0.17	-0.16	-0.13
	(0.14)	(0.20)	(0.19)	(0.21)
T-Bond Yield	0.92*	0.90*	0.89*	0.89*
	(0.05)	(0.06)	(0.06)	(0.07)
Year = 1987	-0.60*	-	-	-
	(0.18)			
Sample Size:	272	136	136	136
R^2	0.90	0.77	0.76	0.87
F-Test (Ratings)	5.42	0.75	-	0.84
(p-value)	(0.00003)	(0.61)		(0.54)
degrees of freedom	6,246	6,111		6,111

Chi Square Specification Tests	Statistic	df.	(p-value)
Random Effects vs Fixed Effects[1]			
Rating Indicators:	1.89	6	(0.93)
All Issuer Characteristics:	19.02	9	(0.025)
Debt Variables: Endogenous vs Exogenous[2]			
Debt Per Capita:	0.11	1	(0.74)
Debt Issued Per Capita:	0.86	1	(0.35)
Issue Size:	0.12	1	(0.73)

*Significant at 5% level **Significant at 10% level
(Standard Errors in Parentheses)
[1]Hausman-Wu test statistic of the hypothesis that random effects coefficients equal fixed effects coefficients, for the variables shown.
[2]Hausman-Wu test statistic comparing the fixed effects estimator that treats the variable listed as endogenous and the fixed effects estimator that treats it as exogenous.

can be compared as part of a specification test (Hausman (1978)). These tests are performed first for both the credit rating indicator variables and for the entire set of issuer specific characteristics[11] (bottom of Table 5). The statistics indicate that there is a significant difference between the two sets of coefficients on the nine municipal characteristic variables; one explanation for this finding is that the error term contains an issuer specific component that is correlated with the included credit-related variables.

The third column of Table 5 shows estimates of the reduced form yield equation which include fixed effects but exclude the rating indicators. When the ratings are excluded, we find that the interest rate responds to changes in assessed value, per capita income, and debt outstanding by other local governments within the county. The increased significance (higher t statistics), in part, reflects the indirect effect which each of these variables exerts on the credit rating; however, part of the increased significance is attributable to the reduction in multicollinearity that is brought about with the exclusion of the rating indicators.

Endogeneity of Municipal Debt

Another potential source of bias in the estimation of the yield equations arises because the level of municipal borrowing may be affected by exogenous changes in the borrowing rate; just as the borrowing rate may rise with the level of debt, the level of debt may fall with increases in the borrowing rate.

To account for this possibility, the fixed effects model is re-estimated using two stage least squares; per capita debt outstanding, per capita debt issued, and the unscaled issue size are treated as endogenous variables. The selection of instruments is motivated by Gordon and Slemrod's (1985) finding that municipal residents' taste for debt finance vs. tax finance is affected by their federal tax status; namely communities in which low marginal tax rate individuals reside will have a greater preference for debt finance than communities in which high tax rate individuals reside. This preference reflects the depressing effect that high income tax rates have on the opportunity cost of private borrowing relative to the cost of public borrowing. Town specific federal tax rates are difficult to obtain; however, the census of housing contains information on the percent of occupied households that are owner-occupied. This will presumably serve as a good indicator for whether or not residents itemize their deductions; consequently, it will serve as a good indicator for the residents' after tax cost of private borrowing.

Variables reflecting the change in the age distribution of the community are used as additional instruments, since elderly individuals may prefer debt finance to tax finance if future tax liabilities are not perfectly capitalized into current property values. Finally, the lagged value of debt per capita (taken from the previous census of governments) is used as an instrument for the level of per capita debt in the most recent census of governments.

The two stage results are shown in the fourth column of Table 5. The coefficient on the issue size variable rises substantially; however, the specification tests fail to find significant differences in the coefficient estimates when the debt variables are treated endogenously as opposed to exogenously. Furthermore, the estimated effects of rating changes are barely affected.

4. Conclusion

This paper investigates the channels through which changes in the credit worthiness of municipal governments affect the general obligation cost of borrowing. The paper finds that both the credit rating and the cost of borrowing are sensitive to changes in the fiscal condition of the issuer; furthermore, the borrowing rate responds in ways that are consistent with the hypothesis that credit markets can serve to impose fiscal discipline on local governments.

A municipality's credit rating is positively related to the size of its tax base (as measured by assessed valuation and personal income) and negatively related to its debt burden (as measured by the quantity of debt issued). These findings confirm both intuition and existing empirical studies of municipal ratings (e.g. Rubinfeld (1973)).

The effects of rating changes on the cost of borrowing are less clear. The estimated magnitudes of the effects are substantial, though smaller than the magnitudes found in the random effects specification; for example, an upgrade from Baa to Aaa is associated with a decline of 115 basis points, or roughly 75 percent of the response found in the random effects estimates. However, because these responses have large standard errors, conclusions about the effect of rating changes on yields should be interpreted with caution.

Finally, borrowing rates do seem to respond directly to certain changes in the issuer's fiscal situation; holding credit ratings fixed, the cost of borrowing declines with increases in the issuer's property tax base. Surprisingly, however, the study finds no direct correlation between the cost of borrowing and many other indicators of fiscal stress. The reduced form estimates suggest that this is due in part to multicollinearity between the credit ratings and the issuer characteristics.

A variety of issues about the determinants of risk premia still remain open. This study focuses on general obligation bonds rather than revenue bonds, because GO's provide a barometer on the issuer's *overall* fiscal condition, rather than just the condition of a single project within its budget. While competitive auction is still the dominant form of sale for general obligations,[12] it is not clear that the results found here will generalize to negotiated bonds. In some cases, a municipality may sell a bond through negotiation rather than auction, because the bond contains complex credit risks that hamper a potential bidder's ability to make accurate bids. On such bonds, the credit rating may be relied on more heavily than it is on a competitive issue.

Another shortcoming of the study lies in the limited range of rating changes that it analyzes. All of the bonds in the sample have investment grade ratings. However, the market's reaction to a change in rating from investment grade to speculative grade (or vice versa) may well exceed its reaction to a change from one investment grade rating to another, since many institutional investors are required to hold only investment grade bonds.

ENDNOTES

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[1]New York State's creation of the M.A.C. is considered to be an important ingredient to the resolution of New York City's fiscal crisis in the 1970s (Shalala and Bellamy (1976)).

[2]General obligation debt service payments have a prior claim over many other competing uses of revenues; however, in the event of a default, courts will typically reserve a portion of the existing pool of revenues to maintain a level of current expenditures that is considered to be necessary for the continued provision of basic public services (*Duke Law Journal* (1976)). The costs of maintaining a given minimum level of service will vary from municipality to municipality.

[3]Insofar as the error term of the yield equation is correlated with the issue size, the microfiche's sampling procedure may introduce bias. This correlation is tested for in section 3.

[4]For example, suppose that a municipality has a June 30 end of fiscal year and issues bonds on 5/10/82 and 3/1/87. The municipality is included in the sample if it is also included in both the 1981 and 1986 Survey of Governments (which cover the fiscal years 7/1/80–6/30/81 and 7/1/85–6/30/86 respectively). This municipality would not be included, however, if the sale dates for its bonds were 5/10/82 and 7/31/87, since the issues are six fiscal years apart rather than five.

[5]The sample of 136 municipalities excludes one municipality that was dropped from the sample because it was unrated by Moody's. In addition, 11 issues in the sample had no rating listed on the Bond Buyer Post Sale Summary, but did have a rating listed in the Moody's *Bond Record*. These are cases where the rating review for the issue had not been completed by the time the Bond Buyer completed its post sale summary sheet for the auction. The rating assigned in these cases is the rating which corresponds to the most recently available general obligation rating.

[6]Callable Treasury bonds and "flower bonds" (which are redeemable at par for purposes of paying estate taxes) are excluded from the set of candidate Treasury bonds examined here.

[7]The yields that are chosen in constructing the implicit tax rate are based on a maturity equal to the average maturity of the municipal issue. The yields at non-reported maturities are calculated by linear interpolation of the yields at reported maturities.

[8]The after-tax Treasury rate is chosen over the prime grade G.O. index as the basis for comparison because the prime grade G.O. index is quoted on a monthly basis, whereas the Treasury rate is taken from the day of the auction.

[9]The yield to first call assumes that all callable bonds in the issue are redeemed at the prespecified redemption premium on the earliest call date. A third yield

measure (not shown) was also constructed which attempts to estimate the value of the implicit call option (using the Binomial based bond option pricing model of Rendleman and Bartter (1980)) and calculate the "non-callable equivalent yield" which nets out the value of the call option when calculating the yield to maturity. The results using this yield measure are similar to the results shown.

[10]The only notable difference between the specifications that use yield to first call rather than yield to maturity is the finding of a significant *positive* effect on yields from the presence of a sinking fund. This reflects the peculiar nature of one of the two issues in the sample that contains a sinking fund. The bond issue in question consists of several non-callable bonds which have extremely high coupon rates and small par values. In addition, the bond issue contains one callable bond which offers a very low coupon rate, but accounts for the majority of the bond issue's par value. As a result, the yield to first call measure (which assumes that the bond will be redeemed at the first possible date) is based on a payment stream that consists almost entirely of payments on the non-callable high coupon bonds. Unfortunately, detailed information on the mandatory payment schedule in the sinking fund is not provided in the data set.

[11]The nine variables tested are debt, debt issued, county debt, general revenue, aid share, assessed valuation, population, income, and percent non-white.

[12]Between 1982 and 1991, competitive issues accounted for 50 percent of the volume and 70 percent of the number of general obligation issues. (Information provided courtesy of Securities Data Corporation.)

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