International Review of Business Research Papers
Vol. 2 No. 4, December 2006, Pp. 1-9

Population Variables As Determinants Of Municipal Bond Ratings

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Municipal bonds constitute a large portion of the total number of securities offered every year in the United States. A number of factors have been suggested in the literature to affect the ratings assigned to a locality's bonds by the rating agencies. Using an ordinal probit model, this paper investigates the impacts of population variables on municipal bond ratings. The ordinal probit model correctly classifies 60 percent of the actual sample. Results indicate that high population has a favorable impact on bond ratings. This is significant, especially for small localities, which may find it difficult to access the municipal bond market. The evidence suggests that there should be inter-jurisdictional cooperation between smaller localities, in order to enhance their ratings in the municipal bond market.

Field of Research: Municipal Bonds, Local Government Finance, Bond Ratings, Municipal Securities

1. Introduction

Local governments across the United States depend to a great extent on long-term borrowing and debt to finance capital projects within their jurisdictions. Such debts, known as municipal bonds, constitute a large proportion of the total number of securities offered every year. The volume outstanding is more than that of all federal agency debt (Stanhouse and Stock, 2001). The municipal securities market provides an efficient mechanism for financing local government capital projects. The market enables municipalities to issue bonds that are relatively cheaper than bank and other loans. The purchase of a municipal bond entails a risk, and the buyer expects to be compensated accordingly (Badu et al., 2002).

The major credit agencies –Moody's Investors Service (now known as Mergent), and Standard and Poor's Corporation review a variety of factors and characteristics within a municipality when grading its debt issues. These factors are within the categories of: debt, economic, financial, and administrative (Johnson and Kriz, 2005; Harris and Piwowar, 2006). The ratings are intended as a measure of the default risk of a particular bond. Consequently, bonds with lower ratings are considered riskier and investors therefore require higher premiums, and vice versa.

The law of each state provides for the creation of counties, cities, and sometimes townships. These are units of general local government; they have the power to tax, to carry on certain activities, and frequently, the power to enact local ordinances. They have independent legal personality. The state law also determines whether the localities have the power to borrow money, and usually sets the procedures, limits, and remedies associated with the borrowing process. Municipal debt may not exceed a fixed percentage of the valuation of all privately owned property within the municipality (Hackworth, 2002; Kloha et al., 2005). These limits were established to control excess borrowing by municipalities. General obligation debt is secured by the "full faith and credit" of the local unit. This means that it enters into a binding promise to levy taxes (usually taxes on immovable property within its limits) necessary to pay the principal and interest payments due. Such taxation is usually separate from the general current purposes of taxation of the district and is kept in a separate fund. It thus provides good security for the underlying obligations.

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This study examines the impacts of a locality's population on its bond ratings using the Commonwealth of Virginia as a case study. The local government structure in Virginia consists of 136 self-governing municipalities. Each incorporated city in Virginia is independent of its surrounding county. As a result, a city's tax base does not extend to the county although some city services are demanded and are accessible to county residents. The Commonwealth statues also establish uniform rules governing the sale of debt instruments, financial disclosure guidelines, financial accounting and reporting requirements and limitations on taxation and spending. The municipalities cannot legally exceed 10 percent of assessed valuation of property within their jurisdictions when issuing debt instruments. Voter approval is required before counties can issue debt instruments.

2. Review of Literature

There is great interest among researchers and practitioners alike, on the factors considered by the rating agencies during the bond rating process. Given the great impact of ratings on the bond market, there have been concerted efforts to model the factors that determine municipal bond ratings. Since the late 1960's there have been a number of studies conducted to determine the key factors that affect municipal bond ratings. One of the first studies on the determinants of municipal bond ratings, was conducted by Carleton and Lerner (1969). In the study, they used multiple discriminant analysis to predict Moody's municpal bond ratings for states and local governments. Carleton and Lerner's attempt was later improved upon by Horton (1970), who examined an equal number of investment quality (above Ba) and non-investment quality bonds, based on some of the variables used by Moody's. Horton's model appears to predict non-investment quality bonds more accurately than investment quality bonds. Loviscek & Crowley (1990) employed Akaike's information criterion and Lachenbruch's U method to show that a probit model specified with economic base diversification, economic expansion, and fiscal management variables may be an improvement over the application of discriminant analysis to financial accounting variables in the determination of Aaa bond ratings. Their findings support earlier studies by Michel (1977), and Cole & Millar (1982), which suggest that economic variables deserve more attention.

Perhaps one of the few studies that examined the statistical methods used by previous studies to analyze municipal bond ratings was conducted by Loviscek & Crowley (1990). Results of their study showed that the probit model may be superior to the use of discriminant analysis based on debt and revenue variables.

Using data from 1973-1995, Lowry (2001) examined the effects of fiscal institutions, such as, debt limitations, balanced budget rules, and tax and expenditure limitations on state government bond ratings. Their results suggest that laws which restrict state governments' ability to carry forward a deficit tend to lead to higher credit ratings and lower interest costs. Johnson and Kriz (2005) conducted a follow-up study on the impacts of fiscal institutions on state's credit ratings and interest costs. Their results confirm earlier study by Lowry (2001), that revenue limits are associated with higher bond ratings. Additionally, they found that expenditure limits, such as, stricter balanced budget rules, and restrictions on state debt issuance are associated with higher credit ratings and lower interest costs.

There have been concerns among market participants about the effect of corruption of public officials on municipal bond ratings and consequently on municipal borrowing costs. Depken and Lafountain (2006) empirically investigated the effect of public corruption in the United States on state bond ratings, which previous research shows are inversely related to net

interest costs on public debt. In the study, they used federal conviction records of federal, state, and local public officials for public corruption as reported by the Public Integrity Section of the Department of Justice. After controlling for various economic influences on bond ratings, their results suggest that more corrupt states have lower bond ratings, which implies that taxpayers in more corrupt states face a negative pecuniary externality by paying a premium for debt.

Hackworth (2002) conducted a study on the impacts of bond rating agencies on local autonomy and concluded that rating agencies influence the autonomy of municipalities more now than the past three decades. Nanda & Singh (2004), and Robbins & Daehwan (2003) both examined the impacts of credit enhancement programs on borrowing costs and concluded that credit enhancement programs have a positive effect on reducing municipal borrowing costs. Using new econometric model, Harris and Piwowar (2006) investigated the average transaction costs of over 167,000 bonds from a one-year sample of all U.S. municipal bond trades. Their results suggest that municipal bond transaction costs decrease with trade size and do not depend significantly on trade frequency. Additionally, they found that municipal bond trades are substantially more expensive than similar-sized equity trades. They attribute these results to, among other things, the lack of bond market price transparency.

With all these observations, it seems clear that bond ratings play a vital role in a locality's financial well-being. An analysis of credit rating changes over time provides a useful framework for analyzing the relationship between government financial management decisions and actions of rating agencies. A viable option for municipalities expecting a rating below Aa is to consider some kind of credit enhancement, such as bond insurance or stand-by letter of credit (Reid, 1990; Nanda & Singh, 2004; Robbins and Daehwan, 2003; Denison, 2003).

3. Methodology

This study identifies the factors used by rating agencies in grading municipal debt in Virginia, and evaluates the relative significance of population as a demographic variable in the bond rating process, buy using 2002 cross-sectional data. An ordinal probit model is used due to the categorical nature of the dependent variable. Ordinal probit analysis is appropriate for analyzing ordinal dependent variables such as municipal bond ratings. The bond ratings as a dependent variable fit this property well. The ordinal probit model assumes a linear effect of each of the independent variables. Following the ordinal probit technique of McKelvey and Zavoina (1975) it is assumed that the observed dependent variable, *Z*, is an approximation of the true credit rating, *Y*, which is also ordinal in its level. Assuming a sample of *n* observations on the true dependent variable, *Y*, and *K* independent variables, the following model is derived:

$$Y_i = \sum \beta_i X_i + \in_i \qquad (1)$$

The variable X_i represents the set of explanatory variables, and $\in_i$ is the white-noise residual which is multivariate normal with a zero mean and variance covariance matrix, $\sigma^2 I$. The observed dependent variable, *Z*, comes from the *m* possible ratings represented by $R_{i,\ldots\ldots,} R_m$, which proxies the true credit rating. The ordinal probit technique assumes that there are m+ *1* threshold real numbers, $\alpha_0, \alpha_1, \ldots, \alpha_m$, with α_0 equal to $-\infty$ and + α_m equal to $+\infty$. In addition the threshold real numbers meet the following conditions:

$$\alpha_0 \leq \alpha_1 \leq \ldots \leq \alpha_m, \text{ such that} \qquad (2)$$

$$Z_j \in R_i \Leftrightarrow \alpha_{i-1} < Y_j \leq \alpha_i \text{ for } 1 \leq j \leq m \qquad (3)$$

A series of dummy variables can be constructed, given the observed dependent variable *Z* as follows:

$Z_{jk} = 1$ if Y_j falls in the *jth* category, (4)
$Z_{jk} = 0$ otherwise, for $1 \leq K \leq n$, $1 \leq j \leq m$.

Thus, the probability function of Z can be written as follows:
$Pr[Z_{jk} = 1] = Pr[Z_j \in R_k] = \phi [(\alpha_k - \sum \beta_i X_{ij}) / \sigma] - \phi [\alpha_{k-1} - \sum \beta_i X_{ij})] / \sigma$, (5)
where $\phi(t)$ represents the cumulative standard normal density function.

The independent variables used in the analysis were selected to represent the four general categories used by Moody's/Mergent: (1) debt factors (2) financial factors (3) administrative factors and (4) economic base factors. In addition the data set includes some of the variables used in earlier studies, as well as new ones that are unique to the Commonwealth of Virginia. Table 1 lists the entire data set, where Z_i is the municipality's bond rating, and a value of 1, 2, 3, 4, and 5 represents a rating of Aaa, Aa, A, Baa, and No Rating, respectively.

The hypothesis to be tested in the model is:
$H_0 \quad \beta_i = 0$ (6)

That is, we seek the effects of population factors on a municipality's bond rating.

4. EMPIRICAL RESULTS

The study presents an ordinal probit model of all municipalities in the Commonwealth of Virginia. The inclusion of all the municipalities avoids the problem of sample selection bias as discussed in Moon and Stotsky (1993). The population variables of interest are the population classification (PCLASS), and the percentage change in population within a five year period (POPCHG).

Table 1 provides the list of all variables used in the study with their definitions. The distribution of the ratings categories, the mean, and standard deviation of each variable are presented in Tables 2, and 3 respectively. Table 4 presents the best ordinal probit model according to the percentage of the actual sample correctly predicted. The variables that produce the best ordinal probit results consist of revenue per capita (PCAPITA), unemployment rate (UMPRATE), population classification (PCLASS), ratio of long-term debt to total debt (RLTDEBT), and the city/county differentiation variable (CTY). The model correctly predicted 59.55 percent of the actual sample. The goodness-of-fit measure, pseudo-R^2 is 55.44 percent. This suggests that about 60 percent of the variation in bond ratings is explained by variables in the model. All the variables in the model exceed the 5 percent significant level and have the expected signs. Additionally, the ordered probit model produces significant threshold values as shown by α_1 through α_4 respectively.

PCAPITA denotes the revenue per capita and has a negative coefficient. PCAPITA represents the wealth that is generated in a locality. This could be as a result of the locality's economic activity and may include federal and state aids. Higher revenue per capita increases the probability of a favorable rating. In the absence of state and federal revenues, PCAPITA is a clear indicator of the ability to honor debt obligations and may also be an indicator of the level of economic development in a locality.

UMPRATE denotes a localities unemployment rate and has a positive coefficient as expected indicating a negative impact on bond ratings. A high rate of unemployment is a signal of a locality's inability to generate the revenue needed to make timely debt payments. High unemployment rate has a negative effect on bond ratings for two reasons: First, it erodes a city's tax base and thus limits revenues collected from taxes. Second, it has the propensity to reduce a locality's resources since the locality has to assist the unemployed by providing basic

services in the areas of health, food and shelter. These factors tend to limit a city's ability to make debt payments.

The population classification of localities is denoted by PCLASS and has a negative coefficient indicating a favorable rating. Municipalities with larger population have a higher probability of a favorable rating. This is true as long as residents in localities with high population are engaged in economic activities that contribute to the economic base of the community through taxes or other forms of gainful employment. This lends support to earlier studies on the impacts of population size on bond ratings (see Rivers & Yates, 1997; Simonsen, Robbins, & Helgerson, 2001). This means that a good percentage of the population should have the skills needed for employment in order to contribute to the locality's economic base. New residents to a locality buy new homes, pay taxes, and are involved in other economic activities that increase the locality's revenue base. In this case, higher revenues from a change in population reflects the ability to pay, which increases the likelihood that a locality will be in a higher rating category (Badu et al, 2002). This is also true as long as the change in population does not include a high number of new residents who depend on the resources of the city (such as welfare payments) for their support. These conclusions support previous studies by Rivers and Yates (1997), Wilson and Howard (1984). The issue of population size is especially important for the Commonwealth of Virginia because of the large sample of small, independent cities and counties. For example, municipalities with a population of less than 25,000 represent about 67 percent of the 136 cities and counties in the state (Badu et al, 2002).

RLTDEBT is the ratio of long-term debt to total debt and has a positive coefficient, indicating an unfavorable impact on ratings. This suggests that a high ratio of long-term to total debt is a signal that the locality may be under undue debt burden and may have difficulty making timely future principal and interest payments on debt obligations (Kloha et al, 2005). High ratio of long-term to total debt implies a later maturity and repayment schedule on debt instruments. While this may not place more immediate demands on city revenues, it may signal a city's inability to meet future debt obligations.

The dummy variable, CTY, depicts the city and county differentiation and has a negative coefficient, indicating a favorable impact on ratings.

5. Conclusions

The study identifies the impacts of population variables on a locality's bond ratings. The primary factors identified by the ordinal probit model are PCAPITA, UMPRATE, PCLASS, RLTDEBT, and CTY. These determinants represent the revenue generating and wealth sustaining ability, as well as, the debt burden of a locality.

A locality's revenue per capita (PCAPITA) is associated with positive ratings because it represents the wealth that is generated within a locality and is a clear indicator of a locality's ability to honor debt obligations. A city's unemployment rate (UMPRATE) is significant because it affects the city's ability to make debt payments if it has to use its resources to support the unemployed. The ratio of long-term debt to total debt (RLTDEBT), is significant and has a negative impact on ratings because it suggests high long term debt burden, and may signal future inability to meet debt obligations. The variables of interest in the study are population classification (PCLASS) and percentage change in population (POPCHG). The size of a locality's population, (PCLASS) is significant because it affects the ability of smaller localities to receive higher ratings, since localities with larger population are at an advantage to receive higher ratings. This ultimately increases the cost of capital projects for smaller communities, and consequently, increases the disparity between small and large communities. Due to multicollinearity, PCLASS as a variable looses its significance when the change in population (POPCHG) is included in the model. Thus, it is assumed that PCLASS captures most of the attributes of POPCHG in the model.

Results of this study suggest that regional cooperation between localities can improve the financing structure for small localities through loan pooling programs, which produce economies of scale. The ordinal probit technique correctly classifies about 60 percent of the original sample, and indicates that smaller localities are at a disadvantage in the bond rating process. It is suggested that the bond rating process may be improved by allowing small localities to pool their financing needs, and for state and federal involvement in economically depressed localities. The study also lends support to the significance of population variables in the bond rating process as reported in the literature (see Rivers and Yates, 1997; Simonsen et al., 2001).

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TABLE 1
LIST OF VARIABLES

Y: the dependent variable, is the locality's Moody's bond rating, where 1 = Aaa; 2 = Aa; 3 = A; 4 = B or lower; 5 = no rating.

PCLASS: population classification, where 3 = 100,000 or higher; 2 = 25,000 to 99,999; 1 = 10,000 to 24,000; 0 = 9,000 or lower.

POPCH: percentage change in population from 1996-2001.

SI: fiscal stress, the degree of fiscal strain experienced by the locality, as measured by index released by the Commission on Local Government.

REFFORT: revenue (or tax) effort, the ratio of tax receipts to total revenue base, as calculated by the Commission on Local Government.

RLTDEBT: ratio of long-term debt to total debt

MEDAI: log of median household income.

CONTED: percentage of high school graduates continuing into higher education.

LOCREF: Log of local revenue

PCAPITA: log of local revenue per capita.

CAPEXP: ratio of capital expenditure to revenue base.

GDEBTR: ratio of gross debt to total revenue

DEBTREV: ratio of debt to local revenue

RTAX: real estate tax rate per $100 of assessed property value.

HSTART: new housing starts, represents the number of new housing permits issued for new housing construction activity.

UMPRATE: local unemployment rate.

POOR: percentage of population classified as poor.

CTY: city/county differentiation: CTY = 1 for city, otherwise = 0.

TABLE 2
OBSERVED AND PREDICTED OUTCOMES

	Aaa	Aa	A	Baa	NR	Observed	Percent
Aaa	5	3	4	0	2	14	10.29
Aa	10	6	6	0	1	23	16.91
A	2	4	11	0	13	30	22.06
Baa	0	0	3	0	5	8	5.88
NR	0	0	2	0	59	61	44.86
Predicted Total	17	13	26	0	80	136	100

TABLE 3
DESCRIPTIVE STATISTICS (N=136)

	Mean	Std Dev	Minimum	Maximum
PCAPITA	2.9008	0.1926	2.5100	3.4040
UMPRATE	6.0243	2.5313	1.4000	16.2000
PCLASS	1.3971	0.08716	0.0000	3.0000
RLTDEBT	0.2277	0.1781	0.0180	0.9190
CTY	0.3015	0.4606	0.0000	1.0000

TABLE 4
ORDINAL PROBIT RESULTS

Variable	Probit Estimate	Standard Error	t-value	P(|t|)>0
PCAPITA	-2.15860	0.8793	-2.46*	0.015
UMPRATE	0.09831	0.0514	1.91*	0.058
PCLASS	-0.70954	0.1259	-5.64*	0.000
RLTDEBT	1.29198	0.7487	1.73*	0.087
CTY	-1.37078	0.3587	-3.82*	0.000

* Significant at the 5 percent level.

Constant	Estimate	Std Error	t-value	p(t)>0
Alpha 1	-8.92487	2.6705	-3.34	0.001
Alpha 2	-7.89312	2.6598	-2.97	0.004
Alpha 3	-6.73989	2.5598	-2.68	0.010
Alpha 4	-6.45788	2.5426	-2.54	0.012

Measures of Fit:
Likelihood ratio Chi-square: 110.3365
With 5 d.f., prob = 0.0000
Percent Correctly Predicted 59.5588
Pseudo R^2 55.44%