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Examining the Determinants of State Borrowing Costs: Controlling for Different Terms to Maturity

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Introduction

Prior studies have developed models to identify factors that determine the borrowing costs for state governments. When state governments borrow money, they usually issue serial bonds. With a serial bond issue, a portion of the principal borrowed is repaid each year, along with the interest payments, over the life of the bond issue. Also, a separate yield-to-maturity (YTM) is assigned for the yearly maturities under the serial bond issue.

Prior studies (Marks and Raman 1985, 1987, 1988; Raman and Wilson 1990) identifying factors that determine states' borrowing costs used the average YTM as well as the average maturity for each serial bond issue when estimating their models, treating each serial bond issue as one observation. This methodology examines the relationship between the explanatory variables included in the model and the average borrowing costs, assuming the average maturity is the maturity date. This approach implicitly assumes that these relationships are stable across the different maturities under a serial bond issue.

The purpose of this study is to determine if this assumption of stable relationships is reasonable. We initially estimate a model based on the methodology used in the earlier studies. We then estimate the model treating each of the different maturities under a serial bond issue as separate observations, using the YTM and actual maturity values for each maturity. Thus, a twenty-year serial bond issue is treated as twenty observations with different maturities and yield-to-maturities, as opposed to being one observation with the average maturity and the average YTM. The relationships between the explanatory variables and YTM are compared to determine if they are stable across the two models.

Treating each observation under a serial bond issue as a separate observation allows us to control for differences in the relationships between the explanatory variables and YTM across different maturities. One example where a difference is expected to vary across different maturities is the relationship between unfunded pension debt and YTM. As a general rule, higher levels of unfunded pension debt increase the default risk on bond issues. Thus, we expect a positive relationship between unfunded pension debt and YTM.

However, the unfunded pension debt represents a claim that, based on today's demographics, will not have to be repaid until several years in the future. Since the unfunded pension debt will not compete for a state's resources with short-term bond issues, we only expect a significant relationship between unfunded pension debt and YTM for the longer maturities under the bond issue. Thus, controlling for differences in maturities under the serial bond issues should strengthen the relationship between unfunded pension debt and YTM.

We hypothesise that the relationships between the explanatory variables and YTM are not stable across the different maturities. The results of the analysis support our hypothesis as the relationships are substantially different when the model is estimated treating each maturity under a serial bond issue as a separate observation.

Data and Methodology

The following regression model is estimated to examine the relationship between unfunded pension obligations and bond yields for new state bond issues:

$$YTM_{i,t} = b0 + b1LMAT_{i,t} + b2LGODEBT_{i,t} + b3EXLIM_{i,t} + b4LOWNREV_{i,t} + b5UNEMP_{i,t} + b6LVITEXP_{i,t} + b7LUPO_{i,t} + b8D1 + b9D2 + E_{i,t}$$

where:

YTM = yield to maturity;

MAT = term to maturity, measured in years;

LGODEBT = general obligation debt per capita;

EXLIM = expenditure/revenue limitations - 1 if the state has one, 0 otherwise;

LOWNREV = ratio of general revenues from own sources to total general revenues;

UNEMP = the unemployment rate for the state/year;

LVITEXP = ratio of vital expenditures to total general expenditures;

LUPO = projected benefit obligation/pension assets.

D1 = 1 if bond issued in 1991, 0 otherwise;

D2 = 1 if bond issued in 1992, 0 otherwise;

i = state;

t = year;

E = random error term.

(All variables with a L at the front are used in natural log form to meet the normality assumption for linear regression).

This model is similar to the model used by Raman and Wilson [1990] as well as to models used in numerous studies in the finance literature [Benson 1979; Benson et al. 1981; Cook 1982] that seek to explain the yield on new bond issues.[1]

The dependent variable, yield-to-maturity, for all new state bond issues from

1990 to 1992 was collected from Bloomberg's Financial Markets data base.[2] Examining the data indicated that 26 states combined for a total of 91 new bond issues during this period (see Appendix A for a listing of the state/year combinations of new bond issues). The majority of the new bond issues are serial bonds, where a portion of the principal is repaid each year.

The MAT variable is included in the model to control for differences in yields across different maturities. Longer maturities are expected to have higher yields due to increased risk. Thus, we expect a positive relationship between MAT and the yield to maturity. We also expect this to be a stronger relationship when we treat each maturity as a separate observation instead of using the average maturity value for each serial bond issue.

Debt burden also is an important factor in general obligation credit analysis [Lamb and Rappaport 1987; Public Securities Association 1987]. The LGODEBT variable measures the debt burden of each state versus the ability to repay as the ratio of general obligation debt to the population of the state. The higher the ratio the riskier the bonds, which should result in a higher yield. Therefore, we expect a positive relationship between LGODEBT and the net borrowing cost.

The EXLIM variable is included in the model to determine if revenue and/or expenditure limitation agreements, which are designed to restrict state spending, impact a state's borrowing costs. If the agreements are effective, a state's default risk would decrease. This decrease in risk should result in a negative relationship between yield to maturity and revenue/expenditure limitation agreements.

Three other variables [LOWNREV, UNEMP, LVITEXP] are included in the model to control for state characteristics that could affect default risk. These variables were selected based on the findings of prior studies [Wallace 1981; Wilson and Howard 1984; Raman and Wilson 1990]. The LOWNREV variable measures the percentage of a state's general revenues that are provided by the state's own sources, which the state controls. This variable measures a state's self-reliance in generating revenues. The higher the ratio the lower the default risk, which should result in a negative relationship between LOWNREV and yield to maturity.

The UNEMP variable is included in the model to control for the financial position of the state at the time the bonds were issued. The higher the unemployment rate, the weaker the state's financial position. Thus, we expect a positive relationship between yield to maturity and the unemployment rate as a weaker financial position results in increased default risk.

The third additional variable (LVITEXP) is the ratio of vital expenditures to total expenditures.[3] This variable measures the financial flexibility of the state in determining its ability to decrease expenditures during recessionary periods. Higher ratios of nondiscretionary expenditures to total expenditures are anticipated to reduce flexibility, resulting in higher default risk. Thus, we expect a positive relationship between LVITEXP and yield to maturity.

The final explanatory variable included in the model is LUPO. This variable measures the relationship between pension obligations and pension assets. The higher the ratio the higher the unfunded pension obligation, resulting in increased default risk. However, the increased risk is only associated with bonds with long-term maturities as the pension obligation will not be paid until several years in the future. Therefore, we expect a positive relationship between LUPO and yield to maturity for long-term maturities but no relation for short-term maturities.

The model is estimated using new state bond issues from 1990 to 1992. Over this time period there were substantial changes in the general level of interest rates. To control for this change, two dummy variables (D1 & D2) were added to the model. Since interest rates declined during this period, we expect a negative relationship between the dummy variables and yield to maturity.

We initially estimated the model using the average YTM and average maturity for each serial bond issue. Bloomberg's reports a separate yield to maturity for each of the principal repayment maturities. We next estimated the model treating each maturity date under a serial bond issue as a separate observation, resulting in 1,377 observations. This sampling procedure allows us to control for differences in the relationships between the explanatory variables and YTM across different maturities.

The objective of this study is to determine if the relationships between the explanatory variables and YTM are stable across different maturities. We will compare the relationships across the two models estimated to determine if the relationships are stable across different maturities.

Results of the Analysis

The descriptive statistics for all variables are presented in Table 1. The coefficients and p-values for the explanatory variables for the two models estimated are presented in Table 2.

For the model using the average maturity and the average YTM, the EXLIM variable is the only significant explanatory variable (using a .10 significance level), having the expected negative relationship with YTM. Also, as anticipated, the two time dummy variables have a significant negative relationship with YTM. These variables are controlling for the overall decrease in interests rates over this time period. All other explanatory variables had an insignificant relationship with YTM for this model.

The model treating each different maturity under a serial bond issue as a separate observation provided substantially different results. The MAT and LUPO variables have the anticipated positive relationship with YTM in this model while the LOWNREV variable has the anticipated negative relationship. One surprising result was that the LVITEXP has a significant negative relationship with YTM while we anticipated a significant positive relationship. One potential explanation for this finding is that states with high levels of fixed expenditures may have developed tax structures to reduce the variability in tax revenues, reducing default risk. If this has occurred, the relationship between vital expenditures and YTM would be negative.

The EXLIM variable, which was significant in the initial model, is insignificant in this model. As in the earlier model, the two time dummy variables have the anticipated negative relationship with YTM, controlling for the decrease in interest rates over this time period.

The substantial differences in the relationships between the explanatory variables and YTM across the two models indicates that the relationships are not stable across different maturities. Several of the variables became significant when we treated each maturity as a separate observation, allowing the relationships to vary across maturities.

Summary and Conclusions

The results of this study indicate the importance of controlling for differences in maturities when examining the relationship between the explanatory variables and YTM. Since the relationships appear to vary across the different maturities under a serial bond issue, interpreting the relationships from models using the average maturity and the average YTM could provide misleading information.

The changes in the relationships will create a larger problem for studies using new bond issues as opposed to seasoned bond issues. Most new state bond issues will have similar maturities (usually 20 years). Thus, there is little variability in the maturity value when you take the average for all issues. We expect that this problem resulted in the insignificant relationship for the maturity variable in the initial model, even though it is common knowledge that issues with longer maturities have higher yields. Also, taking the average YTM reduces the variability in the dependent variable, making it more difficult to find significant relationships as well as hiding the true relationships across the different maturities.

For seasoned bond issues, there may be different maturities remaining based on the number of years the bonds have been outstanding. In either case, however, we believe that treating each observation under a serial bond issue as a separate observation provides a clearer interpretation of the relationship between YTM and the explanatory variables included in the model.

Endnotes

1. The model used by Raman and Wilson (1990) included a variable for the coupon rate of each bond issue. Since we are using new bond issues instead of seasoned bond issues, the coupon rate and yield to maturity are approximately the same for many of the observations. For this reason, the coupon rate is excluded from the model.

2. This database is used extensively by investors on Wall Street to track security prices.

3. Vital expenditures are defined as nondiscretionary expenditures. They include expenditures for financial administration, police protection, highways, public welfare, education, and interest on general obligation debt.

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Table 1:
Descriptive Statistics for All Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
YTM	5.8923	.9125	2.30	10.00
AVGYTM	5.8634	.6437	4.40	9.11
MAT	9.9586	5.9608	1.00	30.00
AVGMAT	9.1060	2.6112	2.50	15.50
GODEBT	414.09	415.37	12.20	2001.00
EXLIM	.59840	.49040	.0000	1.0
OWNREV	.71219	.05633	.6073	.8311
UNEMP	6.5125	1.1550	4.000	9.00
VITEXP	.74196	.03243	.6784	.8027
UPO	1.2471	.28575	.8980	2.9300

*All variables listed above are in raw form for presenting the descriptive statistics. For the statistical analysis, all variables except YTM, MAT, UNEMP, and EXLIM were transformed using the natural log transformation to meet the required statistical assumptions. The AVGYTM and AVGMAT variables are based on treating each serial bond issue as one observation.

Table 2:
Results of Regression Analysis Coefficients and (P- Values)

Dependent Variable: Yield to Maturity (or AVGYTM)

Average YTM and Maturity Versus Individual Observations

Variable	Average	Individual
Constant	5.294 (.000)	4.584 (.000)
MAT	.0294 (.112)	.0866 (.000)
LGODEBT	.0334 (.328)	.0076 (.396)
EXLIM	-.1723 (.060)	-.0437 (.119)
LOWNREV	-.0029 (.499)	-.8427 (.001)
UNEMP	.0780 (.107)	.0142 (.190)
LVITEXP	-1.374 (.178)	-2.179 (.000)
LUPO	.1790 (.238)	.1379 (.076)
D1	-.6966 (.000)	-.6194 (.000)
D2	-1.217 (.000)	-1.028 (.000)
N	91	1377
Adj. R^2	.388	.507

Appendix A

State/Year Combinations of New Bond Issues

State	*Year*	*# of Issues*
Alabama	1990 1992	1 1
Arkansas	1990 1992	2 1
California	1990 1991	1 2
Connecticut	1992	3
Delaware	1991	1
Florida	1991 1992	1 2
Georgia	1990 1991 1992	1 2 2
Illinois	1991	1
Louisiana	1990	1
Maryland	1990 1991 1992	1 2 1
Minnesota	1992	1
Mississippi	1990 1991 1992	1 4 6
Missouri	1991 1992	2 3
Nevada	1991	4
New Jersey	1991	2
New Mexico	1991	1
New York	1990 1991 1992	1 3 1
Oregon	1990 1992	1 3
Pennsylvania	1990 1991	3 1
Rhode Island	1990 1991	1 2
South Carolina	1991 1992	7 4
Tennessee	1990 1991	2 3
Texas	1992	1
Utah	1991	1
Vermont	1990	1
Washington	1990	1