2013

THREE ESSAYS ON LOCAL GOVERNMENT DEBT

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Robert Greer, Student

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Dr. Edward Jennings, Director of Graduate Studies
THREE ESSAYS ON LOCAL GOVERNMENT DEBT


A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Graduate School at the University of Kentucky

By

Robert A. Greer

Lexington, Kentucky

Director: Dwight V. Denison, Ph.D., Professor of Public Policy and Administration

Lexington, Kentucky

2013

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ABSTRACT OF DISSERTATION

THREE ESSAYS ON LOCAL GOVERNMENT DEBT

The local government tax-exempt debt market is a growing, and complex, sector of public finance. As local governments turn to debt financing the factors that contribute to interest costs of that debt have become important considerations for local government officials and politicians. Governance at the local level involves a network of overlapping governments some of which share a tax base. This system of overlapping governments that share a tax base are subject to externalities that arise from taxation, expenditures, and debt. These externalities are usually analyzed in terms of tax or expenditure reactions, but there are implications for local government debt as well. For example, it can be shown that overlapping governments that share a tax base and issue debt can increase the interest costs paid on bonds by a higher level government. Further complicating the debt situation of local governments is the prevalence of a variety of special districts with the authority to issue tax-exempt debt. These special districts may have the authority to issue debt, but little is known about their financing processes. By comparing how different types of government approach the credit rating process this dissertation compares risk assessment of traditional municipalities and special districts. Through this comparison similarities and differences in the credit rating process across types of local governments can be identified. To explore these issues of local government debt several advanced econometric techniques are used to estimate various models. For example, by using semiparametric techniques a less restrictive estimation methods can be used to address important issue in local government finance.

KEYWORDS: Public Finance, Municipal Securities, Local Government, Public Debt, Public Policy
THREE ESSAYS ON LOCAL GOVERNMENT DEBT

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April 26, 2013
I dedicate this dissertation to my wife, daughter, and parents. May this document stand as a symbol of my professional achievement made possible through tremendous personal support.
ACKNOWLEDGMENTS

The following dissertation was made possible through an assortment of supportive influences. I wish to thank my committee members who were always willing to provide feedback, and allowed me the creative freedom to pursue a variety of research ideas. A special thanks to Dr. J.S. Butler for always being there, no matter what time of day or night, and dedicating a disproportionate amount of time and energy to my education. Dr. Butler’s encouragement and willingness to teach to student’s interests is an invaluable resource. Another special thanks to Dr. Dwight Denison, my committee chairman, for allowing me to be a part of several research projects that have given me great experience and furthered my advancement in academia. Thank you Dr. Bill Hoyt and Dr. Merl Hackbart for your insightful comments, and agreeing to serve on my committee.

While my committee provided professional support it was my family that made it possible for me to complete this dissertation. To my beautiful wife, Laura Greer, for her many years of unwavering support and encouragement. To my parents, Russ and Cindy Greer, for their dedication to my education from the very start. To my brother, Ricky Greer, for the support and inspiration only a brother can provide. To my in-laws, The Insley’s and Meador’s, and to my friends, Jared Hasbrouck, Tyler Browder, and Paul LeMaire for providing much needed breaks as well as being the best sounding boards a Ph.D. student could ask for.

I would like to acknowledge the Texas Bond Review Board for allowing me to use their data for all three essays in this dissertation. Their willingness to comply with my many data requests allowed me to complete the dissertation in a timely manner. I would
also like to acknowledge the many conference discussants and participants that provided feedback back on the material in several of the following chapters.

Finally I would like to acknowledge my friends and colleagues in the Martin School. A special thanks to Alex Jacobs, Pete Jones, and their families who have been with me every step of the way in my pursuit of a doctorate. Without the help of Alex, Susan, Gabe, Bethany, Pete, and Allison I may not have held on to my sanity throughout this process.
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Chapter One

Introduction to Debt Competition

Introduction

It is well known that local governments are an integral piece of the governance system in the United States. Local governments are the first place that citizens turn to when problems arise, and deal directly with both other local governments and foreign governments. Yet they receive far less attention than state and federal governments in both academic literature and popular media. Understanding the complex relationship between governments in a federalist system is of considerable interest for economists, political scientists, and policy researchers. Within each state exists hundreds of separate governments including counties, cities, townships, school districts, special districts, and municipal districts. Most of these districts have the power to tax, set regulation, and issue their own debt. The result is complicated network of various policies affecting citizens and corporations alike, and this system continues grow.

As this system of governments grows more layers of government are added, and the level of strategic interactions among them increases. According to the 2007 United States Census of Governments since 1972 the total number of local governments has increased from 78,269 to 89,476. The make-up of type of local governments has also changed. As Figure 1.1 shows the overall number has increased, but the number of special districts has increased significantly while the number of school districts has actually decreased. With an increasing number of local governments with debt issuing
authority understanding the relationships between different types of governments becomes important.

![Figure 1.1 Number of Governments by Type](image)


As the amount of federal and state funding to local governments has decreased and citizen willingness to accept higher taxes remains unchanged local governments have turned to issuing debt to fund both short and long term projects. As shown in Figure 1.2, the amount of general obligation debt issued by state and local governments has grown significantly over the last twenty years. This increased amount of state and local debt combined with the increased number of local governments over the same period suggests that understanding the complexities of local government debt is an important policy issue.
There are myriad of interesting and important topics in local government debt. As the number of special districts grows governance at the local level becomes a complex web of governments. The result is many different local governments performing complimentary as well as competing services. These governments often overlap in their tax bases and service delivery areas, and are almost always given the power to issue debt. Understanding the interactions between these overlapping local governments is an area of study that has serious implications for local government finance. Furthermore, understanding the differences between the various types of special districts, especially in comparison to the traditional municipal governments in terms of debt issuance, is an area that has received little attention.

It is commonly understood that the operating budgets of state and local governments are under strict requirements to be balanced. Debt may be used by state and local governments to expand the resources available to finance new construction of buildings and other tangible assets. However, debt is not a source of revenue; debt is a financial obligation that commits future taxes and fees in order to make the financial resources available in the present. The amount that a government can borrow is restricted by the jurisdiction's capacity to repay the liability, which depends upon the property and income wealth of the citizens that reside in the jurisdiction. Property, sales, and income are the three major tax bases utilized by state and local governments. These tax bases have a limited capacity to support debt. Very often these tax bases are shared among multiple jurisdictions such as cities, school districts, counties, and special districts. As a result, these overlapping jurisdictions must compete with each other for the available debt capacity. Every time one jurisdiction issues debt, it reduces the amount available for the other jurisdiction to borrow.

**Markets for State and Local Debt**

State and local governments issue municipal bonds to finance infrastructure used for a wide range of purposes including education, utilities, public buildings, hospitals, and transportation. While state and local governments may borrow money from a bank through a note, loan, or mortgage, the majority of the debt held by state and local government is in the form of tax-exempt bonds. This is because qualifying municipal bonds are exempt from the investor’s taxable income and therefore offer lower interest rates. Of the $434.2 billion of debt issued by state and local governments in 2010, about
thirteen percent was issued by states, twenty percent was issued by cities and counties, and the remaining sixty-seven percent was issued by special districts and authorities. The volume of outstanding state and local debt exceeded $2.4 trillion in 2009 (Federal Reserve Board of Governors).

Municipal bonds are issued as general obligation debt or revenue backed debt. General obligation (GO) bonds are backed by the full faith and credit of the issuing government, which means the general tax revenues of the government are obligated to pay the bonds. Revenue backed debt, or non-guaranteed debt, is supported from dedicated fees or other earmarked sources of revenue. It is the general obligation bonds that are most subject to intrajurisdictional competition, because the backing for GO bonds comes from a shared tax. However, the bond market generally considers revenue bonds as a moral obligation of the jurisdiction where shortfalls in the pledged revenues may be fulfilled through general revenue sources. This moral obligation contributes indirectly to the competition for debt among overlapping jurisdictions. Leased backed bonds are a type of revenue bonds, but they are different in that the pledged revenues are future appropriations through the general fund or other tax revenues. For this reason leased backed bonds induce more intrajurisdictional competition than a typical revenue bond. Even the fees pledged for a generic revenue bond may be influenced by the actions of overlapping jurisdictions because the overlapping jurisdictions share a common population and income base.

One important element in determining the price, or interest costs, of a bond is the credit rating. Credit ratings are purchased by the government issuing a bond from one or
more credit rating agency such as Standard and Poor’s, Moody’s, or Fitch. These rating signal to the market the risk of default for a government bond. Governments make several decisions related to credit ratings. They decide whether or not to purchase a rating, how many ratings to purchase, and who to purchase ratings from. While the decision making process may be different for each individual government there are several plausible approaches. A government may first decide to purchase a rating, then decide how many rating, then decide from whom to purchase a rating. Alternatively they may make the decisions simultaneously. For example, they may decide from the start to purchase all three ratings. Differences in the decision making process by type of government are explored in chapter three.

The use of debt, type of debt issued, and credit rating decisions are all tied to the pursuit of the lower interest rates on government bonds. Lower interest rates mean that the government is paying less to borrow of the life of the bond. There are several methods for calculating municipal interest costs. Net interest cost (NIC) and true interest cost (TIC) are the two most common. Of the two true interest cost has become the preferred method in both academic literature and practice. TIC is more complicated than NIC because it takes into account the time value of money to calculate an internal rate of return on a bond, whereas NIC produces the average annual cost of debt. Two bids may have the same NIC but different TIC if one involves higher interest payments in the early maturities of the issue and lower interest payments in the later maturities (Fabozzi and Fabozzi 1989).
Constraints on Debt Financing

There are various constraints that are placed on state and local government debt that dictate the amount, and terms, of debt that can be issued. States can institute constitutional debt limits that restrict the amount that can be issued by state governments. One estimate by the National Association of State Treasurers (2001) finds that twenty-seven states have some combination of constitutional or statutory limitations on general obligation debt. In contrast, only four states restrict revenue or nonguaranteed debt. Hackbart et al. (2004) identify fourteen states as having policies with “umbrella policies” which encompass both GO and nonguaranteed debt. States can also impose taxation and expenditure limits for local governments, which will indirectly limit the amount of GO debt those local governments can issue.

This dissertation will study local government debt using data from the State of Texas. The Texas Constitution prohibits the issuances of additional state debt if the percentage of debt service payable by general revenue in any fiscal year exceeds 5% of the average of unrestricted general revenue for the past three years. The state of Texas currently has a AA credit rating from Standard and Poor’s, a Aa1 from Moody’s, and a AA+ from Fitch. Texas limits local government debt indirectly through state statues that set maximum ad valorem tax rates per $100 of assessed property value. The rates vary by government type, but all governments must generate sufficient funds based on annual ad valorem tax collections to provide for the payments of the principal and interest no all GO debt. All local debt issuances must be approved by the Office of the Attorney General – Public Finance Division and registered with the Texas Comptroller of Public Accounts.
Governments can also have indirect or informal debt limitations. The informal debt limitation is not established through law, but is determined by the amount of debt a jurisdiction may issue without altering its credit rating. Thus, informal debt limits are determined by credit quality of the jurisdiction and the bond markets. These market-driven constraints are referred to as the debt capacity or debt affordability of a government. Debt affordability and debt capacity are related, but distinct terms. Debt affordability is defined as the amount of debt that any one government can financially support. Debt capacity is more specifically defined as the level of debt and/or debt service relative to current revenues that an issuing entity could support without creating undue budgetary constraints that might impair the issuer’s ability to repay outstanding bonds or make timely debt service payments (Denison et al. 2006). One practical approach to managing debt levels is the use of “rules of thumb” that might include setting ceilings on debt service payments as a percentage of state government expenditures, total debt per capita or other level of debt or debt service ratios.

While it is generally agreed upon that debt affordability and debt capacity are important factors in debt management, there is little consensus on how to measure affordability. There is no clear standard for making judgments about the specific amount of debt that is affordable for a jurisdiction. A theory put forth by Hildreth and Miller (2002) argues that debt affordability depends on factors of economic concentration in revenue sources, and interjurisdictional coordination. They posit that resources bases are at risk of being drawn upon by multiple jurisdictions. In their framework the ability to repay debt with balanced revenue sources is significantly different than the ability to
Empirically there has been little done to test theories of debt affordability or capacity. Martell (2007) is the one exception. Martell looks at the effect of jurisdictional overlap, specifically the effect of special districts, on county debt affordability. The study investigates Jefferson County, Colorado, and finds that the number of overlapping jurisdictions is negatively related to various levels of debt. This would suggest that the number of overlapping jurisdictions may not be a concern for local governments in regard to debt affordability. Martell also found that the type of overlapping jurisdictions did matter, and that metropolitan districts yielded much greater debt burdens relative to municipal governments.

Government jurisdictions face restrictions in the amount of debt that can be issued as a result of formal (legal) debt policies, informal administrative rules, and fiscal constraints of debt affordability. For example, the bond referendum is a common legal restriction on general obligation bond issues requiring new bond issues to receive voter approval. A bond referendum may have the same effect as a debt limit if citizens vote down bond issues that exceed the public’s notion of acceptable debt levels. These constraints can lead to competition among departments within a single government, between different government entities, and throughout various levels of government. These departments and governments compete over the ability to issue debt, the amount they can issue, and the interest rates they receive on that debt. Bond referendum laws and debt limits, both formal and informal, restrict the amount of debt that can be issued and repay with concentrated revenue sources when overlapping jurisdictions are competing with each other.
create a scarcity in debt financing. This scarcity results in a competition for debt resources.

**Special Districts**

The term local government is wide reaching and includes the traditionally studied municipalities such as cities and counties as well as the broad category of special districts. As shown in the introduction (Figure 1.1) the number of special districts has grown over the last thirty years. The classification of special district is a complicated category. Special districts are independent, political subdivisions of the state, and are also known as public authorities. Their jurisdictional reach is usually less than state wide, although may include multiple counties. They are organized for the purpose of performing governmental or other prescribed functions within limited boundaries, and are created to “fill the gaps” that may exist in the services of cities and counties. These governments are associated with less political oversight and more business like management practices. Special districts typically have limited taxing and bonding powers, which allows them to be used to get around constitutional limits on debt and taxation.

A common hypothesis in literature on special districts is that most fiscal rules are applied to traditional municipalities more than special districts so policymakers circumvent rules by diverting polices to special districts. A common means of circumvention is through the sale of debt, because while balanced budget requirements exist is most states special districts are less transparent, and harder to hold accountable. It is also argued that special districts are able to issue more non-guaranteed debt because of
less regulation (Bennett and DiLorenzo 1982; Marlow 1995). Bunch (1991) finds that states with constitutional or statutory debt limitations tend to create more special districts than states without limitations. There have been several studies that support the general hypothesis that state limits on local debt or spending also stimulate the creation of special districts (Joyce and Mullins 1991; Nelson 1990). In addition, when states restrict only cities fiscal powers, the county may assume more service responsibilities. If both cities and counties fiscal powers are limited more special districts are created to handle service responsibilities (McCabe 2000).

The literature on special districts and public finance has focused on the use of special districts to circumvent, or relieve services from, cities and counties. Little attention has been paid to the fact that as more special districts are created they will compete in the debt market against each other and the existing governments. This relationship is further complicated when it is considered that cities, counties, and special districts may share the same tax base. Therefore while states may create special districts to get around debt limitations an unintended consequence is that they are creating their own worst competition in debt markets.

**Nature of Debt Competition**

There are several ways debt competition can manifest itself within state and local governments. On form is when state agencies within a single state government can compete with each other in interagency debt competition. A potentially more complicated relationship is that state government can compete with local governments within the state. Also, various levels of local governments can compete with each other in intrastate
vertical debt competition. Finally, local governments of the same or similar type can compete with each other in intrastate horizontal debt competition.

In states with balanced budget requirements and binding limits on the amount of state debt that can be issued, policy makers are forced to choose among several types of budgetary tradeoffs. One tradeoff is among different agencies that may have different infrastructure needs. Both state tax revenues and new debt resources can be used to acquire capital assets in a given year. However taxes are generated each year while debt issued is a liability that carries over into future fiscal periods. Therefore, debt needs to be managed on two dimensions in regard to debt capacity and competition. The first dimension is the accumulated debt balances issued for various purposes in the past, and the second dimension is the annual amount of debt that is newly issued for various purposes. Debt limit policies and financial constraints will restrain the amount of debt a state and composite agencies may issue and therefore force competition for available bond capacity. The debt issuance allocation process can produce winners and losers among those agencies competing for available credit.

Denison et al. (2009) reports that trade-offs for debt resources occur between the highway debt and other state debt in those states with formal umbrella debt policies. In states without umbrella debt limits there is not intrastate competition among the highway debt and all other state debt. Instead, the relationship is complimentary in that increases in all other debt leads to dramatic increases in highway debt. It appears that the intensity of the intrastate competition for debt resources depends on the amount of debt “slack” available to the state and whether binding debt limits are on both general obligation and
revenue bonds. The states that decreased their overall debt show most evidence of intrastate competition for the remaining debt resources.

The second type of debt competition is vertical competition between state and local governments. This type is possibly the most complicated relationship because the jurisdictions are overlapping. Overlapping jurisdictions mean that two governments are providing services and levying taxes to a shared geographic area. This is relevant for debt management because as one government issues general obligation debt it obligates future tax revenues. If the issuing government shares the tax base in part or entirety with another government, then the second government to issue debt may face a higher default risk and interest costs. This creates a debt competition scenario where governments compete on timing and issue size of their debt to receive more favorable municipal interest costs.

Vertical debt competition can occur between various levels of state and local governments. One key factor in vertical debt competition is whether the state’s debt issuance is centralized or decentralized. Some states issue the majority of debt at the state level and pass funds through to local governments, while other states issue relatively little at the state level and allow local governments to issue debt as needed. The map in Figure 1.3 shows a breakdown by state of the percentage of total state and local debt that was issued by local governments in 2009. In 2009 Rhode Island had the lowest percentage of debt issued by local governments at around 22%. Conversely Tennessee had the highest with 87%. In general the map shows that southern states tend to have higher proportions of government debt issued at the local level compared to northeastern states.
Vertical debt competition can also arise between different levels of local governments. As an example of vertical debt competition among local governments, Figure 1.4 is a map of Denton County which is in north central Texas about 40 miles north of the Dallas- Fort Worth Metro area. The municipalities are darkest with the main city being the City of Denton right in the middle. In addition to the county and city governments there are several school districts (grey outline), municipal districts, and other special districts.
Table 1.5 is a list from a recent Denton County Bond issue with all of the overlapping jurisdictions and their tax rates for the county. In total Denton County has thirty-four overlapping cities, seventeen overlapping school districts, and seventeen overlapping special districts for a total of $4.4 billion in direct and overlapping debt principal. This means that Denton County has $6,907 per capita in direct and overlapping outstanding debt. This total amount is not transparent, and therefore citizens may be unaware of their total debt burden. Denton County is not a unique government in the number of overlapping school districts and special districts. This “stacking” of local
governments with debt issuing authority is likely to result non-transparent total debt burdens across the country.

<table>
<thead>
<tr>
<th>Taxing Entity</th>
<th>As of</th>
<th>2009 Tax Rate</th>
<th>Net Debt Principal Outstanding</th>
<th>Percent Overlapping</th>
<th>Amount Overlapping</th>
</tr>
</thead>
<tbody>
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<td><strong>Cities</strong></td>
<td></td>
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<td>Carrollton</td>
<td>2/28/2010</td>
<td>0.6178</td>
<td>165285000</td>
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<td>Frisco</td>
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<td><strong>Special Districts</strong></td>
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<td></td>
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<tr>
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<td>Denton Co FWSD 10</td>
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<td>1</td>
<td>33590000</td>
<td>100.00%</td>
<td>33,590,000</td>
</tr>
<tr>
<td>Denton FWSD #6</td>
<td>9/30/2009</td>
<td>1</td>
<td>60574983</td>
<td>100.00%</td>
<td>60,574,983</td>
</tr>
<tr>
<td>Other Special Districts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>115,187,780</td>
</tr>
<tr>
<td><strong>Total Gross Overlapping Principal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3,883,456,495</td>
</tr>
<tr>
<td>Denton County</td>
<td></td>
<td>0.2498</td>
<td>513080733</td>
<td>100%</td>
<td>513,080,733</td>
</tr>
<tr>
<td><strong>Total Direct and Overlapping Principle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4,396,537,228</td>
</tr>
<tr>
<td><strong>Ratio of Direct and Overlapping Debt Principal to 2009 Net Taxable Value</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8.24%</td>
</tr>
<tr>
<td><strong>Total Direct and Overlapping Debt Principal Per Capita</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6,907</td>
</tr>
</tbody>
</table>

Source: Preliminary Office Statement. Denton County Bond Counsel. CUSIP Prefix 248775. June 1, 2010
The third type of debt competition is horizontal competition across local governments of the same level. This competition is similar to the state-to-state competition where two or more local governments of the same or similar type compete to issue municipal securities. This competition can occur between local governments that share a border or between local governments that are similar in their socioeconomic makeup. For example, cities may compete for debt if they share common risk factors resulting from attributes such as similar population and industry composition.

Horizontal form of competition is tied to the well known the tax competition literature. Tax competition among local governments has its roots in Tiebout (1956) who hypothesized that residents would sort themselves into different local governments based on their preferences for public goods and services and the associated tax costs. Since residents are mobile, and jurisdictions are in a competition for those residents, competition results in a type of sorting of citizens into municipalities that offer a mix of goods and services to match citizen preferences. The result will be tax structures that represent those preferences, and those tax structures will dictate the debt capacity and affordability of a local government. In this way debt competition is inherently tied to tax competition among local governments.

Consequences of Intrastate Debt Competition

Excessive intrastate competition among states and local governments may produce several adverse effects. One outcome is that excessive competition may result in a shortage of debt capacity available to the other jurisdictions desiring to issue debt. As previously discussed, the jurisdiction who issues bonds first will have the advantage in
terms of reduced credit risk and interest costs. The incentive for jurisdictions who issue
bonds first will be to maximize the size of the bond issues in order to lock in debt at
lower interest rates. Without coordination, competing jurisdictions may find that the
available debt capacity gets used without consideration of the holistic priorities of the
area.

Intrastate debt competition influences interest rates primarily from the supply
perspective. The supply of bonds in the markets is influenced by both horizontal and
vertical competition, and the increase in bond supply will put downward pressure on
bond prices and drive up interest rates.

Fragmented financial reporting of debt obligations of overlapping jurisdictions
may reduce the public transparency of the overall debt burden. Referring back to Table
1.1, we see that Denton County has just over $513 million in outstanding direct debt.
Since Denton County has a population of around 636 thousand, the direct debt per capita
is $806 per person. However, the debt per capita number for just the county dramatically
underestimates the real debt burden to residents in Denton County since the total direct
and overlapping debt is $6,907 per capita. Lack of transparency may lead to excessive
debt (and tax) burdens.

**Dissertation Chapters**

The variety of interesting research topics in local government debt serves as the
motivation for this dissertation. The following chapters are a series of three essays that
explore local government debt from three different perspectives. All three essays deal
with local government’s debt issuances. The first essay takes a fiscal federalism approach
in that it looks at fiscal externalities created by debt, and the effects of local government borrowing on county government municipal interest costs. The second essay drills down to explore the differences between types of special districts and compares how those governments approach the risk assessment, and debt issuing process to traditional municipalities. The third essay seeks to expand the limited set of econometric tools that are used to model local government interest costs. The goal of this dissertation is to address three distinct research questions:

1. Do overlapping governments create debt externalities, and if so what is the effect of those externalities on interest costs?
2. Are there differences between local government types in the selection of a credit rating agency or the number of ratings purchased?
3. Can semiparametric techniques be used to model municipal interest cost, and are the underlying assumptions of existing OLS models valid?

Addressing this collection of research questions increases our understanding of local government debt in several ways. First, it adds to our understanding of the relationship across governments that share tax bases in debt issues. Second, it provides some empirical evidence regarding the differences in how types of local governments in evaluating risk as well as some general descriptive statistics about the credit ratings of special district governments. Third, the current set of econometric tools used to analyze local government finance will be expanded. By utilizing advanced econometrics to analyze local government debt not only can the field move forward with the ability to answer different empirical questions, but existing questions can be answered with more precision and fewer restrictions.
More specific findings of this dissertation include the effect of overlapping debt on interest costs, a comparison of the credit rating decision process for local governments, and an alternative method for modeling municipal interest costs. In chapter two both ordinary least squares and two stage least squares models are used to show that the aggregated sub-county amount of debt that overlaps with a county government increases the county interest costs on tax-supported bonds. In addition as the number of overlapping sub-county governments that issue the debt increases the county interest costs increase.

In chapter three uses the theory of financial intermediation to explore differences in local government credit rating agency decisions. A multivariate probit model is used to estimate the effect government type has on the decision to be rated by each of the three main credit rating agencies (Standard and Poor’s, Moody’s, and Fitch). Results show that cities and counties are similar in their rating decisions, and that school districts behave more like cities and counties than other special districts. Results also suggest that special districts are not the same in their rating decisions. For example, health districts are more likely to be rated by Moody’s while other districts are more likely to be rated by Standard and Poor’s. A negative binomial model is also used to estimate the effect of government type on the number of credit ratings purchased. The implications for these findings suggest that risk assessment by different types of governments will determine the prices paid on their debt. Different debt prices for local government types can inform the assignment of responsibilities across local governments.

In addition to contributing to academic literature the results from this dissertation will have implications for several policy implications. These recommendations include the
effects of adding additional local governments in terms of debt levels and municipal interest costs. Also, these essays point out several important recommendations about strategies for local governments to achieve the lowest true interest cost through either pooled debt issues, or by strategic issuing through various types of corporate government entities. These policy implications also include ideas for future research on local government debt, and the methods used in its analysis.
Chapter 2

Vertical Debt Externalities in Overlapping Governments

Introduction

Competition among local governments is a phenomenon that has been discussed and studied extensively in economics and policy literature. One side argues that competition is good, keeps tax rates low, and government services competitive. Another side argues that competition does not result in welfare gains, at best merely moves resources between communities, and at worse is welfare decreasing. In that redistribution governments lose revenues and resources competing over attracting businesses through incentives or tax rates. The arguments are well developed and consider a variety of perspectives on taxation, expenditures, citizen welfare, and industry growth. One aspect of the argument that is less developed has been the role local government debt plays in competition. Debt competition may influence governments in different ways, but in general jurisdictions are competing for the ability to issue debt at the lowest interest cost it can obtain.

State and local government debt has been on the rise for the last twenty years. As shown in Figure 2.1 state and local debt has increased as a whole (real dollars), but the amount of debt issued by special districts has far outpaced other government types. The recent recession and media attention to national debt issues combined with several high profile municipal bankruptcy filings including Jefferson County, Alabama and Harrisburg, Pennsylvania that resulted from significant municipal debt obligations has drawn attention to the issue of local government debt. Trying to measure and analyze local government debt and be a tricky endeavor, because the current governance
landscape is a complex network of overlapping jurisdictions including a variety of special districts.

![Figure 2.1 Annual Issues of State and Local Debt](image)


In the United States within each of the fifty states exists hundreds of separate governments including counties, cities, townships, school districts, special districts, and municipal utility districts to name a few. Most of these districts have the power to tax, set regulation, and issue their own debt. The result is a complicated network of various policies affecting citizens and corporations alike. The fiscal policies of one government may directly or indirectly affect other governments through both horizontal and vertical interactions. One form of these interactions is through fiscal competition. Fiscal competition may take a variety of forms including through tax policy and debt capacity.
As an illustration consider Denton County, which is a county in north-central Texas just north of the Dallas-Fort Worth metroplex. In the official statement for a recent 2010 issue of permanent improvement bonds all taxing entities that overlapping with Denton County were listed with their tax rates and amount of net debt principal outstanding. In total Denton County had 68 overlapping tax entities including 34 cities, 17 school districts, and 17 special districts. This resulted in around $4.4 billion worth of overlapping outstanding debt for this one county. When the own outstanding debt for Denton County is added in residents had $6,907 worth of total direct and overlapping debt principal per capita. It is unclear whether residents of the 68 lower level jurisdictions that are contributing to that total are aware of that situation, but it almost certainly has implications for risk of default, interest cost payments, and fiscal sustainability of the area. Denton County is not alone in this situation. In fact the number of total local governments has increased by over ten thousand in the last thirty years. Figure 2.2 shows that while the number of school districts have gone down, the number of special districts is on the rise.
This paper adds to the current literature by contributing a relatively simple model of debt competition between governments with a shared tax base in a second-best world, which is an area that has yet to be fully explored in the literature. The theoretical argument is that for a given tax base there is a set level of debt capacity for tax-backed debt issued by state and local governments. This means that for a given interest rate a government can only borrow a limited amount before the risk of default would increase, which would drive up the interest cost of the debt. The existence of multiple governments that share the same tax base results in negative externalities as the amount of debt issued by one government affects the interest costs of other governments’ debt since both are backed by the same tax base. These negative externalities have consequences for local governments in terms of the amount of debt they issue, the interest rate they pay on that debt, and the timing of their debt issuance. There are also policy implications for regional

Source: Census of Governments
planners considering adding new jurisdictions to existing areas, and coordination among
debt issuing governments.

Federalism and Fiscal Externalities

The subject of fiscal competition among governments is not new to the field of
economics, and it includes a variety of approaches resulting in various policy
implications. The literature can be broadly divided into studies of horizontal competition
and vertical competition. Horizontal competition focuses on intergovernmental
relationships between equal or similar levels of government while vertical competition
focuses on the hierarchical relationship between levels of government in a federalist
system. Horizontal fiscal externalities exist when a voluntary transaction between two
parties affects a third party. An example would be if one city set a property tax rate which
results in a neighboring city losing revenue.

Vertical externalities exist when a policy set at one level of government effects
lower or higher levels of government. One example would be if a state sets a sales tax
rate that then results in a city losing revenue. A subset of the fiscal competition literature
is concerned with governments that share a common tax base or that have overlapping tax
jurisdictions. Of this subset of overlapping jurisdictions in fiscal competition almost all
economic research has been concerned with the implications to tax policy, and the tax
rates of the overlapping jurisdictions. There has been little research on the amount of debt
issued by these governments or the interest rates of the resulting bonds.

The literature typically referred to as tax competition models the horizontal
externalities that arise from the interactions across the same level of governments, and is
a subject that has been well covered (see Wilson 1999). The roots of tax competition can be traced back to Oates' (1972). Most scholars consider Zodrow and Mieszkowski (1986) as the first formal modeling effort of Oates' theory. Since its publication this model has been criticized, revised, and extended but it remains a staple in the literature and is often referred to as “the basic model of tax competition” (Wilson 1999; Edward and Keen 1996).

The basic model begins with assumption that governments maximize citizen welfare and concludes that tax competition results in an under provision of public goods. There have been many modifications, but perhaps the category of tax competition models that provide the starkest contrasts are known as Leviathan models. Leviathan models start with the assumption that governments are revenue maximizing and conclude that tax competition places restrictions on governments which results in less governmental waste. Both the underlying assumptions and technical components of these models are important to understand how tax competition works.

In the lone model of tax competition that allows for government debt, Jensen and Toma (1991) propose a game theoretic tax competition model where governments are allowed to borrow, as well as tax, to finance government expenditures. They find strong incentives for governments to issue debt as well as a more severe problem of under-provision of government services in the period when the debt is retired. While the general tax competition literature also suffers from a lack of consideration of how horizontal competition works with government debt, the focus of this review will be on vertical externalities associated with debt.
In a typology of government interactions Dahlby (1996) describes three basic types of inter-jurisdictional fiscal externalities that occur when "a government’s tax and expenditure decisions affect the well-being of taxpayers in other jurisdictions" (Dahlby 1996 398). This can happen through either directly changing prices or public good provisions, or indirectly by altering tax revenues or expenditures of other governments. The direct externalities affect the utility functions of non-residents whereas the indirect externalities affect the budget constraints of other governments. These effects are always horizontal between same level governments, whereas the indirect effects can be either horizontal or vertical between different levels of governments. As Dahlby (1996) notes, the externalities can be caused by either taxation or expenditures, and can be both positive and negative. This finding highlights the ambiguous reaction effect throughout the literature.

Where Dahlby (1996) describes externalities arising from tax or expenditure decisions, it can be argued that another set of externalities arise from debt decisions. In Dahlby's framework debt externalities would be classified as indirect because they alter the revenues or expenditures of other governments. The major difference is that unlike tax and expenditure indirect externalities, debt externalities are more likely to be observed vertically because of the shared tax base. Vertical debt externalities may arise when overlapping governments issue debt that leverages the same group of tax payers. If debt is issued it is backed by the revenue from a group of tax payers. When another government that shares that group of tax payer's issues additional tax payer backed debt, that additional debt has a higher risk of default due to the fact that the first government has already leveraged future tax revenue from those tax payers. The ability to issue debt
backed by tax payer revenue results in a fiscal externality in that other governments face higher risk when they issue debt, and that higher risk will be reflected in the interest costs. Thus the ability to issue tax payer backed debt is akin to a common-pool resource.

In the economics literature fiscal externalities, and specifically the problem of common-pool resources (CPR), are well known and often discussed. Common pool resources are traditionally thought to be "sufficiently large natural or manmade resources that it is costly (but not necessarily impossible) to exclude potential beneficiaries from obtaining benefits from their use"(Gardner, Ostrom, Walker 1990). The concept of a CPR has been since extended to include fiscal common-pool resources that maintain the properties of rivalrous and non-excludable, but are applied to taxes and debt issues. In these cases the benefits that go along with public spending are accrued to a particular group, but that group does not bear the full costs associated with those benefits. The main prediction of these models is that the disparity between costs and benefits leads to overspending, and as the fiscal externalities increase (i.e. the number of overlapping governments) spending increases. A natural extension of the fiscal common-pool resource models is that if the number of local governments leads to increased spending, it would also lead to increased levels of debt.

**Vertical Fiscal Externalities**

Compared to the research on horizontal tax competition the vertical externality literature is sparse, but over the last fifteen years the number of both theoretical models and empirical tests of vertical interactions between governments has grown substantially. In his review of fiscal federalism literature Keen (1998) notes that the majority of
federalism literature in economics focuses almost exclusively on the tax implications of horizontal tax competition. In the basic models jurisdictions share a border in order to model how mobile resources move between jurisdictions. The problem with this system is that in reality there are many levels of governments with different borders which often overlap one another. Keen (1998) frames the vertical fiscal federalism issue in terms of concurrent taxation. He shows that common public economics issues such as optimal taxation, redistribution through intergovernmental grants, and the allocation of tax instruments across levels of governments can all be addressed through the framework of vertical tax externalities.

The primary question of vertical externalities in a tax setting is: how does one level of government's taxes change with another level of government's taxes? Flowers (1988) and Johnson (1988) were the first to address issues of vertical externalities associated with a shared tax base. Flowers (1988) concluded that in a federation with Leviathan governments both federal and state level governments may end up on the downward sloping portion of the Laffer curve indicating total taxation is too high. Similarly, Johnson (1988) found that with benevolent government’s tax base overlap may create incentives for state governments to redistribute income to their residents, because the cost of the redistribution would be borne to all federal taxpayers and not just state taxpayers. Both of these finding suggest vertical externalities result in over-taxation.

The theoretical framework of Flowers (1988) and Johnson (1988) has sparked a small body of theoretical vertical externality literature. Similar to the horizontal tax competition literature there is a split between those who model benevolent governments and those who model leviathan governments. In the vertical tax externality literature the
two camps are about equal in number of studies. Directly following Johnson several studies published in the 1990's preferred benevolent governments in models of vertical externalities and government redistribution. For example, Boadway and Keen (1996) and Boadway et al. (1998) both modeled tax and expenditure decisions of benevolent governments with wage income taxes, and concluded that tax rates will be too high if state governments ignore the reduction in federal tax revenues that occurs when a state increases a distortionary tax and shrinks the shared tax base.

One important result from the various models of vertical externalities is the ambiguity of the reaction direction from responses to vertical externalities. For example, Dahlby and Wilson (2003) show that an increase in the provision of a public good at the state level can either increase or reduce federal tax revenues, which leads to either under or over-provision of the state produced good. Their model assumes a tax on wage income at both levels of government, and an inelastic labor supply. Wrede (1999) shows that the Leviathans in a federation tax the fiscal common resource more extensively than the single Leviathan in a unitary state. Wrede (2000) also finds that in a federation some coordination may be optimal, and that the optimal level of coordination between levels of governments depends on the degree of complementarity between public goods and tax bases.

Despite the differences in modeling some overarching themes have stood out. For example, vertical externalities are generally unaccounted for by governments and so they result in over-taxation. Also, there is ambiguity in the direction of tax responses at the different levels of governments. It is unclear whether state’s will raise or lower taxes in response to a rise in federal tax rates, and how federal tax rates would respond to state
changes. Some of this ambiguity seems to arise from the degree of elasticity in the taxed
good and the degree to which state and federally produced public goods are
complementary. To more fully explore the vertical externality mechanisms and how they
work it is important to consider the empirical tests of these theories.

Over the last ten years there have been a series of studies that have empirically
tested these theories, although the empirical literature has concentrated more on the tax
externalities than expenditure externalities. They have ranged in scope from the vertical
externalities that arise across OECD Countries (Goodspeed 2000) to those that arise
between municipalities and school districts (Wu and Hendrick 2009). The more well-
known articles have focused on commodity taxation (Devereux et al. 2007; Besley and
Rosen 1998; and Fredriksson and Mamon 2008), although several studies have
considered person income taxation (Goodspeed 2000; Esteller-More and Sole-Olle 2001),
business income taxation (Hayashi and Boadway 2001; Brett and Pinske 2000; and
Leprince et al. 2004), and local property taxation (Wu and Hendrick 2009). To test the
vertical externality theories reaction functions are estimated for the responses in one level
of government to the taxes of another level of government. The general consensus is that
vertical externalities do result in significant reaction functions, although there are mixed
results as to the sign of the reaction function.

Commodity taxes offer perhaps the most obvious test of vertical tax externalities
because both the federal and state governments in the United States often levy excise
taxes on the same commodities, and there has been a large amount of variation in the
rates. The literature has specifically focused on cigarette and gasoline taxation starting
with Besley and Rosen (1998). Besley and Rosen (1998) found that when the federal
government increases taxes on either cigarettes or gasoline there is a significant positive response in state taxes. For gasoline they found that a 10 cent per gallon increase in the federal tax rate leads to a 3.2 cent increase in the state tax rate. In another study of vertical externalities in cigarette taxation Fredriksson and Mamun (2008) find that a federal tax increase may reduce the amount of generated state tax revenues through both a decline in the state tax base and through the decline of the state tax rate. They show that states may reduce their tax rate on cigarettes by as much as forty-eight cents per dollar increase in the federal tax rate. These two studies are in contrast to Devereux et al. (2007) which suggests that with inelastic demand and low transportation costs federal taxes would have little effect on state taxes, and that the tax rates of neighboring states plays a more important role. Some of the differences in findings may be attributed to how neighboring government tax rates are weighted, and the presence of cross boarder shopping.

In addition to commodity taxes several studies using business taxes, income taxes, and property taxes. The property tax studies are obviously more focused on local governments, since property taxes are not typically levied at the federal level. In a recent study Wu and Hendrick (2009) examined tax competition in Florida local governments including school districts, municipalities, and counties. Their results show different reactions to different levels of interactions, for example, the response of municipal governments is negative to county property tax rate, but positive to school districts prop tax rate. Overall there are significant vertical externalities between all three levels, but different directions of tax reactions. Results show that a ten percent increase in the school districts property tax rate results in a 1.7 and 4.6 percentage point increase in the
municipal property tax rate depending on the model specification. However, the estimates are negative and significant for the county property tax rate variable in all models. A ten percent rise in county property tax rate leads to a 1.4 and 2.3 percentage point drop in the municipal tax rate. These results give rise to interesting questions about how reactions to vertical externalities may be different for a given set of hierarchical relationships.

Aside from empirical tests of tax externalities there have been a couple studies that look at the horizontal and vertical externalities that arise from public expenditures. Revelli (2001) set up a model of public spending determination within two levels of English local governments. He finds the degree of vertical interaction to be significant, and by increasing expenditures counties increase taxpayer burdens which reduces the demand for district level services. Significant horizontal interactions are also found. Overall higher and lower level local government services are found to be complements. Turnbull and Djoundourian (1993) also develop a model of the demand relationship between overlapping government activities for U.S. counties and cities. They find a complementary relationship between the two government’s general service expenditures. However, breaking down expenditures into specific categories they found no effect for police and road expenditures. These findings suggest that while not all municipal and county services are perfect compliments, on the whole increasing expenditures at the county level will also increase spending at the municipal level. In the terminology of the tax reaction literature these studies show a positive expenditure reaction for a lower level government given an increase in expenditures by a higher level government.

In the last ten years the number of empirical tests for vertical interactions between two governments that share tax base has grown to match the theoretical predictions
previous made. Table 2.1 summarizes these empirical tests for both tax and expenditure reactions. As shown the studies have included the major tax types as well as various levels of interaction. While the results are mixed, the trend seems to point to positive reactions of lower level governments to increases in both taxes and expenditure increases by higher level governments.

<table>
<thead>
<tr>
<th>Authors (Year)</th>
<th>Fiscal Type</th>
<th>Level of Interaction</th>
<th>Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Besley and Rosen (1998 )</td>
<td>commodity tax</td>
<td>federal - state</td>
<td>positive</td>
</tr>
<tr>
<td>Fredriksson and Mamun (2008)</td>
<td>commodity tax</td>
<td>federal - state</td>
<td>positive</td>
</tr>
<tr>
<td>Devereux et al. (2007)</td>
<td>commodity tax</td>
<td>federal - state</td>
<td>no reaction</td>
</tr>
<tr>
<td>Hayashi and Boadway (2001)</td>
<td>business tax</td>
<td>federal - province</td>
<td>negative</td>
</tr>
<tr>
<td>Leprince, Mades and Paty (2004)</td>
<td>business tax</td>
<td>region - department</td>
<td>no reaction</td>
</tr>
<tr>
<td>Brett and Pinski (2000)</td>
<td>business tax</td>
<td>province - municipal</td>
<td>mixed</td>
</tr>
<tr>
<td>Goodspeed (2000)</td>
<td>personal income tax</td>
<td>federal - local</td>
<td>negative</td>
</tr>
<tr>
<td>Esteller-More and Sole-Olle (2002)</td>
<td>personal income tax</td>
<td>federal - state</td>
<td>positive</td>
</tr>
<tr>
<td>Esteller-More and Sole-Olle (2001)</td>
<td>personal income tax</td>
<td>federal - province</td>
<td>positive</td>
</tr>
<tr>
<td>Wu and Hendrick (2009)</td>
<td>property tax</td>
<td>county-city-school</td>
<td>mixed</td>
</tr>
<tr>
<td>Revelli (2001)</td>
<td>expenditures</td>
<td>county-district</td>
<td>positive</td>
</tr>
<tr>
<td>Turnbull and Djourdourian (1993)</td>
<td>expenditures</td>
<td>county-city</td>
<td>positive</td>
</tr>
</tbody>
</table>

The obvious gap in the empirical literature mirrors the gap in its theoretical counterpart, which is there has been no consideration of debt in the tests of vertical externalities. The studies by Revelli (2001) and Turnbull and Djourdourian (1993) fall short the full analysis in their discussion of the tradeoff between taxes and expenditures in overlapping governments. A natural extension should then be to consider how government debt would be affected. If expenditures of a city increase with the increased expenditures of a county these government services will either be paid for by an increase
in taxes, as Turnbull and Djoundourian (1993) point out, or they could be paid for by
government borrowing. The second option has not been considered in the existing
literature.

Theoretical Framework

To conceptualize the problem of fiscal externalities arising from debt in a
situation of overlapping jurisdictions it is helpful to think of a city government that shares
a tax base with a school district both of which are within the borders of a county or state
government. In this example when all three governments issue tax backed debt they are
pledging future incomes based on the same tax base. While it may be the case that
different levels of government tax different goods (property, incomes, sales, etc.) they are
still taxing the same geographic area and in most cases have the ability to levy additional
types of taxes to service the debt. In the debt management literature it is well known that
governments are concerned with "debt affordability" or "debt capacity," which is "the
level of debt and/or debt service relative to current revenues that an issuing entity could
support without creating undue budgetary constraints that might impair the ability of the
issuer to repay bond outstanding or make timely debt service payments" (Ramsey and
Hackbart 1996). The problem that arises is that the amount of debt issued by one level of
government may cause another level of government to pay a higher interest rate resulting
in a vertical as well as horizontal fiscal externality.

The subnational government interest rate literature has done a fairly
comprehensive job at explaining the factors that explain variance in interest costs.
Simonsen (2003) reviews some of these studies pointing to a number of studies that use
OLS regression to predict true interest cost, which is the most compressive measure of borrowing costs, with coefficient correlation between .7 and .96. The explanatory variables are usually classified into two groups. The first are factors of the actual bond issue such as the amount of the bond and the credit rating. The second set of factors are economic or financial characteristics such as the government's current level of debt or population. The vertical externalities created by overlapping jurisdictions may affect the ability for governments to repay their debt, which could decrease their credit rating as well as make the overall economic region's ability to repay more risky. This would affect both sets of factors that are commonly associated with true interest costs.

The result of the externality is a common good problem akin to Hardin's (1968) tragedy of the commons where each jurisdiction's marginal cost of accumulating debt is less than the social marginal cost of that accumulation. Each jurisdiction issues debt to increase their own utility or to maximize a representative citizen's utility, and they receive the positive benefit from that debt. The problem is that the externality component reduces the debt capacity and increases the interest rate shared by all the jurisdictions that share that tax base. The effect on debt capacity can be considered in connection with the findings of Trautman (1995) who found that states with decentralized management structures have higher levels of outstanding debt than centralized states. Trautman’s findings support the hypothesis that reduced oversight and institutional control leads to increased levels of borrowing. If these findings are considered in the context of the common-pool resource problem it seems that debt capacity would be affected by a system of overlapping governments.
To develop a theoretical model of these externalities a more simplified scenario is needed. A hierarchical government system with multiple lower level jurisdictions, and one higher level jurisdiction is considered. All jurisdictions levy taxes and issue debt to finance a government service, and the interest paid on government debt is a function of how much debt is borrowed. The following section formalizes this theory in a simplified economic model based on fiscal competition models found in the literature.

**Basic Model**

A standard framework of a second-best world is considered to model debt in fiscal competition with overlapping jurisdictions and vertical fiscal externalities. For simplicity some assumptions need to be made. While these assumptions may not fully capture the complexities of the government debt market, they are necessary to develop a basic economic model.

It is assumed that there are \( N \) identical local government jurisdictions that have the same objectives. As jurisdictions are identical this analysis focuses on the policies of a single representative jurisdiction. Local governments are represented with lower case letters and the state government is represented with upper case letters. All local jurisdictions, and thus the representative jurisdiction, are assumed to be atomistic so that they are price takers in the market for debt. The state government is assumed to be large enough to affect the market, and that is taken into consideration when issuing debt. This assumption may not hold in cases where one jurisdiction makes up the majority of a state, but in cases of federal to state interactions and most state to local government interactions
this is a reasonable assumption. While vertical debt externalities can also be shown without this assumption, but they are more complex and do not add to the analysis.

It is also assumed that the deductibility of interest costs from taxes at a higher level of government are ignored in this analysis. Relaxing this assumption would make for an interesting extension of the model, but is not currently considered. In addition, credit risk factors are assumed to be the same for all levels of governments and all governments make their borrowing decisions simultaneously with perfect knowledge of other government’s decisions. There is assumed to be a large number of identical individuals acting as consumers, workers, and citizens. They are all born at the beginning of period one and die in the second period in a two period finite-horizon case. In the lower level government, and thus the state government there is one input, labor, used in the production of a private good, \( c \), and two public goods, \( g \) and \( G \), both of which are normal goods.

Each individual has the objective function:

\[
U_1(c_1, g, G) + \beta U_2(c_2, g, G)
\]

(1)

Where \( c \) is private consumption, \( g \) is a public good produced by a lower level government, \( G \) is a public good produced by the higher level government, and \( \beta \) is the discount rate of future consumption. In this scenario public goods can be thought of as infrastructure, which a common use of government debt. The utility function for a representative individual, \( U_i \) is continuous, at least three times continuously differentiable, strictly increasing, and strictly concave where \( i \) is the time period. Both governments produced goods, \( g \) and \( G \), are financed through taxes and bonds. Both the lower level governments issue bonds, \( b \), and the higher level government issues bonds, \( B \).
Consumption in period 1, $c_1$, is determined by income, $w_1$, and a lump sum tax $\tau$; whereas consumption in period 2 is determined by income period 2, $w_2$. Debt is exogenously supplied, but the interest rate is a function of the total demand for debt so that:

$$ g = \tau + b $$

$$ G = T + B $$

$$ c_1 = w_1 - \tau - T $$

$$ c_2 = w_2 - (1 + r)b - (1 + r)B $$

$$ r = f(b + B) $$

Maximizing the representative resident’s utility produces a social welfare function.

$$ Max_{b,\tau} w = U_1(w_1 - \tau - T, \tau + b, T + B) $$

$$ + \beta U_2(w_2 - (1 + r)b - (1 + r)B, \tau + b, T + B) $$

Maximizing with respect to both taxes and debt a representative local government chooses gives the first order condition

$$ \frac{\partial w}{\partial b} = -U_{1g} + \beta U_{2g} - \beta U_{2c}(1 + r) = 0 $$

$$ \frac{\partial w}{\partial \tau} = -U_{1c} + U_{1g} + \beta U_{2g} = 0 $$

From (8) and (9) the marginal rate of substitution between period 1 and period 2 consumption for the local government is determined. Once rearranged (12) shows the marginal utility of consumption in period one equal to the discounted marginal utility of consumption in period two times the interest rate. It can also be rearranged to show the
marginal rate of substitution between period one and two is equal to the discounted interest rate (13).

\[ \beta U_{2g}' = \beta U_{2c}'(1 + r) + U_{1g}' \]  \hspace{1cm} (11)

\[ \beta U_{2g}' = U_{1c}' - U_{1g}' \]  \hspace{1cm} (11)

\[ \beta U_{2c}'(1 + r) = U_{1c}' \]  \hspace{1cm} (12)

\[ \frac{MU_1}{MU_2} = \beta(1 + r) \]  \hspace{1cm} (13)

Equation 14 represents the marginal rate of substitution between consumption in period 1 and consumption in period 2 for all local jurisdictions within the state. Since they do not consider their individual effect on the overall interest rate the tradeoff between the two time periods is simply the discounted interest rate. The interest rate is a function of total borrowing, and so each jurisdiction creates an externality when they borrow that is does not factor into their social welfare optimization problem. The externality that is created by local government borrowing can be seen in the state optimization problem,

The state government would maximize the same social welfare function, only they are proving a public good, G, to all local jurisdictions in the state. This means they maximize the same social welfare function times N jurisdictions and choose the amount of state bonds, B, and state taxes, T, that maximize social welfare across all jurisdictions.

\[ \text{Max}_{b,T} W = nU_1(w_1 - \tau - T, \tau + b, T + B) \]  \hspace{1cm} (14)

\[ + \beta nU_2(w_2 - (1 + r)b - (1 + r)B, \tau + b, T + B) \]
\[
\frac{\partial W}{\partial B} = nU'_{1c} + \beta nU'_1(1 + r) + \beta nU'_2(1 + r) - \beta nU'_{2c}(b + B) \frac{\partial r}{\partial b} = 0 \quad (15)
\]

\[
\frac{\partial W}{\partial T} = -nU'_{1c} + nU'_1 + \beta nU'_{2c} = 0 \quad (16)
\]

Solving for the marginal rate of substitution the same analysis can also be done for the state government by rearranging for (15) and (16) and solving for the marginal rates of substitution. Because the state takes into account the effect state borrowing has on the interest rate the last term illustrates the fiscal externality created by the local jurisdictions and internalized by the state government. The term \( \beta nU'_2c(b + B) \frac{\partial r}{\partial b} \) can be interpreted as the total effect on interest rates created by multiple borrowing governments, and will be positive in the state maximization problem where is was zero in the local jurisdiction maximization problem. From the state perspective the social planner considers the direct welfare implications for state borrowing, but also the impact state borrowing has on local government budgets.

\[
\beta nU'_{2c} = \beta nU'_2c(b + B) \frac{\partial r}{\partial b} + \beta nU'_2c(1 + r) - nU'_{1c} \quad (17)
\]

\[
\beta nU'_2c = nU'_1 - nU'_{1c} \quad (18)
\]

\[
\beta nU'_2c(b + B) \frac{\partial r}{\partial b} + \beta nU'_2c(1 + r) = nU'_1 \quad (19)
\]

\[
\beta(b + B) \frac{\partial r}{\partial b} + \beta(1 + r) = \frac{MU_1}{MU_2} \quad (20)
\]

\[
\beta(b + B) \frac{\partial r}{\partial b} + \beta(1 + r) \neq \beta(1 + r) \quad (21)
\]
Since the term $\beta nU^2_z(c(b + B)\frac{\partial r}{\partial b}) > 0$ the externality created by local borrowing is internalized by state borrowing, and the aggregated first period marginal rates of substitution for the local and state government is not equal to the aggregated second period marginal rates of substitution. The distortion causes the tradeoff between public and private consumption between government levels and time periods to be different. It should be noted that this interaction only exists if both governments issue debt, because if not the first term in (20) is zero. If the externality is measured through the interest rate paid on bonds these theoretical results can be used to make several empirical predictions. This model serves as an example of the state and local debt externalities. While lemmas are not proven from the model the results inform the following predictions.

Prediction 1: In overlapping jurisdictions that share a tax base increasing the total amount of debt at one level of government will increase the interest costs paid on tax-backed debt for other levels of government.

Using this basic model as a starting point several extensions can be considered. For example, the model does not account for different types of lower government jurisdictions. This would be a realistic problem where several types of overlapping local governments shared a tax base under a central government. This situation could easily arise in a metropolitan area where a county, city, school district, and municipal district all share a tax base within a state. If this were the case, and the interest rate is maintained as a function of the total demand for public debt it could be formalized as:

$$r = f \left( \sum_{i=1}^{n} b_{1i} + b_{1s} \right)$$
This would not directly affect the marginal rate of substitution for each of the local governments, although from maximizing the social welfare function for all local governments and for the state produces the following marginal rates of substitution:

\[ MRS_{c1c2}^g = \beta (1 + r) \]  

(25)

\[ MRS_{c1c2}^g = \sum_{j=1}^{n} \left( b + B \right) \frac{\partial r}{\partial b} + \beta (1 + r) \]  

(26)

This shows that as the number of jurisdictions increases there are more fiscal externalities, which leads to a second empirical prediction. This prediction is also consistent with the network theory of Complex Adaptive Supply (CAS). These overlapping governments are an interconnected network of multiple entities in a self-organizing market that requires dynamic interactions among agents and their environment. Therefore, adding additional entities to the network increases complexity and makes self-organization more difficult (Pathak et al. 2007).

Prediction 2: As the total number of issuing jurisdictions increases the extent of the externality will increase. Therefore, as the number of overlapping lower level governments increases the interest costs paid on tax-backed debt will also increase.

There are many more extensions to this basic model that could account for more realistic conditions. Future extensions could include a redistribution role for either government through grants or other inter-governmental transfers. This simple model holds taxes and expenditures constant to focus on the externalities related to debt, but a more robust model may consider all three factors. While there are many theoretical and empirical extensions it is important to have a foundation for understanding how debt works in a model of fiscal externalities.
Empirical Framework

From the theoretical section it is predicted that increasing the amount of lower level government debt will increase the interest cost paid by higher level governments. One of the complicating factors in this model is distinguishing the effect of the number of overlapping governments from the effect of aggregate lower level debt (predictions 1 and 2). To address this issue empirically two separate models will be estimated. The first will aggregate all sub-county local government debt to examine the effect of total lower level debt on interest costs of a higher level government bond, and the second will examine the effect of the number of debt issuing governments on the interest costs of a higher level government bond. To correct for any downward bias in the standard errors Huber-White standard errors will be used in an ordinary least squares regression.

These models will be tested on local government tax-exempt bonds. Local governments include city, school district, municipal district, hospital district, community college district, and special district debt. There are several advantages to studying the relationship of overlapping jurisdictions with local level governments as opposed to the relationship between federal and state governments. First, federal and state debt markets may be significantly different because debt levels are a function of economic conditions as well as cultural and political factors that fluctuate with electoral cycles (Clingermayer and Wood 1995). Those differences are likely to be larger between federal and state governments than between overlapping local governments. The research on local government debt, especially in special districts, is less robust so this study adds to that field as well.
The dependent variable for this study is the interest cost paid by county governments on tax-backed debt. While there are several methods for calculating municipal interest rates the public finance literature has been fairly clear on the point that true interest cost is the superior method (Robbins et al. 2001). The true interest cost (TIC) is an overall interest rate indicating the performance of a bond. TIC is the most accurate measure of the total cost of debt issuance, because it takes into account the time value of money and is essentially an internal rate of return (IRR) calculation. This is superior to the alternative, net interest cost (NIC), which is a more simplistic calculation of the average value of the coupon rate.

True interest cost is the interest rate which equates the amount of dollars received by the bond issuer with the present value of the flow of principal and interest payments of the life of the issue so that,

\[ B = \sum_{i=1}^{m} \frac{A_i + I_i}{(1 + TIC)^i} \] (27)

Where \( B \) is the aggregate dollar amount received by the issuer, \( i \) is the number of years to cash payments, \( I_i \) is the aggregate interest payment in period (assuming one interest payment per year, and \( A_i \) is the annual principal in dollars repaid in period \( i \) (Denison 2012). The equation is solved recursively for TIC. This method is more complicated than the NIC method because it accounts for the time value of money. Two bids could have the same NIC but different TICs if one involves higher interest payments in the early maturities of the issuer and lower interest payments in the alter maturities. NIC produces a less complicated average annual cost of debt. NIC is calculated by first
computing the total dollar cost of coupon payments over the life of the bond and then dividing by the bond year dollars (Denison 2012).

There have been many studies that model TIC to answer a variety of questions including the effect of multiple credit ratings (Hsueh and Kidwell 1988), competitive-only laws (Peng and Brucato 2001), income tax differentials (Clarke and Bland 2003), and jurisdiction size and sale type (Simonsen, Robbins, and Helgerson 2001). Some of the key factors identified in these studies that influence TIC are the number and type of credit enhancements including how many credit ratings are purchased, the type of sale, the level of experience of the government issuing the bond, the tax-exempt status of the state in which the bond is being issued, the size of the bond, and the size of the jurisdiction.

To identify the impact of either aggregate lower level debt or the number of issuing jurisdictions the models need to control for other variables that may influence true interest cost. For these controls a fairly standard model of TIC derived from the literature is used. These explanatory variables include total county expenditures, tax debt per capita, a Bond Buyer 20-Bond GO Index, median income, population, par amount, years to maturity, and dummy variables for credit rating categories.

The basic estimating equation for Model 1 takes the form:

\[ t_{ict} = \beta \ln D_{ct} + \gamma X_{ct} + \delta Z_{ict} + \alpha_t + \varepsilon_{ict} \]  \hspace{1cm} (28)

Where \( t_{it} \) is the true interest cost of a county, \( c \), bond issue, \( i \), in fiscal year, \( t \), \( D_{it} \) is the total amount of sub-county debt issued in county, \( c \), in fiscal year \( t \), \( X_{ct} \) is a vector of control variables that vary by county, \( Z_{it} \) is a vector of control variables that vary by
issue, $\alpha_t$ controls for the fiscal year, and $\varepsilon_{it}$ is a random error term. The equation for Model 2 takes the form:

$$t_{it} = \beta \ln N_{ct} + \gamma X_{ct} + \delta Z_{ict} + \alpha_t + \varepsilon_{ict}$$  \hspace{1cm} (29)$$

Where the model is the same except instead of total amount of lower level debt the number of issuing lower level governments is $N_{it}$. The log of both explanatory variables of interest will be used because there are likely to be large values with diminishing marginal impact. This requires counties with no overlapping jurisdiction debt to be dropped.

**Data and Results**

The data used for this study consists of tax-exempt bonds issued by county governments in the state of Texas between fiscal years 2005 and 2010. The data is restricted to general obligation debt, which is different in risk and other characteristics from revenue backed debt. The bond issue data were obtained from the Texas Bond Review Board, an oversight agency that collects, analyzes, and reports information on debt issued by state and local entities as well as approving state debt issues and lease purchases greater than $250,000 or longer than five years maturity. Population estimates for counties came from the Texas State Data Center. Median income estimates are from U.S. Census Bureau’s Small Area Income and Poverty Estimates. The Bond Buyer Indices are from Bondbuyer.com.

The State of Texas has 254 counties, but not every county issues tax-exempt debt in every year. Furthermore, some counties issue debt multiple times in the same year. Out of the 254 counties 113 of them issue tax-exempt debt in this data set. In the 113 that
do issue 64 of them only issued once meaning that the remaining 49 issued multiple times. The top issuer, Travis County, home to the state capital Austin, issued 27 times. The distribution by year also fluctuates with the lowest amount being issued in fiscal year 2009 at 59 issues, and the highest in 2008 at 95 issues. The other years fall between 64 and 84 issues each. The unbalanced nature of the panel will not complicate the analysis. However, it may limit the generalizability of the study to all counties in all years. Conclusions drawn from this analysis only apply to counties that issue debt and have overlapping debt.

Table 2.2 shows the descriptive statistics for the tax-exempt bond sales in Texas. The unit of analysis is Texas Counties that issued tax backed debt between fiscal years 2005 and 2010. The average True Interest Cost (TIC) is just over 4%, and is fairly symmetrical with only slight skewness. The main explanatory variable of interest, amount of overlapping debt, averages $338 million issued by lower level governments within the county. The median is significantly lower at $62 million showing a skewed distribution.

The dependent variable for all models is the TIC of the bond. Model 1’s main explanatory variable of interest is the amount of overlapping debt from lower level governments. The amount of overlapping lower level debt was calculated by aggregating the par value of all tax backed bonds in a fiscal year for local governments located within a county. Local governments include cities, school districts, municipal utility districts, health districts, community college districts, and other special districts. In cases where a lower level government crossed multiple county lines that district’s debt was assigned to
its primary service area county. Note that only counties with overlapping debt are included, and the maximum amount of overlapping debt exceeded $3.3 billion.

The main explanatory variable of interest for (2) is the number of overlapping sub-county governments. The number of overlapping governments figure was calculated by adding up the total number of governments that issued debt within a county, as opposed to the amount of debt that was issued. There was also a wide spread in the number of overlapping governments ranging from zero to 173. The county with 173 overlapping governments is Harris County where the city of Houston is located.

The rest of the explanatory variables are categorized as either county variables, issue variables, or market variables. County variables include the county expenditures, debt per capita, income, and population. These variables are measured by the fiscal year. Issue variables come from each bond that is issued by the county. Issue variables include the par amount (amount of the bond), years to maturity, type of sale (competitive or not), bond insurance, and credit rating if the issue was rated. Market variables are controls for the tax-exempt bond market and include the visible supply for the next thirty days of tax-exempt debt for the State of Texas and the BondBuyer.com Index of 20 general obligation bonds. Visible supply projected for 30 days in the future for each issue while the BondBuyer Index is weekly data.
Table 2.2 Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>True Interest Cost (TIC)</td>
<td>Internal rate of return on a bond</td>
<td>4.042</td>
<td>0.93</td>
</tr>
<tr>
<td>Log (Overlapping Lower Level Debt)</td>
<td>Log amount of tax-exempt debt that has been issued by all sub-county governments in the same fiscal year</td>
<td>18.2</td>
<td>2.19</td>
</tr>
<tr>
<td>Log (Number of Overlapping Governments)</td>
<td>Log number of sub-county governments that share a tax base with the county and issued debt</td>
<td>2.07</td>
<td>1.42</td>
</tr>
<tr>
<td>Texas Visible Supply (in billions)</td>
<td>Amount of debt available over the next 30 days</td>
<td>1.5</td>
<td>0.63</td>
</tr>
<tr>
<td>Total Expenditures (in billions)</td>
<td>Total County Expenditures for the fiscal year</td>
<td>1.87</td>
<td>3.19</td>
</tr>
<tr>
<td>Tax Debt Per Capita (in hundreds)</td>
<td>County Tax Debt per capita for the fiscal year</td>
<td>4.52</td>
<td>5.55</td>
</tr>
<tr>
<td>Bond Buyer Index</td>
<td>A national index of municipal bonds</td>
<td>4.53</td>
<td>0.24</td>
</tr>
<tr>
<td>Median Income</td>
<td>County median income for the fiscal year</td>
<td>46,589</td>
<td>14,080</td>
</tr>
<tr>
<td>Population</td>
<td>County population for the fiscal year</td>
<td>521,941</td>
<td>911,932</td>
</tr>
<tr>
<td>Log Par Amount (in millions)</td>
<td>Amount the bond is being issued for</td>
<td>15.7</td>
<td>1.57</td>
</tr>
<tr>
<td>Years to Maturity</td>
<td>Years to maturity for the bond</td>
<td>13.44</td>
<td>7.55</td>
</tr>
<tr>
<td>Competitive Sale</td>
<td>If the bond was competitively sold</td>
<td>0.11</td>
<td>0.32</td>
</tr>
<tr>
<td>Bond Insurance</td>
<td>If the bond had insurance</td>
<td>0.33</td>
<td>0.47</td>
</tr>
<tr>
<td>AAA</td>
<td>AAA rating by S&amp;P</td>
<td>0.47</td>
<td>0.5</td>
</tr>
<tr>
<td>AA</td>
<td>AA rating by S&amp;P</td>
<td>0.18</td>
<td>0.38</td>
</tr>
<tr>
<td>A</td>
<td>A rating by S&amp;P</td>
<td>0.03</td>
<td>0.16</td>
</tr>
<tr>
<td>No Credit Rating</td>
<td>No rating by S&amp;P</td>
<td>0.32</td>
<td>0.47</td>
</tr>
</tbody>
</table>

There is a large range in the 30 day visible supply suggesting that there are certain times throughout the year when more debt is issued, although on average there is about $1.5 billion worth of tax-exempt debt available. The average county has about $1.87 billion in expenditures and about $452 of debt per capita. These figures are most likely driven by several large counties in Texas. This is further confirmed by the large range in both population and median income. Very few of the issues are competitive sale, meaning they are either issued by negotiated sale or private placement. The majority of
rated issues receive AAA bond ratings from Standard and Poor’s, which is the highest available. In the following model the category of receiving a BBB rating from standard and poor’s is the left out category. It is also noteworthy that roughly a third of issues have no bond rating.

The results for all three models are presented in Table 2.3. Column (1) reports the results from estimating (28) where the main explanatory variable of interest is log par overlap. Column (2) reports (29) results where the main explanatory variable of interest is log number of overlapping governments. Model 3 is an instrumental variable model corrected for endogeneity of log par overlap which may be endogenous if local governments react to the county’s TIC. This is discussed below. Overall all three perform well with a majority of the controls being statistically significant, and an R²’s of roughly 45%. Both Model’s 1 and 2 are estimated with ordinary least squares and Huber-White robust standard errors. The robust standard errors are used to correct for any heteroscedasticity that may exist in the model. It should be noted that counties that had no overlapping debt were dropped from the estimation. These observations are dropped because as specified in the theory section no predictions can be made if there are no overlapping jurisdictions that both issue debt.

It can be shown from the results in (1) in Table 2.3 that the total amount of debt for lower level governments is positive and statistically significant at the .05 level. This suggests that on average increasing the amount of lower level overlapping debt will increase true interest cost for county tax backed debt issues. Specifically, on average a ten percent increase in the amount of overlapping lower level debt (10% increase is approximately an increase the log of 0.10) is associated with a .0065 (0.1 times 0.065,
from the Table 2.3), or 65 basis points, increase in the true interest cost of a county bond issue, ceteris paribus. Considering the average TIC is 4.042% this can be an important factor. For example, the average county has approximately $338 million worth of lower level overlapping debt. If a city within an average county decided to issue a $34 million bond, holding everything else constant, that county's TIC would increase from 4.04% to 4.05%, which over a thirty year bond would be a significant cost increase. The statistical significance offers support for prediction 1, which hypothesized that increasing the amount of debt issued by a lower level government would increase the interest costs of a higher level government.
Table 2.3 Estimation Results

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th></th>
<th>(2)</th>
<th></th>
<th>(3)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Standard Error</td>
<td>Coefficient</td>
<td>Standard Error</td>
<td>Coefficient</td>
<td>Standard Error</td>
</tr>
<tr>
<td>Log Par Overlap</td>
<td>0.065**</td>
<td>0.029</td>
<td>------</td>
<td>------</td>
<td>0.071**</td>
<td>0.030</td>
</tr>
<tr>
<td>Log Num. Overlapping</td>
<td>------</td>
<td>------</td>
<td>0.095**</td>
<td>0.046</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Log Par Amount</td>
<td>-0.082</td>
<td>0.055</td>
<td>-0.076</td>
<td>0.052</td>
<td>-0.084**</td>
<td>0.041</td>
</tr>
<tr>
<td>30 Day Visible Supply</td>
<td>0.130**</td>
<td>0.057</td>
<td>0.129**</td>
<td>0.058</td>
<td>0.130**</td>
<td>0.059</td>
</tr>
<tr>
<td>Total Exp</td>
<td>-0.079**</td>
<td>0.035</td>
<td>-0.074**</td>
<td>0.034</td>
<td>-0.081**</td>
<td>0.036</td>
</tr>
<tr>
<td>Tax Debt Per Capita</td>
<td>0.035***</td>
<td>0.012</td>
<td>0.032***</td>
<td>0.012</td>
<td>0.035***</td>
<td>0.011</td>
</tr>
<tr>
<td>BondBuyer Index</td>
<td>0.482**</td>
<td>0.199</td>
<td>0.457**</td>
<td>0.199</td>
<td>0.483***</td>
<td>0.179</td>
</tr>
<tr>
<td>Median Income</td>
<td>-10.283***</td>
<td>3.970</td>
<td>-10.137***</td>
<td>3.832</td>
<td>-10.569***</td>
<td>3.571</td>
</tr>
<tr>
<td>Population</td>
<td>0.225**</td>
<td>0.108</td>
<td>0.202*</td>
<td>0.109</td>
<td>0.224*</td>
<td>0.118</td>
</tr>
<tr>
<td>Years to Maturity</td>
<td>0.077***</td>
<td>0.011</td>
<td>0.077***</td>
<td>0.010</td>
<td>0.077***</td>
<td>0.006</td>
</tr>
<tr>
<td>Issue Comp Sale</td>
<td>-0.276***</td>
<td>0.070</td>
<td>-0.264***</td>
<td>0.070</td>
<td>-0.276**</td>
<td>0.114</td>
</tr>
<tr>
<td>Issue Insurance</td>
<td>-0.173</td>
<td>0.145</td>
<td>-0.148</td>
<td>0.144</td>
<td>-0.173</td>
<td>0.142</td>
</tr>
<tr>
<td>AAA Rating</td>
<td>-0.065</td>
<td>0.169</td>
<td>-0.078</td>
<td>0.170</td>
<td>-0.067</td>
<td>0.668</td>
</tr>
<tr>
<td>AA Rating</td>
<td>-0.322**</td>
<td>0.149</td>
<td>-0.325**</td>
<td>0.150</td>
<td>-0.323</td>
<td>0.665</td>
</tr>
<tr>
<td>A Rating</td>
<td>-0.567***</td>
<td>0.214</td>
<td>-0.561**</td>
<td>0.220</td>
<td>-0.563</td>
<td>0.688</td>
</tr>
<tr>
<td>No Rating</td>
<td>0.303**</td>
<td>0.125</td>
<td>0.296**</td>
<td>0.124</td>
<td>0.304</td>
<td>0.660</td>
</tr>
<tr>
<td>2006</td>
<td>0.311***</td>
<td>0.104</td>
<td>0.300***</td>
<td>0.100</td>
<td>0.314***</td>
<td>0.119</td>
</tr>
<tr>
<td>2007</td>
<td>0.336***</td>
<td>0.108</td>
<td>0.340***</td>
<td>0.108</td>
<td>0.337***</td>
<td>0.117</td>
</tr>
<tr>
<td>2008</td>
<td>0.036</td>
<td>0.098</td>
<td>0.063</td>
<td>0.100</td>
<td>0.039</td>
<td>0.120</td>
</tr>
<tr>
<td>2009</td>
<td>0.025</td>
<td>0.171</td>
<td>0.027</td>
<td>0.169</td>
<td>0.030</td>
<td>0.156</td>
</tr>
<tr>
<td>2010</td>
<td>-0.065</td>
<td>0.160</td>
<td>-0.085</td>
<td>0.157</td>
<td>-0.059</td>
<td>0.140</td>
</tr>
<tr>
<td>Constant</td>
<td>1.055</td>
<td>1.199</td>
<td>2.075*</td>
<td>1.206</td>
<td>0.992</td>
<td>1.207</td>
</tr>
</tbody>
</table>

Observations: 386 386 386
R-squared: 0.451 0.448

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Several other variables were statistically significant for increasing TIC on average including tax debt per capita, population, years to maturity, and not having a credit rating. These results show that on average having higher debt per capita, having a larger population, longer duration, and not receiving a credit rating all increase true interest costs for counties. On the other side increasing total expenditures, higher median income, competitive bond sales, and credit ratings A through AAA all decrease TIC on average. These results are consistent with existing literature on municipal interest cost models.

The results of Model 2 are similar to Model 1. The positive coefficient on log number of overlapping governments suggests that as the number of governments that share a tax base with the county, and issue tax backed debt, increases the true interest cost paid on county bond issues also increases. This provides evidence to support proposition 2 which hypothesized that as the total number of overlapping jurisdictions increased the extent of the externality would increase, and in this case that externality can be observed through higher interest costs. On average a 10% increase in the number of sub-county governments that have overlapping tax bases with a county will increase that county's TIC by 95 basis points, ceteris paribus. The average number of overlapping governments is about 18, which means that on average if two addition jurisdictions are created within a county that both issue debt that county's true interest cost would also increase from 4.04% to 4.05% (increase of 2/18 times 0.095). This means that both the layering of governments and the stock of overlapping debt influences interest costs, based on the arguments in the theory section that both matter.

Further specifications of these models have also been considered. For example, a county fixed effects model was tested, but the fixed effect was found to not be
statistically significant with a p value of approximately .319 and an F test value of 1.07. The county fixed effect did account for approximately 56% of the variance in true interest cost, but was not close to being statistically significant. Overall the explanatory variables explained around 89% of the fixed effect. Furthermore, the county fixed effect was positively associated with the logged par overlap variable. The correlation coefficient between log par amount overlap and an estimated county fixed effect is 86.6%.

One possible objection to Model 1 with log par amount overlap as the explanatory variable of interest is the presence of endogeneity. If par amount overlap is a measure of the supply of tax-exempt debt, and it is regressed on true interest cost, which is a measure of price, the argument can be made that the two are endogenous. To address this concern the use of an instrumental variable is appropriate. Finding an instrument that is correlated with the amount of total lower level debt of sub-county governments, but should not be included in the original model of TIC is a difficult task. To solve this problem a rather unorthodox instrument is constructed.

As stated previously, county fixed effects are not found to be statistically significant in a model of TIC, and therefore not included in the original model. On the other hand the estimated fixed effects are highly correlated with the amount of overlapping lower government debt. The explanation for this set of results is that historical county factors, such as the degree of fragmentation in that county, are reflected in the county fixed effects. At the same time the market does not consider these historical county factors when determining the interest rate of the bond. Economic conditions and specific issue factors influence interest costs whereas fixed county characteristics do not.
Since county is a geographic designation it is exogenous, and the county fixed effect makes a valid instrument for log par amount overlap.

Statistically this satisfies the requirements of an instrument because estimated county fixed effects do not appear in the original model, are correlated with log par amount overlap, and are exogenous. Theoretically this addresses any questions of endogeneity because county fixed effects can be historical in nature and will capture elements like fragmentation of local governments. A county like Dallas County has considerably more local governments within its borders compared to somewhere like Bexar County because Dallas has historically allowed municipalities and special districts to form easily. Bexar County, on the other hand, is home to the city of San Antonio, which has historically annexed newly developed areas aggressively. Those counties with more fragmentation, and thus more governments, are going to have more entities issuing debt therefore they have more overlapping sub-county debt.

The results of an instrumental variable regression with county fixed effects with the described specifications are listed as Model 3 in Table 2.3. When the county fixed effect is used as an instrument for log par overlap it is still statistically significant, and even has a slightly higher coefficient. The results of Model 3 as a whole look very similar to Model 1 with only slight variations in significance and coefficient magnitudes. Correcting for possible endogeneity on average when log par overlap is increased by 10% true interest cost will increase by 70 basis points. Correcting for endogeneity also makes the log par amount of the bond issue significant and negative so that on average as the amount of bond issue increases the TIC decreases holding everything else constant. It makes sense that larger bond issues would receive more favorable interest rates. The
endogeneity correction eliminates significance of the credit rating variables, which is not too surprising since credit ratings may be captured by the county fixed effects.

**Discussion and Policy Implications**

The results found in the last section are an extension of existing literature on tax externalities to include debt externalities. The majority of vertical tax externality studies focus on the tax reaction of a lower level government to the change in taxes from a higher level government. This analysis focuses on the opposite direction, and aggregates many different lower level governments rather than focusing on one, which makes the results more difficult to compare to previous literature. Also, there is the obvious difference between taxes and debt. While related, there is no direct comparison to be made between a tax reaction and the response in interest costs.

Even with the difficulties in a direct comparison we do observe a positive reaction at the higher level (county) interest rates in response to increased lower level aggregate debt. Of the empirical studies on vertical tax externalities that found a statistically significant reaction the majority of those findings were positive. In fact the only two that were negative involved the interaction between a federal and local government. In the studies of local governments both Revelli (2001) and Turnbull and Djoundourian (1993) found positive reactions between county and district or county and city interactions. Even Wu and Hendrick (2009) who found mixed reaction saw positive reactions between municipal tax rates and the lower level school district tax rates. While the comparisons are not direct there is some evidence that supports the findings for debt externalities being
consistent with existing literature for tax externalities. In the sense that they can be compared this leads to debt competition, the borrowing equivalent of tax competition.

As theorized the debt capacity of a region can be viewed as a fiscal common pool resource. As lower level governments draw on that resource it diminishes the ability of higher level governments to draw on that resource without paying higher costs. As local governments compete over debt resources the institutional constraints, individual government debt policies, and strategic interactions between governments become increasingly important. With millions of dollars’ worth of interest payments at stake local governments should be carefully observing the debt issuing policies of those governments it shares a tax base with. Furthermore, these findings fit into a larger discussion about centralized and decentralized debt policy at the state and local level. If the problem is externalities created through fragmentation and allowing multiple government borrowing power over the same taxing areas then one solution would be to centralize the borrowing in that area.

One major policy implication for these findings is the effect of creating additional governments which overlap an existing tax base. The results from the second model show that on average adding an additional lower level government that issues debt will increase the true interest cost. With multi-million dollar debt issuances this can add up to economically significant amounts. These findings have implications for the fragmentation literature as well as the centralization literature. Speaking only of the effect on debt costs, it may be beneficial to limit the amount of special districts with borrowing power that overlap traditional municipal governments such as cities and counties. Another policy implication is that within coordination across debt issuing jurisdictions there can be debt
competition interactions that increase costs. The increased costs may be avoided through coordination efforts so that future generations are not burdened with higher debt service payments.

This study extends the existing literature of vertical competition and fiscal interactions across overlapping governments, and shows that there are many opportunities to further explore in this line of research. Going forward it would be helpful to look at multiple directions in the effect of externalities. For example, does county debt affect school district interest costs in the same way? It would also be interesting to apply the same theory at different levels of government to see if local debt affects State interest costs. Finally, these effects have been analyzed in isolation so it would be helpful to see how various tax rates change with both level of overlapping debt, number of overlapping governments, and interest costs.

Conclusion

Governments makes fiscal choices based on the tradeoffs between taxation, expenditures, and debt. Each of these fiscal choices has implications beyond the direct impact to the government making the decision. The interaction between governments as taxes and expenditure decisions are made has been explored both across similar governments and between governmental hierarchies. The natural extension of this literature is to consider debt as an alternative to taxes in financing government goods and services, and the indirect effects that may result from those decisions.

This study lays out a basic conceptual framework and model to think about the externalities that arise from overlapping governments that are issuing debt. The model
predicts that interest costs will rise as the level of total amount of debt being issued in a region rises. Results from three different models show that on average both the total amount of lower level government debt that overlaps a county as well as the total number of governments issuing that debt increases the true interest costs that a county pays on tax backed bonds. These results have several policy implications for centralization and fragmentation of governments, the creation of special districts with borrowing authority, and the types of fiscal competition in which local government are involved. Given the current importance of debt at all levels of government these are important considerations for fiscal policy and interregional governance.
Chapter 3
Local Government Risk Assessment:
The Effect of Government Type on Credit Rating Decisions

Introduction

Over the last twenty years state and local governments have been borrowing more funds to finance infrastructure needs. An important component of determining the interest costs of that debt has been credit ratings. Credit ratings are grades assigned by one of three major agencies that convey information about the fiscal and economic health of a government. These ratings are used as a source of information for evaluating the risk associated with a debt instrument such as a municipal bond. The literature on governmental credit ratings is vast, and addresses a variety of factors associated with risk assessment. One factor that has not been fully considered has been the differences between types of local governments, and the comparison of traditional municipalities such as cities and counties to various special districts.

When governments issue debt they face a variety of decisions related to credit ratings. They have to decide whether or not they want to be rated, how many ratings they want, and who they want to purchase ratings from. While high credit ratings are shown to lower interest costs an estimated twenty-five percent of local governments choose not to be rated. Avoiding the ratings market represents a real option for some governments, but the types of local governments that make this choice is unclear. Those who decide to purchase a rating have a choice of three main stream options: Standard and Poor’s, Moody’s, and Fitch. The decision to get rated by just one, a combination of any two, or
all three is an interesting one that has not been fully explored especially in the context of comparing different types of local governments.

As the amount of state and local debt has increased the make-up of local government governance has also changed. Over the last twenty years the number of city and county governments has grown slowly, the number of school districts has decreased, and the number of special districts has increased greatly (Board of Governors of the Federal Reserve System). Special district governments are an interesting group because they are usually created for specific purposes, are given limited taxing powers, and usually have the ability to issue general obligation debt. Debt issued by special districts has been a main driver in the growth of total local government debt. While the literature on special districts is somewhat limited it has been shown that they operate differently than traditional municipalities (Ostrom, et al. 1961). The differences in risk assessment by different types of local governments have implications for understanding the complete local government debt picture.

The Role of Credit Ratings

Credit ratings have been found to influence borrowing costs in several empirical studies, yet the credit rating decision process of local governments not fully understood. Local governments are responsible for paying for their own credit ratings, and some chose not to go through the expensive process. Generally a high credit rating is considered necessary to get the best interest rate, because credit ratings provide signals of risk quality to the market and reduce uncertainty. This allows local governments from around the country to have access to investors that may not be familiar with that
particular government’s financial health. With increased access to debt markets
government’s tax-exempt bonds can be sold faster and with lower interest rates. The
function of the credit rating can be divided into three categories: as a source of
information, as an evaluator of risk, and as a determinate of interest costs (Ziebell and
Rivers 1992; Rivers and Herring 1986).

It is commonly assumed that credit ratings represent a source of information about
the financial, economic, and administrative environment of the entity being rated.
Historically it has been found that investors do not always have access to financial and
economic information on cities (Morse and Deely 1983; Jovanovic 1982). And while this
access may have been somewhat mitigated by electronic resources that were not available
at the time of these studies it is still reasonable to assume that either there is a lack of
transparency with municipal financial data (Reck and Wilson 2006), or the information
presented is not easily understood (Copeland and Ingram 1982, Davidson et al. 1977). In
either case information asymmetry exists between issuers and investors. In an effort to
close the gap in information credit ratings are a signal to the market with additional
information for investors. In addition to condensing and synthesizing the information,
ranking agencies also claim to have access to additional information not privy to the public
(Pottier and Sommer 1999).

The information provided by rating agencies may be used in a variety of ways,
but the primary use is in the evaluation of risk. At the most basic level ratings are used to
designated bonds that are “investment grade,” that is a bond that has a rating of at least a
BBB for Standard and Poor’s and Fitch or Baa for Moody’s. Some institutional investors
have regulations that prohibit the investment is bonds that are not investment grade.
Beyond the investment grade distinction each letter grade is subdivided into subcategories. For example, Standard and Poor’s and Fitch have a plus minus system (AA+, AA, AA-), and Moody’s adds a 1, 2, or 3 to ratings (Aa1, Aa2, Aa3). The subcategories denote relative strength and weakness within each rating category. These signals can be used to differentiate the risk associated with relative ratings.

The additional information and the evaluation of risk that come from credit ratings plays an important role in determining the interest cost of government bonds. In an efficient market governments with higher credit ratings will pay lower interest costs, because they are less risky investments. Lower credit ratings signal to investors increased risk of ability to repay debt so investors will demand higher interest costs as compensation for greater risk. Credit ratings have been a standard factor in models of interest cost over the last thirty years (Bland 1980; Bland and Chen 1990; Robins and Simonsen 1996, 1999, 2001). Debt service payments are of the upmost importance in government budgets because without debt service access to credit markets is severely restricted. Given the importance of debt service government have a strong incentive to obtain the lowest interest rates possible, thus they have incentives to obtain high credit ratings.

The Decision to be Rated

Credit ratings close information asymmetries which allow investors to more readily evaluate risk, and ultimately determine interest costs. An interesting question becomes why some governments choose not to purchase any ratings when selling bonds. There may be several possible reasons why governments may not purchase credit ratings
despite their ability to close information asymmetries. For example, if the financial or
economic situation of a government is extremely poor there may be no advantage to
closing information gaps and allowing investors a chance to completely evaluate the risk
(Reeve and Herring 1986). The government may not be hiding their risk, but simply there
would be no benefit from purchasing a rating. In this case the assumption is that only the
lowest quality governments chose to be nonrated. This perspective has gained some
support from several findings that suggest nonrated bonds have on average higher interest
costs (Jantscher 1970; Bensen 1979).

The perspective that nonrated bonds are of uniformly lower quality than rated
bonds is challenged by Reeve and Herring (1986) who argue that nonrated bonds are
either self-selected or are the result of rational cost/benefit analysis from the inherent
riskiness of an issue. Their results indicate that nonrated bonds are systematically
different from rated issues. They find that unrated bonds are smaller, have shorter
average maturity, issued by smaller governments, and have fewer bids from underwriters
compared to rated bonds. Moon and Stotsky (1993a) in a model correcting for sample
selection bias also find that volume of debt, geographic location, and city size are
significant determents of the decision to obtain a rating. Reeve and Herring (1986) find a
market distinction between small nonrated bonds and large nonrated bonds. Smaller (less
than one million par value) nonrated bonds were found to be priced 10 basis points lower
than the lowest invest grade class, while large nonrated bonds were priced an average of
30 basis point higher than the lowest investment grade class. This finding suggests that
lower governments may be better off not purchasing rating.
Similarly, Ziebell and Rivers (1992) studied the various characteristics associated with non-rated securities and found that smaller cities have a lower probability of being rated than large cities. They also find that small non-rated cities vary greatly across several economic, financial, and demographic characteristics, and that specific variables can be used to distinguish between cities that seek ratings and those that do not including geographic region indicators. The results of this study show that nonrated issues should have quality characteristics similar to investment grade issues, and that the decision to purchase a rating for small cities is related to their per capita incomes, densities, and rates of population growth. There was no evidence to suggest that rated and nonrated cities of similar sizes were statistically different in financial, economic, or demographic characteristics.

While there have only been a handful of studies that examine the factors that determine a government’s choice to obtain a credit rating there is surprising consensus. All three studies found that the size of issue as well and the size of the government are both important determinates in the decision to obtain a rating. Reeve and Herring (1986) as well as Ziebell and Rivers (1992) posit that smaller governments conduct a cost-benefit analysis, and determine that the savings from a potential decrease in interest cost does not outweigh the price of a credit rating.

Aside from the choice to be rated governments also choose how many total ratings to purchase. Choosing the number of credit ratings is a decision that has received less attention in the academic literature. While there are studies that look at whether a private firm purchases an optional third rating (Pottier and Sommer 1999; Jewell and Livingston 2002) there is an absence of studies that model the number of government
ratings including the possibility of not purchasing a rating. Hsueh and Kidwell (1988) test the impact of a second credit rating on the issue borrowing cost of a municipality. Specifically they looked at two different scenarios. The first is if a municipality acquires a second rating that is at the same level, and the second is if they acquire a second rating that is a different level. They found that in cases where the ratings were the same category interest costs were lower, and in cases where the second rating was more favorable than the first the interest costs were lower than interest costs associated with the less favorable rating. Their findings suggest that two credit ratings provides additional information, and that split ratings where the second rating is more favorable results in reduced borrowing costs. While this finding is useful, it does not look at the specific determinants of purchasing an additional rating, and those determinant’s marginal effects.

Picking a Rating Agency

Once a government decides to obtain a rating they have to decide how many ratings they want, and which agencies they should get ratings from. There are three major rating agencies: Standard and Poor’s, Moody’s, and Fitch Ratings. They often assign the same rating to a given government, but there are cases of split ratings where the same government is given different ratings by different agencies. All three agencies assign a letter grade from a series starting with the highest grade of AAA (Moody’s) or Aaa (Standard and Poor’s and Fitch) and end with C (Moody’s) or D (Standard and Poor’s and Fitch). To answer the question why a government would choose to be rated by one agency over another it is necessary to consider the differences in how agencies assign
ratings. One of the primary ways these differences have been explored in the literature is through split ratings.

According to Ederington (1986) there are three explanations for split ratings. The agencies could have different standards in how they assign ratings and what constitutes a given grade, they could have different evaluation methods or assign different weights to certain factors, or the differences could be completely random. In a comparison between Standard and Poor’s and Moody’s Ederington finds no evidence of differences in standards or evaluation methods, and concludes that the difference represent random differences of opinion on issues who creditworthiness close to the borderline between ratings.

Alternatively, Moon and Stotsky (1993b) develop a system of equations to model the determinants of a municipality’s rating for Moody’s and Standard and Poor’s using smoothed maximum likelihood estimation. They formally test the differences between the two agencies and find that self-selection is important in Moody’s ratings while not in Standard and Poor’s ratings. Contrary to Ederington’s (1986) study they find that split ratings reflect differences in both the weight attached to specific determinants of ratings as well as differences in the way the bonds are classified. These contrasting findings can be attributed to several important differences in both data and methods. The first is that Ederington’s sample consisted of industrial bonds, while Moon and Stotsky’s study used cities. The second difference is the sophistication in methods used in each study. Ederington used a relatively simple ordered probit, while Moon and Stotsky use smooth simulated maximum likelihood estimation in a system of equations.
In a slightly different third study Cantor and Packer (1997) examine firms that purchase a third optional rating after the automatic rating from Moody’s and Standard and Poor’s, and test whether differences in credit ratings for a particular firm reflect different rating scales or result from sample selection. They find that the third agency, usually Fitch, assigned a higher average rating which was not from selection bias, but rather from differences in rating scales. They then look at why firms choose to obtain additional ratings and find that firms are more likely to obtain a third rating if they are large and experienced issues in the capital market.

There have several empirical studies that model the factors that attribute to credit ratings for different agencies, although the majority of these studies are for industrial bonds of firms rather than governments. Pottier and Sommer (1999) identify factors influencing the decision of insurance firms to obtain a rating or multiple ratings, the determinants of ratings for three agencies, and reasons for differences across agencies. They find that higher leverage is associated with greater uncertainty, and thus a lower rating. This finding is consistent with Cantor and Packer’s (1997) findings. They find that firms with higher growth have a lower probability of getting a rating, and that larger firms tend to have higher ratings. They also find that rating agencies differ systematically in weighting various factors. Moody’s appears to use a much smaller number of publicly available quantitative factors in its rating process, and may rely on more private or qualitative information. The cutoff points between ratings (AAA, AA, etc.) are not statistically different.

In a comparison of Moody’s and Standard and Poor’s ratings to Fitch Jewell and Livingston (2002) compare the rating levels, rating changes, and relative impact of bond
yields of industrial firms. Their results show that firms with publicly available Fitch ratings have high ratings from Moody’s and S&P than firms without Fitch ratings. Firms that release a Fitch rating on average have a lower yield, a more stable rating, and are more likely to receive an upgrade. They find evidence that 85% of the difference in the mean rating when a firm has all three ratings is caused by selection bias. This is in contrast to the Pottier and Sommer (1999) study that found no evidence of selection bias. This difference could be attributed to the type of firm that is being studied. Pottier and Sommer (1999) were using insurance companies, while Jewell and Livingston (2002) were using industrial bonds.

In a test of the different determinants of Moody’s and S&P ratings for municipalities Moon and Stotsky (1993) find that self-selection is found to be important in Moody’s ratings while not in those of S&P. They find that split ratings appear to reflect differences in both the weight attached to certain determinants and differences in the way bonds are classified. This is slightly different from the Pottier and Sommer (1999) findings that suggest no differences in classification or cutoff points. This is also contrasted with Ederington (1986) who found no systematic differences between the rating agencies in their ratings of industrial bonds. These finds could be driven by a less restrictive smooth simulated maximum likelihood estimation used by Moon and Stotsky (1993).
Theoretical Framework

The underlying theoretical motivation in the literature on credit ratings is the theory of financial intermediation. The principal role of credit rating agencies is the reduction of ex ante uncertainty or informational asymmetry about the probability of financial distress (Ramakrishnan and Thakor 1984; Millon and Thakir 1985; Pottier and Sommer 1999). So that the greater uncertainty about the risk of an issuer the greater the incentive and value of credit rating. A credit rating represents an outside opinion of the fiscal health of an organization, which decreases the uncertainty and decreases the information asymmetry between issuer and purchaser. This relationship implies that factors that lead to higher levels of uncertainty will increase the likelihood of purchasing one or more credit ratings.

While every government that issues a bond has some inherent uncertainty there has been little research on the differences in the amount of uncertainty associated with different types of local governments. In fact there has been little research on the credit rating or risk assessment of non-municipality local governments. An exception is Denison et al. (2007) considers the effect of management performance on credit ratings of school districts. While they include school districts under the heading of “municipality” there is little discussion of the commonality between school districts and the cities or counties that have been previous subjects of analysis.

While the particular levels of uncertainty associated with different types of local government is somewhat ambiguous there are several reasons to believe that there will be differences. Traditionally municipalities such as cities and counties have been used to
study credit risk in local governments. These municipalities are contrasted with a myriad of special-purpose governments including school districts, water districts, community college districts, hospital districts, and many others. These different types have various revenue streams and infrastructure needs. In general, because cities and counties have access to a wider range of revenue streams they have more flexibility to adjust to market conditions and therefore have less uncertainty. Comparing traditional municipalities to special-purpose governments it is expected that special-purpose governments will have higher uncertainty, and therefore will have higher demand for credit ratings.

Government size has been recognized in the literature as a driving indicator in the decision to be rated, but type of government could also be an important factor. If a cost-benefit analysis is the reason for not purchasing a rating there are several factors associated with size that may produce the same rating decision. For example, the resources available to the government as well as the scope of the projects that are to be funded will both differ with government size. Different types of local governments will have a variety of revenue sources, and thus available resources, as well as a variety of projects that need to be funded. Certain special districts are created for purposes that require large infrastructure investments such as hospitals for health districts or sewer systems for water districts. These types of districts may be large in population, but small in scope.

By modeling the effect of various types of local governments on credit rating decisions this study adds depth the government size explanation in the literature. Several facets of the rating decision are to be modeled including: the selection of a credit rating agency, the probability of being unrated, and the decision of how many ratings to
purchase. While there are several interesting explanatory variables in these models the
one that has yet to be fully identified in the literature are the differences between types of
local governments namely counties, cities, school districts, and a variety of special
districts. This study aims to both describe the credit rating choices made by local
governments and estimate the impact various factors have on both the agency choice and
the number of ratings choice.

**Empirical Framework**

In modeling the choice of credit rating agencies there are several econometric
issues that have to be addressed. For example, the decision to be rated by all three
agencies will be related. That decision can be related in two ways. The first is that the
error terms are not independent, and the second is that the decisions are recursively
determined. To address the covarying error term scenario the following equations are
estimated:

Propensity to be rated by S&P
\[ y_{s,i} = X_{s,i} \beta_{s,i} + \epsilon_{s,i} \]  

Propensity to be rated by Moody’s
\[ y_{m,i} = X_{m,i} \beta_{m,i} + \epsilon_{m,i} \]  

Propensity to be rated by Fitch
\[ y_{f,i} = X_{f,i} \beta_{f,i} + \epsilon_{f,i} \]  

Where \( i = 1, \ldots, N \) where \( N \) denotes the number of observations and \( y_{k,i} \) where \( k \)
denotes the rating agency (s, m, f). \( X_i \) is a vector of explanatory variables including a
type of government, type of bond sale, type of bond (GO or Revenue), bond insurance,
 bond amount, total tax rates, years to maturity, population, and cost of bond issue. In the
above set of equations the error vectors \((\epsilon_s, \epsilon_m, \epsilon_f)\) are assumed to be identically and independently distributed with the following trivariate normal distribution:

\[
\begin{pmatrix}
\epsilon_{s,1} \\
\epsilon_{m,2} \\
\epsilon_{f,3}
\end{pmatrix} \sim N_3 \left( \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{bmatrix} 1 & \rho_{12} & \rho_{23} \\ \rho_{12} & 1 & \rho_{23} \\ \rho_{13} & \rho_{23} & 1 \end{bmatrix} \right)
\]

One complicating factor is that we do not directly observe \(y_{k,i}^*\), but rather binary variables \(y_{k,i}\) in the following manner where \(1(\cdot)\) is the indicator function:

\[
y_{k,i} = 1(y_{k,i}^* > 0)
\]

From this set up the likelihood functions can be derived and maximized using simulation-based estimation methods developed by McFadden (1989) and Pakes and Pollard (1989) (Moon and Stotsky 1993). A simulation method is used in a maximum likelihood estimation of the multivariate probit regression (Greene 2003, 931-933; Cappellari and Jenkins 2003). This technique evaluates a multivariate normal distribution using the GHK smooth recursive conditioning simulator. The GHK simulator has several nice properties including “the simulated probabilities are unbiased, they are bounded within the \((0,1)\) interval, and the simulator is continuous and differentiable function of the model’s parameters” (Cappellari and Jenkins 2003).

The simulated maximum likelihood (SML) estimator is also consistent as the number of draws and the number of observations goes to infinity. This means the SML estimator properties are asymptotic as long as the sample size increases with the number of estimating equations. Simulation bias can be reduced by increasing the number of draws as the sample size increases. To ensure the number of draws is sufficient it should exceed
the square root of the sample size (Hajivassiliou and Ruud 1994, 2416–2419). Following this guideline the following estimations will use one hundred draws.

The second scenario in which the decisions to be rated are related is that jurisdictions decide which agencies to get rated by through a recursive process. Rather than making independent decisions they go through a series of decisions for each agency. For example, a city would decide to be rated by S&P, given that decision they decide to be rated by Moody’s, and finally decide to be rated by Fitch. To set up a recursive process some assumptions have to be made as to the sequence of agency ratings. The following recursive process is based on the number of total ratings that are being given by each agency. In a sample of Texas bonds Standard and Poor’s rate the most (6,820), Moody’s rates the second most (4,471), and Fitch the least (1,703). Therefore I set up the following set of recursive equations:

Propensity to be rated by S&PP

\[ y_{s,i}^* = X_{s,i} \beta_{s,i} + \epsilon_{s,i1} \]  

Propensity to be rated by Moody’s

\[ y_{m,i}^* = X_{m,i} \beta_{m,i} + y_{s,i}y_{s,i} + \epsilon_{m,i} \]  

Propensity to be rated by Fitch

\[ y_{f,i}^* = X_{f,i} \beta_{f,i} + y_{s,i}y_{s,i} + y_{m,i} + \epsilon_{f,i} \]  

In this system a jurisdiction decides to be rated by Standard and Poor’s then decides to be rated by Moody’s factoring in the decision to be rated by Standard and Poor’s, and finally decides to be rated by Fitch considering the decision to be rated by the first two. While this is one possible set of systems it seems to be the most likely scenario if the decisions are directly related. The error terms of the recursive equations are also joint normal, and are estimated using the same multivariate probit technique.
Data

The credit rating selection process will be modeled for each local government bond issue assuming that each government has the choice to purchase a rating from Standard and Poor’s, Moody’s, and Fitch. The dependent variable for each agency equation will be whether or not the Texas local government was rated by that particular agency. The main explanatory variables are dummy variables that specify the type of local governments. Government types include: city, school district, community college district, water district, and other special district (hereby referred to special districts). The reference category is county government. There are also a series of control variables including dummy’s for revenue bond or lease purchase bond (the reference category is general obligation), debt outstanding, negotiated or competitive sale (the reference category is privately placed), bond insurance, a total tax rate, population, year to maturity on the bond issue, the assessed property value of the district in the previous tax year, a dummy variable for whether the district is in a metropolitan statistical area, a dummy if the district borders overlap multiple counties, and a figure of general cost of issuance.

The control variables are chosen from previous studies, and are designed to capture the factors associated with choosing a rating. Reeve and Herring (1986) found that average maturity, government size, and underwriter competition mattered for unrated bonds. Moon and Stotsky (1993a) found that volume of debt, geographic location, and city size are significant factors. While Ziebell and Rivers (1992) found that while smaller governments have a lower probability of being rated they varied on economic, financial, and demographic characteristics. These sources of variation are controlled for in the all the following models.
The data used for this study consists of bond issues in the state of Texas between fiscal years 2000 and 2010. The bond issue data were obtained from the Texas Bond Review Board, an oversight agency which collects, analyzes, and reports information on debt issued by state and local entities as well as approves state debt issues and lease purchases greater than $250,000 or longer than five years. In total there are 10,899 bond issues, but because of missing data for tax rates and assessed values 1,661 observations are dropped leaving a sample size of 9,238. The majority of the governments issuing bonds are cities, school districts, and water districts.

Table 3.1 shows a cross-tabulation of the type of government and rating agency. While this table over counts the number of bond issues because governments can be rated by multiple agencies it gives an overview of the percentage frequency distributions. As shown there are trends in the rating agency choice by type of government. Cities, counties, and community college districts tend to be rated by S&P and Moody’s whereas health districts have a larger relative proportion that are not rated. School districts are rated more frequently by Fitch, and other special districts by Moody’s. A chi square test shows that there is a statistically significant relationship between rating agency and type of local government (α=.005).

<table>
<thead>
<tr>
<th>Table 3.1 Rating Agency Crosstab</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>SP (%)</td>
</tr>
<tr>
<td>Moody’s (%)</td>
</tr>
<tr>
<td>Fitch (%)</td>
</tr>
<tr>
<td>Not Rated (%)</td>
</tr>
<tr>
<td>N</td>
</tr>
</tbody>
</table>
The percentage cross tab for type of local government and the number of credit ratings is shown in Table 3.1. The majority of cities, counties, community college districts, and other special districts purchase two ratings, while the majority of school districts and water districts only purchase one rating. Health districts stand out because the over half of them do not purchase any credit ratings. From Table 3.1 it can be seen that the majority of the bonds with ratings from all three agencies are municipalities rather than special purpose governments.

<table>
<thead>
<tr>
<th>Type of Government</th>
<th>City</th>
<th>County</th>
<th>Community College</th>
<th>Health</th>
<th>Special</th>
<th>School</th>
<th>Water</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Ratings</td>
<td>0</td>
<td>31.79%</td>
<td>25.76%</td>
<td>17.95%</td>
<td>53.39%</td>
<td>22.73%</td>
<td>13.73%</td>
<td>26.91%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>19.27%</td>
<td>20.61%</td>
<td>20.51%</td>
<td>21.19%</td>
<td>18.18%</td>
<td>43.57%</td>
<td>60.88%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>35.35%</td>
<td>38.33%</td>
<td>51.92%</td>
<td>20.34%</td>
<td>47.73%</td>
<td>38.45%</td>
<td>10.28%</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>13.59%</td>
<td>15.30%</td>
<td>9.62%</td>
<td>5.08%</td>
<td>11.36%</td>
<td>4.25%</td>
<td>1.93%</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>3,960</td>
<td>621</td>
<td>156</td>
<td>118</td>
<td>88</td>
<td>3,009</td>
<td>2,947</td>
</tr>
</tbody>
</table>

The descriptive statistics for the continuous control variables population, debt outstanding, assessed property value, and years to maturity by number of ratings are in Appendix A. While the majority of local governments are rated at least once about 25% of local government bonds that are not rated. In general the nonrated governments are smaller, have lower amounts of debt outstanding, and have a lower assessed property value. Of those governments that were rated 4,047 (37%) were only rated once, 3,242 (30%) were rated twice, and 821 (7.8%) were rated three times. On average governments with more credit ratings also have higher average populations, debt outstanding, and assessed property values.
The descriptive statistics broken down by type of government are in Appendix B. Some interesting results from looking at the explanatory variables by type of government include the amount of debt outstanding for other special districts, which has an average of $306 million. The rest of the local government types average between $14 and $40 million. Also, the community college districts have the largest average assessed property value although the highest single government assessed value is a special district. The average time to maturity is relatively similar across types of government, which suggest that they are issuing similar amounts of short and long term debt.

Results

Table 3.3 presents the empirical results from the trivariate probit model estimation, which estimates equations 1, 2, and 3. These equations estimate the effect of local government type on the propensity of receiving a rating from each rating agency. The control variables for type of bond (GO, LP, Revenue), type of sale (negotiated sale and competitive sale), bond insurance, population, debt outstanding, overlapping districts, issuing cost, and being in an MSA all increase the propensity to be rated by all three agencies. On average the control variables have less statistical significance in predicting a Fitch rating. The total tax rate is an interesting result because it is negative for both S&P and Moody’s, but is positive for Fitch. Conversely the assessed property value is only statistically significant for the Fitch rating, and as property value increases the propensity of a Fitch rating decreases.

Overall there is a statistically significant relationship between type of local government and rating agency selection. The reference category for each rating selection
equation is the county government, which means that in the S&P equation being a city increases the propensity to be rated by S&P, while being a community college district, health district, and special district lowers the propensity for a S&P rating. In the Moody’s equation being a community college district, health district, special district, and water district all lower the propensity to be rated by Moody’s when compared with a county government. Also, the negative coefficients on special district and water district in the Moody’s equation are at least five times as large as the other coefficients. The Fitch equation results for cities and community college districts are similar to S&P, but the coefficient on health district is positive while the coefficients on school and water districts are negative and statistically significant.
## Table 3.3 Multivariate Probit Results

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>City</td>
<td>0.243***</td>
<td>0.0427</td>
<td>0.277***</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(0.0857)</td>
<td>(0.0755)</td>
<td>(0.0849)</td>
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</tr>
<tr>
<td>Community</td>
<td>-0.588***</td>
<td>-0.348**</td>
<td>-0.760***</td>
<td></td>
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<tr>
<td>(0.177)</td>
<td>(0.152)</td>
<td>(0.172)</td>
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<tr>
<td>Health District</td>
<td>-0.733***</td>
<td>-0.274</td>
<td>0.490*</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(0.263)</td>
<td>(0.242)</td>
<td>(0.282)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Special District</td>
<td>-0.627**</td>
<td>-1.503***</td>
<td>-0.0276</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.317)</td>
<td>(0.362)</td>
<td>(0.335)</td>
<td></td>
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<tr>
<td>School District</td>
<td>-0.140</td>
<td>0.128</td>
<td>-0.434***</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(0.111)</td>
<td>(0.105)</td>
<td>(0.136)</td>
<td></td>
<td></td>
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<tr>
<td>Water District</td>
<td>-0.0858</td>
<td>-1.526***</td>
<td>-1.565***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.0966)</td>
<td>(0.0881)</td>
<td>(0.135)</td>
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<tr>
<td>Revenue Bond</td>
<td>-0.0167</td>
<td>0.147**</td>
<td>0.203***</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(0.0708)</td>
<td>(0.0602)</td>
<td>(0.0637)</td>
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<td></td>
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<td></td>
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<tr>
<td>Lease Purchase</td>
<td>-0.356*</td>
<td>-1.204***</td>
<td>-0.355</td>
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<tr>
<td>(0.205)</td>
<td>(0.263)</td>
<td>(0.246)</td>
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<td></td>
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<tr>
<td>Negotiated Sale</td>
<td>2.110***</td>
<td>1.531***</td>
<td>1.630***</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(0.0616)</td>
<td>(0.0618)</td>
<td>(0.0957)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp Sale</td>
<td>1.907***</td>
<td>1.835***</td>
<td>1.161***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.0668)</td>
<td>(0.0677)</td>
<td>(0.103)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Bond Insurance</td>
<td>0.761***</td>
<td>0.546***</td>
<td>-0.0184</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.0407)</td>
<td>(0.0404)</td>
<td>(0.0501)</td>
<td></td>
<td></td>
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<tr>
<td>Total Tax Rate</td>
<td>-0.199**</td>
<td>-0.583***</td>
<td>0.677***</td>
<td></td>
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<tr>
<td>(0.0828)</td>
<td>(0.0846)</td>
<td>(0.121)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Population</td>
<td>0.761***</td>
<td>0.563***</td>
<td>2.376***</td>
<td></td>
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<tr>
<td>(0.266)</td>
<td>(0.187)</td>
<td>(0.210)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years to</td>
<td>0.00107</td>
<td>-0.000304</td>
<td>0.00430*</td>
<td></td>
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</tr>
<tr>
<td>(0.00232)</td>
<td>(0.00214)</td>
<td>(0.00257)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Debt</td>
<td>2.510***</td>
<td>2.381***</td>
<td>1.079***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.661)</td>
<td>(0.464)</td>
<td>(0.403)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Assessed Value</td>
<td>0.00546</td>
<td>-0.000391</td>
<td>-0.0234***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.00385)</td>
<td>(0.00276)</td>
<td>(0.00312)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Issuing</td>
<td>0.581***</td>
<td>0.101</td>
<td>0.385*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.190)</td>
<td>(0.186)</td>
<td>(0.233)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Overlaps</td>
<td>0.273**</td>
<td>0.447***</td>
<td>0.114</td>
<td></td>
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<tr>
<td>(0.112)</td>
<td>(0.0958)</td>
<td>(0.105)</td>
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<tr>
<td>MSA</td>
<td>0.187***</td>
<td>0.511***</td>
<td>0.590***</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(0.0436)</td>
<td>(0.0418)</td>
<td>(0.0579)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-1.969***</td>
<td>-1.787***</td>
<td>-3.553***</td>
<td>-0.727***</td>
<td>-0.0471*</td>
<td>-0.239***</td>
</tr>
<tr>
<td>(0.108)</td>
<td>(0.102)</td>
<td>(0.145)</td>
<td>(0.0255)</td>
<td>(0.0279)</td>
<td>(0.0264)</td>
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<tr>
<td>Observations</td>
<td>9238</td>
<td>9238</td>
<td>9238</td>
<td>9238</td>
<td>9238</td>
<td>9238</td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, * p<0.1
We can also interpret the rho value between each pair of rating agencies to analyze the covariation of the unmeasured characteristics in each model. The rho values for both the S&P-Moody’s pair and the Moody’s-Fitch pair are statistically significant and negative. This means that the unmeasured information is having a negative impact on purchasing a Moody’s rating compared with S&P and Fitch. The results for rho provide evidence that there are opposing factors in the choice to be rated by S&P and Moody’s, and similarly for Moody’s and Fitch. This suggests that S&P and Moody’s ratings are substitutes as opposed to compliments, which is a divergence from the literature (Hsueh and Kidwell 1988; Moon and Stotsky 1993).

There are also interesting results for the control variables. Local governments are more likely to be rated by S&P if they are issuing more traditional general obligation or revenue bonds when compared to a lease-purchase bond. Similarly they are more likely to be rated by S&P if they are issuing negotiated or competitively sold bonds as opposed to privately placed bonds. Positive coefficients on population and debt outstanding for S&P, Moody’s, and Fitch suggest that as local governments get larger and have more debt they are more likely to be rated by all three agencies. Also they are more likely to be rated by all three if the local government is in a designated metropolitan statistical area. Interestingly if the local government geographic boarders crossover multiple county lines they are also more likely to be rated by S&P and Moody’s than Fitch. In Texas this overlapping jurisdiction finding is most likely to apply to water districts.

The marginal probabilities of success for each equation can also be computed from the estimated equations. Figure 3.1 is a graph of the average marginal probability of success for each agency by type of local government. In this case “success” implies the
purchase of a rating. This shows that most government types have the highest probability of being rated by S&P, and the lowest probability of being rated by Fitch. The exception being health districts which have a higher probability of being rated by Moody’s. As shown the marginal probabilities vary by type of government. Cities, counties, and school districts look relatively similar while water districts have almost no probability of being rated by Fitch. Special districts have almost the same probability of being rated by Moody’s and Fitch. It is important to keep in mind that these are averages, and they control for the various other variables in the model.

![Figure 3.1 Average Marginal Probability of Success](image)

Since 25% of all local government bonds are unrated an equally interesting question is what the marginal probability of not being rated for each government type. The marginal probability of not being rated is the same as the joint probability of all three rating agency equations being equal to zero. Solving for \( Pr(y_k = 0, \forall k) \), where \( k = S&P, Moody’s, and Fitch \) is the marginal probability of not purchasing a rating. The same can be done for the joint probability of receiving a rating from all three agencies.
Figure 3.2 is a graph of the average joint probabilities of no rating or being rated by all three agencies. As shown cities actually have the highest probability of not being rated, despite health districts having a higher frequency of no rating. On average health districts have the highest probability of being rated by all three agencies. In general the average probability of not being rated is higher than the average probability of being rated by all three agencies. The average probability of not being rated for all types of governments is 22% while the average probability of being rated by all three agencies is only 12%.

![Figure 3.2 Average Joint Probability of No Rating or Rated by All Agencies](image)

The results for the multivariate probit with simultaneous equations are shown in Table 3.2 (only type of government coefficients shown). In this specification the decision to purchase subsequent ratings depends on which agency the jurisdiction was rated by previously. This process is solved recursively with S&P being chosen first, Moody’s second, and Fitch third. In general the results from this estimation look similar to the
previous results, although there is more statistical significance. The coefficient for S&P rated in the Moody’s equation and Moody’s rated in the Fitch equation are both negative. This offers further support that the Moody’s rating is a substitute for S&P and Fitch rating.

There are also a few differences in the coefficients on the local government types. For example, being a health district now decreases the propensity to be rated by Moody’s. The same is true for school districts and water districts in the S&P equation. The coefficient sign does not change for any of the variables, but there is more statistical significance. The sign and significance also stays the same for the rho values on the S&P-Moody’s rho and the Moody’s-Fitch rho, although the coefficient decreases on both. Interestingly the S&P-Fitch rho is also negative and statistically significant in this estimation. It is insignificant and positive in the first model. The full model results in are Appendix C.
Table 3.4 Recursive Multivariate Probit Results

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>S&amp;P Rated</td>
<td>-1.146***</td>
<td>0.00307</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.0947)</td>
<td>(0.110)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Moody's Rated</td>
<td></td>
<td>-0.266***</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>(0.101)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City</td>
<td>0.201**</td>
<td>0.0812</td>
<td>0.294***</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.0880)</td>
<td>(0.0795)</td>
<td>(0.0857)</td>
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</tr>
<tr>
<td>Community College District</td>
<td>-0.605***</td>
<td>-0.498***</td>
<td>-0.791***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.181)</td>
<td>(0.162)</td>
<td>(0.175)</td>
<td></td>
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</tr>
<tr>
<td>Health District</td>
<td>-0.847***</td>
<td>-0.538**</td>
<td>0.486*</td>
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<tr>
<td></td>
<td>(0.268)</td>
<td>(0.258)</td>
<td>(0.285)</td>
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<tr>
<td>Special District</td>
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<td>-1.942***</td>
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<td>(0.379)</td>
<td>(0.344)</td>
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<td>School District</td>
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<td>0.0996</td>
<td>-0.418***</td>
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<tr>
<td></td>
<td>(0.113)</td>
<td>(0.112)</td>
<td>(0.138)</td>
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<tr>
<td>Water District</td>
<td>-0.200**</td>
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<tr>
<td></td>
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<td>(0.0962)</td>
<td>(0.149)</td>
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<tr>
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<td>-4.040***</td>
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<td>-0.0984*</td>
<td>-0.0921*</td>
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<td>(0.285)</td>
<td>(0.0451)</td>
<td>(0.0528)</td>
<td>(0.0553)</td>
</tr>
<tr>
<td>Observations</td>
<td>9,238</td>
<td>9,238</td>
<td>9,238</td>
<td>9,238</td>
<td>9,238</td>
<td>9,238</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Number of Ratings

The decision to be rated by each of the three rating agencies is inherently connected
to the decision to purchase multiple ratings. Estimating the effects of various factors on
the decision to purchase additional ratings requires a different model. The number of
ratings that are purchased for each bond issue is a count variable, and there are several
methods that can be used to estimate count variables. A negative binomial regression is
used in this case because there may be over dispersion, every government has the same
exposure time, and there are not an excessive number of bonds with no rating (Lawless
1987). A poisson model was also tested and similar results were found.
In this regression the dependent variable is the number of credit rating each local government received. The explanatory variables are the same as the rating decision equation. The incident rate ratios (IRR) and the coefficients of the negative binomial regression are presented in Table 3.5. The IRR transformation is used for interpretation.

From the IRRs it can be shown that being a city increase the expected number of ratings by 10% compared to a county, whereas community college districts get rated about 20% less often. Special districts and water districts both get rated about 40-45% less often than counties on average. Compared to a lease purchase being a general obligation bond increases the expected number of ratings by 63% whereas being a revenue bond increases the expected number of ratings by 70%. Both negotiated and competitively sold bonds increase the expected number of credit ratings by about 1200% compared to privately placed bonds. Purchasing bond insurance increases the expected number of ratings by about 30%, and being in a MSA increases the expected number of ratings by 40%. Also, local governments that overlap multiple counties also increase the expected number of ratings by 12%. Each additional million dollars in issuing costs is associated with an estimated 30% increase in the number of rating, while each additional million people (population) are associated with a 60% increase. Surprisingly the amount of debt outstanding does not affect the number of credit ratings.
From these results it can be shown that all local governments are not equal when it comes to credit ratings. The type of local government matters in both the choice of which rating agency to select, and how many ratings to purchase. In the decision of which agency to be rated by local governments have the choice of S&P, Moody’s, and Fitch. Of those the majority of cities choose to be rated by S&P (37%) and Moody’s (30%). Holding all other variables constant on average being a city increases the propensity of being rated by S&P and Fitch compared with counties. Cities are also 10% more likely to purchase an additional rating than counties.

<table>
<thead>
<tr>
<th>Variable</th>
<th>IRR</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>City</td>
<td>1.104**</td>
<td>0.0991**</td>
</tr>
<tr>
<td>Community College District</td>
<td>0.794***</td>
<td>-0.231***</td>
</tr>
<tr>
<td>Health District</td>
<td>0.860</td>
<td>-0.151</td>
</tr>
<tr>
<td>School District</td>
<td>1.017</td>
<td>0.0169</td>
</tr>
<tr>
<td>Special District</td>
<td>0.595**</td>
<td>-0.519**</td>
</tr>
<tr>
<td>Water District</td>
<td>0.541***</td>
<td>-0.614***</td>
</tr>
<tr>
<td>General Obligation</td>
<td>1.633***</td>
<td>0.491***</td>
</tr>
<tr>
<td>Revenue</td>
<td>1.709***</td>
<td>0.536***</td>
</tr>
<tr>
<td>Negotiated Sale</td>
<td>12.51***</td>
<td>2.527***</td>
</tr>
<tr>
<td>Competitive Sale</td>
<td>12.05***</td>
<td>2.489***</td>
</tr>
<tr>
<td>Bond Insurance</td>
<td>1.331***</td>
<td>0.286***</td>
</tr>
<tr>
<td>Total Tax Rate</td>
<td>0.879**</td>
<td>-0.129**</td>
</tr>
<tr>
<td>Population</td>
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<td>0.485***</td>
</tr>
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<td>0.000633</td>
</tr>
<tr>
<td>Debt Outstanding</td>
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<td>9.95e-05</td>
</tr>
<tr>
<td>Assessed Value</td>
<td>1.000***</td>
<td>-3.58e-06***</td>
</tr>
<tr>
<td>General Issuing Cost</td>
<td>1.298***</td>
<td>0.261***</td>
</tr>
<tr>
<td>Overlaps Multiple Counties</td>
<td>1.120**</td>
<td>0.113**</td>
</tr>
<tr>
<td>MSA</td>
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<td></td>
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<tr>
<td>Ln(α)</td>
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<td></td>
</tr>
<tr>
<td>Likelihood ratio test α =0</td>
<td>Chibar=0</td>
<td></td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, * p<0.1

89
While city and county credit rating agency choice have both been studied in previous literature, the inclusion of multiple special purpose governments adds a new dimension to the study of credit rating decisions. Four types of special purpose governments are explicitly modeled with a fifth category of other special districts. In the decision to be rated by each of the three agencies the special purpose governments act similarly in that they have lower propensities to be rated. What differs between them is the magnitude of the difference. For example, water and special districts have significantly lower propensities to be rated by Moody’s (Figure 3.1 and 3.2). Looking across all of the results an interesting pattern emerges. School district rating decisions are closely related to both city and county decisions. This can be seen in the frequency distributions of rating agencies, the coefficients on ratings by each agency, and the probabilities of not being rated. These results suggest that school district decision making may be closer to municipalities than other special districts.

By looking at the frequency distributions for each type of special purpose government the differences in agency preference can be seen. The majority of community college districts are rated by S&P, the majority of school districts are rated by Fitch, the majority of special districts are rated by Moody’s, and the majority of health districts are not rated at all (Table 3.1). There is less variability in the number of ratings by type of government since the majority of municipalities and community college districts purchase two ratings, the majority of school and special districts purchase one rating, and the half of health districts go unrated.
Conclusion

Debt financing is an important tool in local government finance. As local governments of all types turn to debt financing the factors that attribute to their interest costs and access to financial markets are important issues. Credit ratings are one option that local governments can use to reach markets they would not usually have access to, and to receive lower interest rates by purchasing signals of credit worthiness from independent agencies. Local governments have several decisions to make in the credit rating process. First they have to decide whether or not to purchase a rating. If they do enter the credit rating market they have to choose which agency to purchase a rating from, and how many ratings to purchase. The process of making these choices may be systematically different depending on the type of local government that is making them.

Several patterns emerge from both the frequency tables and the statistical analysis of the decision to be rated by a credit rating agency. The first is that cities and counties are similar in their decision making process. Cities have a higher propensity to be rated by S&P and Fitch, but the average marginal probabilities of being rated by each agency are approximately equal. Also, the percentage frequencies of the amount of cities and counties that are rated by each agency are similar. Cities are about 10% more likely to receive an additional rating on average, but in terms of the percentage frequency of number of ratings municipalities are similar.

Perhaps more surprising is that school districts also behave similarly to traditional municipalities. The percentage frequencies tell a story of differences, but once all the control factors are considered the decision to be rated by each agency is similar to both cities and counties. Aside from school districts having a lower propensity of being rated
of being rated by Fitch they are not statistically different from counties in rating agency decision. The biggest difference between municipalities and school districts is that on average school districts have a lower probability of being unrated. This could be a result of school districts needing access to credit markets more than cities and counties. Over 70% of school districts are negotiated sale bonds, which is contrasted with 14.5% of bonds competitively sold. The type of sale suggests either lower access to competitive markets, or a preference for negotiated sales.

The rest of the special districts include community college districts, health districts, water districts, and other special districts. These districts types are different from municipalities, but they are also different from each other. There are differences in terms of both the agencies that they are likely to purchase ratings from, their average probabilities of not being rated, and in the number of credit ratings they are likely to purchase. One of the interesting variables that may be attributing to these differences is the assessed property values. Property values would be directly related to the district’s ability to raise revenues since the property tax is a major tax source for special districts in Texas. Other interesting factors that may affect the decision of who to be rated by, and how many ratings to purchase are population, overlapping multiple counties, issuing costs, and being in an MSA. The amount of debt outstanding affects which agency the districts choose, but doesn’t have an effect on the number of ratings.

Often in the literature and popular media special purpose governments are lumped together into one group. These findings suggest that the label “special districts” may be too vague, at least when describing issues of debt financing. These special purpose governments are different in how they choose to access credit markets, and those
differences may be important in determining both the total amount of debt that is issued, and the interest costs paid on that debt. Going forward it may be prudent to consider school districts closer to municipalities, and distinguish other special purpose governments as completely separate entities.

Pervious literature on local government credit rating decision making has been limited to municipalities. From these previous studies it was found that government size as an important factor in predicting an unrated bond. The hypothesis is that for smaller governments the costs of purchasing rating would exceed the benefits from that rating. By exploring the differences in local governments while controlling for population and assessed property value the effect of government type on credit rating decisions can be seen. The results are varied showing that special purpose governments cannot be grouped together when describing credit rating decisions. While government size does matter, the probability of not being rated is generally higher for municipalities than other special districts. Several other factors increase the probability of not being rated including being a privately placed bond (compared to competitive or negotiated sale) and a lease-payment bond (compared to general obligation and revenue bonds). It should be noted that the generalizability of these findings to non-Texas governments is unknown, because there may be differences in rating agency markets shares by state that could affect these findings.

From a policy maker perspective these difference can be important when assigning functions to different levels of governments. For example, in the decision to provide water that task can be given to a municipality (city or county), or a separate government can be set up to handle only water distribution (water district). There are likely to be
different borrowing costs associated with these two options, and those borrowing costs will be determined in part by the credit rating agency and the number of ratings. From this analysis we can see that water districts are most likely to be rated by Standard and Poor’s and about 60% of all water districts purchase one rating, although there is about a 20% chance that they go unrated. These decisions will all result in various borrowing costs, and ultimately different interest payments.
Chapter 4

Semiparametric Estimation of Municipal Interest Cost:

Average Derivative Estimation

Introduction

The sale of bonds is an important tool for state and local governments, and has seen an increased role in government finance over the last ten years. For example, in 2011 there was about $315 billion worth of new state and local government securities issued, which is approximately twice the number of new security issues in 2001 (Federal Reserve Board of Governors). These funds are used in a range on projects, but are generally used to fund infrastructure needs. Given the frequency of this financing method it is apparent that the interest costs governments pay on debt is an important point in public finance. The repayment of debt is important for governments to maintain strong credit ratings, and thus access to credit markets. Debt service payments are an important expenditure for most governments, and to predict future debt service payments an accurate estimate of the interest rate is needed.

Starting with Sorensen (1979) and continuing through current literature modeling municipal interest cost has been of increasing importance. Unfortunately the techniques and methods used in this modeling have not changed. The standard ordinary least squares (OLS) regression has been the go-to method for most social scientists, and so it is no surprise it has been the method of choice in public finance. OLS is a popular method within the parametric class of estimations, meaning it assumes a specific probability distribution to make inferences about estimated parameters. Parametric statistics is contrasted with nonparametric statistics, which assumes either no particular probability
distribution or no functional structure of the relationship between variables. In between lays semiparametric techniques which contain components both classes of methods.

The advantages of nonparametric and semiparametric methods are that they can estimate parameters without imposing unnecessary assumptions about the distribution of variables, or their relationships. In terms of public economics and policy analysis this is particularly useful because it allows for the estimation of marginal impacts of explanatory variables with minimal assumptions. One specific semiparametric method developed by Stoker (1992) is average derivative estimation (ADE). ADE allows us to estimate the average marginal impact that each explanatory variable has on a dependent variable without assuming the structure of the relationship. This is contrasted with OLS regression, which assumes that the explanatory variables are linear in their parameters. This study reviews the theory and application of ADE, and applies ADE to the estimation of municipal interest costs, and compares the results to a standard OLS model. We find differences in the statistical significance of explanatory variables, but when ADE is assumed to be a single index model the relationship is fairly linear which offers support to the standard model of true interest costs.

**Municipal Interest Cost**

There are several methods for calculating municipal interest rates, but the public finance literature has come to the consensus that true interest cost is the superior method (Robbins, Simonsen, and Jump 2001). The true interest cost (TIC) is an overall interest rate indicating the performance of a bond. TIC is the most accurate measure of the total cost of debt issuance, because it takes into account the time value of money and is
essentially an internal rate of return (IRR) calculation. This is superior to the alternative, net interest cost (NIC), which is a more simplistic calculation of the average value of the coupon rate.

There have been many studies that model TIC to answer a variety of questions including the effect of multiple credit ratings (Hsueh and Kidwell 1988), competitive-only laws (Peng and Brucato 2001), income tax differentials (Clarke and Bland 2003), and jurisdiction size and sale type (Simonsen, Robbins, and Helgerson 2001). There are significant factors identified in these studies that influence TIC such as: the number and type of credit enhancements, the type of sale, the level of experience of the government issuing the bond, the tax exempt status of the state in which the bond is being issued, the size of the bond, and the size of the jurisdiction. All these factors are included in our models.

Multiple regressions are the most common method used in the estimation of TIC. In general the factors that influence municipal bond interest rates can be classified into two categories: market factors and issue characteristics (Simonsen 2003). Market characteristics include factors like current market rates or economic conditions. Issue characteristics include specifics of the bond structure such as the type of sale, various credit ratings of the bond, whether or not the bond has insurance, and total amount of debt borrowed (par amount). As Simonsen (2003) points out the R^2 of these models are generally good and can explain up to 96% of the variance in TIC (Simonsen and Robbins 1999).
A potential concern with these studies is that they all utilize a simple ordinary least squares (OLS) regression, or semi-log OLS model in their estimation. This means that typical models are shown to have a high $R^2$ based on the non-trivial assumption that the relationship between the explanatory variables and the true interest cost is linear. Theoretically there is no reason in the literature to assume a linear relationship between the variables, in fact there is no theoretical work to suggest any functional form of the relationship. The basic question at hand is how various factors explanatory factors affect true interest cost. Specifically public administrators and policy analysts would like to know the marginal impacts of each explanatory variable. The purpose of this paper is to estimate a model in which no functional form is assumed, and no prior assumptions about the distribution of the data is assumed. To this end several non-parametric and semi-parametric techniques are available. To use the least amount of restrictions on the model, and ask only the effect explanatory variables have on true interest cost average derivative estimation is an appropriate estimation option.

**Average Derivative Estimation**

Average derivative estimation (ADE) was originally developed by Hardle and Stoker (1989), Powell, Stock and Stoker (1989), and Stoker (1992) as a semiparametric estimation technique to provide an alternative method for determining the correct functional form without presupposing unnecessary assumptions on the model. ADE is a particularly useful technique for policy analysis because it allows marginal impacts to be directly estimated. As Stoker (1992) argues semiparametric methods are “designed to permit estimation of parametric and auxiliary functions simultaneously, without specific
assumptions on the forms of the unknown functions” (Stoker 1992, 5). Being able to evaluate the marginal impact of policies without unjustified assumptions is of considerable importance for economists and policy analysis.

While the theory of ADE is well developed the application of ADE in empirical literature is somewhat limited. Originally ADE was applied in the estimation of various factors that affect automobile collisions (Hardle and Stoker 1989; Stoker 1992). Lee, Kwak, and List (2000) also utilized ADE in the estimation of hedonic pricing models and found the results consistent with theoretical predictions suggesting it is a viable alternative to traditional models. Huang and Fu (1999) used ADE to estimate a semiparametric stochastic frontier regression. They then applied the technique to data on farmers’ credit unions in Taiwan to find that banking services exhibit economies of scale, and there is a high degree of cost inefficiency in their operation. Finally, Deaton and Ng (1998) compared ADE to OLS in a study of tax reform and food prices in Pakistan. While they recognize that “ADE is attractive in principle, because it directly estimates the statistics required for policy analysis,” they find that each method has its own strengths and weaknesses (Deaton and Ng 1998, 900). In each of these studies ADE is used because the authors wanted an estimation technique that was free of assumptions about the form or distribution of the data.

As stated above ADE requires few assumptions, but it is not completely assumption free. First we assume that $x_t$ affects $y_t$ and is either exogenous or predetermined. We assume $x_t$ is continuous and first differentiable with some probability density function $f(x)$, which is also first differentiable. We denote the mean regression of $y$ on $x$ as $m(x) = E(y|x)$ so that,
\[ y = m(x_t) + \varepsilon_t \]

We also define \( l_t \):

\[ l_t = \frac{f'(x_t)}{f(x_t)} = \frac{d \ln f(x_t)}{dx_t} \]

Such that,

\[ E(-l_t y_t) = - \int \frac{f'(x_t)}{f(x_t)} f(x_t) \, dx_t \]

Or,

\[ E(-l_t y_t) = - \int f'(x_t) m(x_t) \, dx_t - \int f'(x_t) \varepsilon_t \, dx_t \]

Where \( \int f'(x_t) \varepsilon_t \, dx_t \) converges in probability to zero in the limit so that,

\[ E(-l_t y_t) = - \int f'(x_t) m(x_t) \, dx_t \]

Solving with integration by parts yields

\[ E(-l_t y_t) = \left[ f(x_t) m(x_t) \right]_{-\infty}^{\infty} - \int \left[ -f(x_t) \frac{dm}{dx_t} \right] \, dx_t \]

Where again \( f(x_t) \) converges in probability to zero so that the whole first term drops out leaving

\[ E(-l_t y_t) = E \left( \frac{dm}{dx_t} \right) = \delta \]
Where \( \delta \) is the average derivative. While it is not strictly necessary, we can then impose a single index condition on the ADE so that:

\[
m(x_t) = g(x_t' \beta)
\]

This then implies,

\[
\frac{dm}{dx_t} = \beta \frac{dg(x_t' \beta)}{dx_t' \beta}
\]

For the result on the line above we can standardize \( E \frac{dg(x_t' \beta)}{dx_t' \beta} = 1 \) and estimate \( g(\cdot) \) with a semiparametric regression of \( y_t \) on \( x_t'b \) where \( b \) is an estimate of \( \beta \). ADE uses a nonparametric kernel estimation of \( f(x) \) to estimate delta (equation 10).

\[
f(x) = \frac{1}{n} \sum_{i=0}^{n} K \left( \frac{x_j - x_i}{h} \right)
\]

Where \( K(\cdot) \) is the kernel function and \( h \) is the bandwidth parameter.

We use the Epanechnikov kernel which has been proved to be optimal for minimum variance (Epanechnikov 1969). An Epanechnikov is a standard kernel that spreads points quadratically as opposed to a normal distribution or other such shapes (see Silverman (1986) for further discussion of kernels). The choice of kernel is independent and does not influence regression results. The bandwidth is chosen using likelihood cross-validation (LCV). In LCV the kernel density estimates are assumed to be asymptotically normally distributed, \( f(x_j) \sim N(\mu, \sigma^2) \). Then the likelihood function is maximized with respect to the bandwidth \( h \), so that:
\[
\max_{\lambda} \frac{1}{n} \sum_{j=1}^{n} \ln f(x_j)
\]

LCV is based on minimizing the Kullback-Leibler distance, which is the distance between a true underlying distribution and the estimated distribution (Silverman 1986; Horne and Garton 2006). Using LCV in picking a bandwidth is an extension of using a likelihood to “judge the adequacy of fit of a statistical model. It is of general applicability, not just in density estimation” (Silverman 1986, 52).

As an example, the kernel density estimate is graphed for the dependent variable TIC below. It can be seen from this that the true interest cost from our sample of Texas bonds is not normally distributed. While the kernel density itself is not important for ADE, the assumption of an existing probability distribution is needed.
As discussed in Hardle and Stocker (1989) and Lee et al. (2000) ADE is root-$n$ consistent and asymptotically normal, which makes it theoretically comparable to other more traditional parametric estimators. Given these properties a standard t-test can be used to compute statistical significance with the average derivative estimates, and their corresponding-covariance matrices. The comparability of ADE to more traditional models provides an excellent opportunity to compare parametric and semiparametric estimates of the same parameters to test assumptions about functional form. This study makes this comparison between a typical OLS regression common in the municipal interest rate literature and ADE.
Model and Data

To examine the differences that may arise between a parametric and semiparametric estimation a standard model of TIC consistent with the literature is considered. Two separate models will be estimated. The first is a typical OLS regression where the dependent variable is TIC and the explanatory variables are a standard mix of market factors and issue factors. The second model is an ADE model that is set up with the same dependent and explanatory variables. Because of the root-n consistency the resulting coefficients and t-statistics will be directly comparable. Although not required by ADE we also assume a single index for the purpose of graphically depicting the transformation function $g(x_i \beta)$.

The explanatory variables are fairly standard from the literature and are recognized as such in Simonsen, Robbins, and Helgerson (2001) as well as Simonsen (2003). Credit ratings are usually classified as A, AA, or AAA by either Standard and Poor’s, Moody’s, or Fitch credit rating agencies and then treated as a series of dummy variables. There are several problems with this classification technique. For example, if treated as a series of dummy variables it is not possible to find the average derivatives of these variables. An alternative to dummy variables is to create an index of risk associated with a bond issue. Indicators such as ordinal credit ratings, bond insurance, and type of sale are all variables that assess the risk to investors. These variables can be factor analyzed to create indices that serve as continuous risk variables. These new variables are equivalent to propensity scores of risk.
Factor Analysis is a standard technique in psychometrics that has also been successfully applied in economics and policy analysis. One of the main uses of factor analysis is to identify common factors associated with a set of dependent variables that are all measuring some latent variable. For example, credit ratings by Standard and Poor’s, Moody’s, and Fitch are all indicators of the credit risk associated with a particular government or bond. So in this case credit risk would be the latent variables, and the credit ratings from each agency would be the indicators. All three ratings are attempting to measure the same thing, and so they have a common factor. In addition to the credit ratings indicators such as whether the bond was sold as a competitive bid or a negotiated sale or whether the bond is insured are also measures of credit risk. All these indicators can be factor analyzed to estimate the common factors. In econometrics this common factor is perfectly equivalent to a random effect.

Finally, two variables are included that are not typically modeled. One is the total visible supply of municipal debt at the closing date of the issue (Denison 2001). Municipal bonds are required by law to be announced thirty days before sale. Since all the bond sales in the dataset are tax exempt basic supply theory suggests that as the supply of tax exempt debt increases price of that debt will decrease. The second new variable is a measure of existing debt per capita. Debt per capita will be directly related to the risk associated with a government, and thus the price they pay on future debt. While we may not be the first to consider these factors, they are not standard in all models of TIC. Listed below are the explanatory variables and their descriptions:
• **30 Day Visible Supply** – Amount of total tax exempt debt that is scheduled to be available in the thirty days after issue date. Includes city, school district, and special district debt.

• **Total County Expenditures** – Total amount of county expenditures for the fiscal year

• **Tax Debt Per Capita** – Amount of tax backed debt per capita for county residents

• **Bond Index** – A Bond Buyer 20-Bond GO Index for the week the bond was sold

• **Income** – Median Income estimate for the county

• **Population** – Population estimate for the county

• **Par Amount** - The size of the bond in dollars

• **Maturity** – Number of years until final bond maturity

• **Common Factor 1** – Low Credit Risk Factor

• **Common Factor 2** – Medium Credit Risk Factor

• **Common Factor 3** – High Credit Risk Factor

The data used for this study consists of tax exempt bonds issued by county governments in the state of Texas between fiscal years 2005 and 2010. For comparability we restricted the data to only general obligation debt. The bond issue data were obtained from the Texas Bond Review Board, an oversight agency which collects, analyzes, and reports information on debt issued by state and local entities as well as approves state debt issues and lease purchases greater than $250,000 or longer than five years. Population estimates for counties came from the Texas State Data Center. Median Income estimates are from U.S. Census Bureau’s Small Area Income and Poverty Estimates. The Bond Buyer Indices are from Bondbuyer.com.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
<th>Skewness</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.0408</td>
<td>0.009</td>
<td>0.0132</td>
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<td>1,410</td>
<td>669</td>
<td>202</td>
<td>4,150</td>
<td>0.717</td>
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<tr>
<td>Total Expenditures (in millions)</td>
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<td>3,190.00</td>
<td>2.3</td>
<td>14,800</td>
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<td>Tax Debt Per Capita</td>
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<td>Bond Buyer Index</td>
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<td>4.51</td>
<td>0.24</td>
<td>3.94</td>
<td>5.85</td>
<td>1.206</td>
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<td>17,843</td>
<td>81,875</td>
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<td>121,889</td>
<td>911,932.10</td>
<td>845</td>
<td>4,092,459</td>
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<td>33</td>
<td>0.14</td>
<td>322</td>
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<td>0.32</td>
<td>0</td>
<td>1</td>
<td>2.448</td>
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<tr>
<td>Bond Insurance</td>
<td>0.33</td>
<td>0</td>
<td>0.47</td>
<td>0</td>
<td>1</td>
<td>0.714</td>
</tr>
<tr>
<td>AAA</td>
<td>0.47</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
<td>1</td>
<td>0.126</td>
</tr>
<tr>
<td>AA</td>
<td>0.18</td>
<td>0</td>
<td>0.38</td>
<td>0</td>
<td>1</td>
<td>1.665</td>
</tr>
<tr>
<td>A</td>
<td>0.03</td>
<td>0</td>
<td>0.16</td>
<td>0</td>
<td>1</td>
<td>5.95</td>
</tr>
<tr>
<td>No Credit Rating</td>
<td>0.32</td>
<td>0</td>
<td>0.47</td>
<td>0</td>
<td>1</td>
<td>0.756</td>
</tr>
<tr>
<td>Risk Factor 1 - Low</td>
<td>0</td>
<td>-0.71</td>
<td>1</td>
<td>-1.25</td>
<td>1.12</td>
<td>0.08</td>
</tr>
<tr>
<td>Risk Factor 2 - Med</td>
<td>0</td>
<td>-0.15</td>
<td>1</td>
<td>-1.01</td>
<td>1.96</td>
<td>1.03</td>
</tr>
<tr>
<td>Risk Factor 3 - High</td>
<td>0</td>
<td>-0.09</td>
<td>1</td>
<td>-0.64</td>
<td>9.28</td>
<td>5.76</td>
</tr>
</tbody>
</table>

Table 4.1 shows the descriptive statistics for 461 tax exempt bond sales. The average TIC is 4.04%, and is fairly symmetrical with only slight skewness. There is a large range in the 30 Day Visible Supply suggesting that there certain times throughout the year when more debt is issued, although on average there is about $1,540 million worth of tax exempt debt available. The average county has about $1,870 million in expenditures and about $452 of debt per capita, although both of these figures are skewed so that the medians are considerably lower. These figures are most likely driven by several large counties in Texas. This is further confirmed by the large range in both population and median income. As shown the amount being borrowed also has a large
range and is skewed suggesting a few counties borrowing very large amounts. Very few of the issues are competitive sale, meaning they are either issued by negotiated sale or private placement. The majority of rated issues receive a AAA bond rating, which is the highest available. Although it is noteworthy that roughly a third of issues chose not to get any bond rating.

**Estimation and Results**

As indicated in the previous section the series of dummy variables associated with credit risk can all be factor analyzed to create continuous propensity score variables of risk. Table 4.2 presents the factor loadings for credit risk. As shown factor 1 is positively associated with the higher credit ratings, and negative for the lower ratings. Factor 2 is positively associated with more mid-range risk. And factor 3 is associated with higher risk. An interesting point is that the factor analysis indicates that bonds with no credit ratings are roughly equivalent to those with AA ratings. This empirically supports findings by Reeve and Herring (1986) who theorize that governments who do not purchase credit ratings would be equivalent to a AA ratings, but are usually too small to justify the cost of getting a credit rating.

<table>
<thead>
<tr>
<th>Table 4.2 Credit Risk Factor Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>AAA Credit Rating</td>
</tr>
<tr>
<td>Bond Insurance</td>
</tr>
<tr>
<td>competitive sale</td>
</tr>
<tr>
<td>AA Credit Rating</td>
</tr>
<tr>
<td>no credit score</td>
</tr>
<tr>
<td>A Credit Rating</td>
</tr>
<tr>
<td>BBB Credit Rating</td>
</tr>
</tbody>
</table>
To test if the factors are reliable and consistent we calculate Cronbach’s alpha for each relationship. The alpha between Factor 1 and AAA credit score, insured bonds, and competitive sales, which are all indicators of the lowest risk, is .77. The alpha between Factor 2 and AA credit score and no credit score, which are the medium risk group, is .768. These are both fairly high and consistent with desired values for applied psychometrics (Peterson 1994). The alpha between Factor 3 and A is lower at .4295, and while below the typical alpha values it is strongest relationship for the lowest quality ratings.

To estimate the marginal impacts of the variables listed in the previous section on TIC two models are estimated. The first is a traditional linear OLS regression with Huber-White standard errors, and the second is a semiparametric average derivative estimation. From previous studies we expect the logged par amount, median income, population, and factors of low risk to lower TIC; whereas years to maturity and factors associated with higher risk will increase TIC. Theory suggests that 30 day visible supply, total expenditures, and tax debt per capita should all should increase TIC. The results from the model run with the dummy variables are presented in Appendix D and the results from the OLS model run with the common factors are presented in Table 4.3. As shown all the variables maintain almost the same significance and the direction of the coefficients does not change. This insures that nothing is lost by using common factors in place of dummy variables.

Table 4.3 presents the results from both OLS and ADE with common factors. As shown for the OLS estimation all the explanatory variables are statistically significant at the .10 level, and most are significant at the .05 level. The $R^2$ is .4393, which is
somewhat lower than previous studies, but not uncommon. As expected the total visible supply, population, years to maturity, and debt per capita are all associated with increased true interest cost while total expenditures, median incomes, the par amount, and the risk factors are all associated with increased TIC. Because we have no theoretical reason as to why the time variable, fiscal year, should enter into TIC linearly even in OLS we include both a linear (fiscal year) and quadratic (fiscal year squared) time variable. Since both are statistically significant, and the coefficients change from positive to negative we can infer quadratic time dependence.

Interpreting the common factors is more abstract, but given the factor loadings correlation with dummy variables that indicate low, med, and higher credit risk we can interpret them as all lowering true interest cost, but in different ways. For example, we can discern that for bond issues that are of medium credit risk indicators of credit worthiness are more important for lowering TIC compared to other levels of risk because the coefficient is larger and negative. Also credit indicators for bond issues with low credit risk are more important to lower TICs than credit indicators for bond issues with high credit risk. While abstract, these findings are not particularly surprising or different from the literature on municipal bond credit ratings.
Table 4.3 OLS vs. ADE Estimation of True Interest Cost

<table>
<thead>
<tr>
<th>Variables</th>
<th>OLS Estimation</th>
<th>ADE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>T-Stat</td>
</tr>
<tr>
<td>Total Visible Supply in Billions</td>
<td>1.15E-03*</td>
<td>1.78</td>
</tr>
<tr>
<td>Total Expenditures in Billions</td>
<td>-7.69E-04***</td>
<td>-3.11</td>
</tr>
<tr>
<td>Bond Buyer Index</td>
<td>2.73E-03*</td>
<td>1.76</td>
</tr>
<tr>
<td>Median Income in Millions</td>
<td>-8.52E-02***</td>
<td>-3.31</td>
</tr>
<tr>
<td>Population in Millions</td>
<td>3.75E-03***</td>
<td>4.1</td>
</tr>
<tr>
<td>Log Par</td>
<td>-1.03E-03**</td>
<td>-2.11</td>
</tr>
<tr>
<td>Years to Maturity</td>
<td>7.10E-04***</td>
<td>7.42</td>
</tr>
<tr>
<td>Risk Factor 1 - Low Risk</td>
<td>-1.50E-03***</td>
<td>-3.32</td>
</tr>
<tr>
<td>Risk Factor 3 - High Risk</td>
<td>-8.05E-04***</td>
<td>-2.54</td>
</tr>
<tr>
<td>Fiscal Year</td>
<td>1.46E-03**</td>
<td>2.28</td>
</tr>
<tr>
<td>Fiscal Year Squared</td>
<td>-3.63E-04***</td>
<td>-2.66</td>
</tr>
<tr>
<td>Debt Per Capita in Millions</td>
<td>4.81E+00***</td>
<td>6.28</td>
</tr>
<tr>
<td>Constant</td>
<td>3.39E-02***</td>
<td>3.34</td>
</tr>
</tbody>
</table>

*** = significance at the .01 level; ** = significance at the .05 level
* = significance at the .10 level; R² = .4393 (For OLS); n = 461

The first set of coefficients in Table 4.3 are from the OLS regression which means they assume the necessary conditions of classic OLS. The second sets of coefficients (dy/dx) are the marginal impacts estimated using average derivative estimation, which assumes no particular functional relationship. Since both methods are root-n consistent we can directly compare their t-statistics, but without forcing linearization it is to be expected that the significance of the individual variables would decrease. Even without forcing linearization we find several statistical significant variables using ADE.

County population, par amount, years to maturity, two of the three factors of risk, and the time variable is all statistically significant using ADE. Curiously the coefficients for population and risk factor 1 switch signs while fiscal year squared is not significant at all. This indicates that increasing the population of a county may on average increase the
true interest cost, holding everything else constant. Also, the quadratic time dependence seems to just be a product of linear assumptions since it disappears when that restriction is lifted. Overall it is apparent that the high significance of variables typically assumed to be associated with true interest cost, may be a product of the OLS assumptions.

The coefficients for ADE presented in Table 4.3 do not assume anything about the relationship between the explanatory variables and true interest cost, other than they are exogenous, have a probability density function, and affect TIC. If we impose a forth assumption of a single index we can graph the predicted values from the ADE model. The assumption of a single index is not uncommon, and most parametric models are single index including OLS regression, Logit, Probit, Tobit, and Poisson regression. A model is single index if it only depends on the vector \( x \) through a single linear combination \( x' \beta \). In this ADE model TIC depends on \( x \) through the function of \( g(x'\beta) \) where \( \beta \in \mathbb{R}^k \) and \( m: \mathbb{R} \rightarrow \mathbb{R} \) are unknown. Below is a graph of \( x \) and \( g(x'\beta) \). It can be seen from this graph that despite the difference in marginal impacts the relationship between \( x \) and \( g(x'\beta) \) is somewhat linear.

The fairly linear graph of the single index function lends credit to the current municipal interest literature’s assumption of a linear OLS regression when testing their hypothesis. Some caution should be taken when making this assumption, especially for larger values of \( x \). One interpretation would be that the current TIC model is good at explaining the majority of county bond issues, but not as good when predicting extreme values. This would be consistent with the general financial transactions literature that suggest stock prices are leptokurtic and so models are less reliable when predicting values in the tail of the distribution.
Conclusion

Debt financing, and particularly the use of general obligation bonds are an important tool for most governments. Therefore the interest costs they pay on that debt can have important consequences for not only the infrastructure built in a community, but also the tax rates and expenditure levels over the life of the bond. This study presents an alternative to the traditional modeling technique of municipal interest cost. The alternative is a semiparametric estimation technique that drops all but the most basic assumptions about the relationship between a series of explanatory variables and TIC. The result is that even without the imposition of linearity several explanatory variables are statistically significant including county population, the par amount, years to
maturity, several factors or credit risk, and the fiscal year in which the debt was issued. In addition, after a single index link function is assumed the nonspecified function can be graphed. The graph shows a fairly linear relationship except for more extreme values. This result suggests that OLS models that assume linearity are appropriate for the majority of issues, but may not hold in extreme cases.

These results have several implications for the modeling of municipal interest cost. First, they give affirmation to current models that assumes linearity in parameters, which lends validation to previous studies. Second, they suggest that a different model may be necessary for extreme value bond issues. Third, going forward it offers a semiparametric technique that can be applied to a variety of public finance problems. While it is true that ADE provides support for linearity in TIC, but that may not be the case in other applications of OLS. Future research can benefit from exploring the linearity assumption of existing models through the use of nonparametric and semiparametric techniques such as average derivative estimation.
Chapter 5

Conclusion and Policy Implications

Introduction

The local government debt tax-exempt market is a growing, and complex section of public finance. As local governments turn to debt financing in increasing numbers the factors that attribute to interest costs of that debt have become important for local government officials and politicians. Further complicating the debt situation of local governments is the prevalence of a variety of special districts which have the authority to issue tax-exempt debt. While these special-purpose governments serve many purposes their general risk assessment, and their effect on the tax-exempt bond market is not well understood. This dissertation contributes to the literature by breaking down the risk assessment of the different types of local governments, and how they differ, and assessing the effect of overlapping governments on municipal interest costs. Finally, this dissertation advances the econometric techniques needed to evaluate these effects. By using semiparametric methods a less restrictive estimation method can be used to address important issues in local government finance.

The introduction chapter of this dissertation lays out the basics of the tax-exempt bond market and the system of local governments that issue debt in that market. Those local governments include both traditional municipalities such as cities and counties as well as a variety of special district types. All of these local governments issue debt to finance infrastructure needs for their jurisdictions. There exists a variety of constraints on their ability to issue general obligation debt, which is backed by the full faith and credit
of the issuing jurisdiction. These constrains include both the legal constraints imposed by federal and state authorities and the debt capacity of the issuing government. These constraints result in debt competition in tax-exempt bond markets. Chapter two explores this competition explicitly and finds that when local governments overlap the amount of lower level government debt can increase the interest cost on county government bonds.

Credit ratings are also an important component to municipal interest costs. To explore the credit risk associated with these different types of local governments chapter three breaks down a series of credit rating decisions by type of local government. All local government make the choice to purchase a credit rating or not, and they have three major rating agencies to choose from. Complicating these choices even further is that many governments choose to be rated by multiple rating agencies. Exploring these differences is important for understanding the debt issuing process for all local governments opposed to just the traditionally studied cities and counties. By comparing traditional municipalities to different special districts it is possible to identify the risk assessment preferences of different local government types.

Aside from the more general goal of advancing research on local government debt, debt competition, and local governments this dissertation also applied some lesser known econometric techniques in the estimation of the various models. Chapter two used a fairly standard two-stage least squared estimation, but offers a unique approach to instrumental variables by using a predicted county fixed effect as an instrument for the amount of overlapping debt outstanding. Chapter three applied a multivariate probit estimation, which is a useful estimator for a series of limited dependent variable equations when the errors terms may not be independent. Chapter three also utilized a
negative binomial estimation, which is a classic estimator that could be used more often for models of count variables. Chapter four represents the largest departure from normal estimation methods with the use of a semiparametric average derivative estimator. The entire class of semiparametric estimators are underutilized in policy research, but ADE represents an estimation methods that can be particularly useful for estimating marginal effects.

**Contributions to Literature**

The three essays included in this dissertation contribution to several streams of literature. The first is the overarching literature on municipal finance. Local governments are an integral part of the system of governance that often receive less attention then state or national governments. Municipalities have at their disposal a limited number of financing options. They often have limited tax revenue options, and are tasked with a wide range of expenditure obligations. An increasing important tool has been their ability to issue debt for infrastructure needs. There is a small, but strong, tradition of studying municipal finance, to which this dissertation contributes. Contributions include the estimation of municipal interest costs, the analysis of credit rating agency selection, the choice of the number of credit ratings purchased by municipalities, and the effect of intergovernmental relationships may have on municipal debt.

A second stream of literature this dissertation contributes to is that of special purpose governments, also known as special districts or public authorities. The majority of literature on special districts in the context of public finance has focused on the use of special districts to circumvent state regulations on cities and counties for the purposes of
additional taxation or bonding powers. Little attention has been given to the unintended, and costly, fiscal consequences of creating special districts. There has also been little explorations of how special districts differ from city and county governments in their credit rating process. The results from chapter three show that school districts are similar to traditional municipalities while hospital districts, community college districts, and water districts have different risk factors, and make significantly different decisions in the rating process.

A third stream of literature is that of vertical fiscal interactions and fiscal federalism. This is by far the largest body of work, with a long publication record in economics journals. There have been several theoretical and empirical studies of vertical fiscal interactions that focus of various types of taxes as described in chapter two. Vertical tax competition is generally thought to result in over taxation, but there is some ambiguity as to the direction of the tax reaction. Chapter two of this dissertation extends the vertical fiscal interaction literature from taxation to debt financing. Instead of asking what happens to a state government’s tax rates when the federal government increases their tax rates chapter two examines what happens to county interest costs on general obligation debt when other local governments increase their borrowing. There is evidence that local governments are competing in the tax-exempt debt market. When lower level governments that share a tax base with the county increase their borrowing the county government pays higher interest costs. This finding shows that vertical fiscal interaction theory can be applied to local government debt in addition to state level taxation.

The final stream of literature is in applied econometrics. Public administration, public policy, and public finance publications often lag behind current econometrics in
the estimation techniques used to address important theoretical concerns. For example, OLS regressions are often the go-to estimation method for continuous variables. Regression analysis is a useful, and versatile tool, but it requires some fairly restrictive assumptions that have to be assumed in order for the results to be valid. Chapter four demonstrates average derivative estimation can be used in place of an OLS regression. While there are other semiparametric and nonparametric choices policy analysis is typically concerned with marginal impacts and ADE is a useful tool in estimating marginal impacts. By exploring alternative estimation techniques public administration and public policy studies can make fewer empirical assumptions, and increase the academic rigor of research methods.

**Future Research**

While this dissertation has extended the literature in several directions, it also provides a starting point for future research. One such direction is in debt competition. There are many research questions that have yet to be answered when applying the fiscal federalism and vertical externalities framework to issues of public debt. For example, chapter two looked at the vertical relationship between sub-county debt and county interest costs. A future research opportunity is to extend that analysis to see if the relationship holds going from county debt to sub-county interest costs. Or, instead of examining the effect of debt prices (interest costs) an interesting direction would be to study the effect of overlapping debt on levels of outstanding debt. Another future research project would be to look at this relationship at different levels of the federalism system. For example, the relationship between state and local governments or the
relationship between federal and state governments. It would also be helpful to control for horizontal externalities at these various levels of analysis.

Another direction would be applying a semiparametric estimation method to the limited dependent variable model in chapter three. To do this the semiparametric method of maximum score estimation (MSE) could be used. MSE is a multinomial choice model that proves consistency without assuming knowledge of the distribution of the error term in the model. It can be used as a semiparametric fixed effect model with limited dependent variables because it differences out the fixed effect, which the probit cannot do. Furthermore, probit models are not estimated to maximize the number of correct predictions. If prediction of a discrete outcome is the goal then maximum score estimator is a more appropriate estimator. MSE is based on maximizing the number of correct predictions so better in-sample performance compared to probit or maximum likelihood is assured. This extension of the dissertation would be offer a more efficient estimation, and further the advancement of semiparmentric methods in public finance research.

Policy and Debt Management Implications

The goal of public finance research is to study, inform, and ultimately help public finance practitioners in the financial management of public funds. Public debt represents a growing area financial managers are dealing with, and can encompass millions of dollars’ worth of tax-payer obligations. Managing debt competition, navigating a complex tax-exempt bond market, and dealing with credit rating agencies are all salient topics where management practices can be informed by academic research.

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One method for managing the externalities associated with intrastate debt competition is to centralize debt management services. Generally, centralized debt management occurs at the state level through a dedicated agency which monitors debt issued by the state and local governments and insures that debt policies are followed. A centralized debt management requires jurisdictions and public authority boards to submit their debt request to a central office. Each request for debt finance essentially competes against the others based on economic and political merits. By centralizing debt issues, local government avoid the competition in the tax-exempt bond market. One example of a centralizing debt management strategy would be to use a state bond bank. A bond bank periodically issues bonds which are then loaned back to sub-jurisdictions based on formal requests. In addition to eliminating the competition factor, local jurisdictions benefit from savings achieved by sharing the fixed costs of bond issuance and other economies of scale.

Another debt management strategy at the state level would be to limit the creation, and power of special districts. Excluding school districts, special districts often represent higher credit risk bond issues. Since the addition of special districts can increase county bond interest costs (chapter 2) an alternative strategy could be to restrict special district bonding authority, but allow them to contract with counties or cities. By only allowing counties and cities to issue debt, but then contracting the construction, management, and maintenance of infrastructure to special districts, debt competition is eliminated. This replaces negative debt externalities and promotes management efficiencies.
The recent years of a sluggish economy and meager tax collections have pressured state and local governments to issue more debt. As the aggregate debt burden increases the competition among overlapping jurisdictions intensifies. It is important for public managers and policy makers to better understand the nature of intrastate competition and the repercussions of acute competition on interest costs and access to the bond market. Strategies to mitigate the negative effects of debt competition should be considered and implemented. The magnitude of state and local debt is not likely to diminish quickly, so intrastate debt competition will remain relevant even after the economy recovers and tax revenues again begin to grow.

The purpose of this dissertation is to explore several distinct but related questions on local government debt issues. Through the various chapters this dissertation advances the field of municipal finance. These essays explore intergovernmental relationships and differences in types of local governments through the lens of public debt. All three essays and the introduction chapter deal with local government debt issuances, but from different perspectives. The complex system of local governance including the relationship among various municipalities and special districts is explored through the framework of debt financing. The effects of these local governments sharing taxes bases as well as the differences across them in their assessment of credit risk are considered. The result is a better understanding of local government debt, which can be used to construct more efficient debt management policies.
### Appendix A: Chapter 3 Continuous Variables by Number of Ratings

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Not Rated</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population</td>
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<td>163.74</td>
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<td>2471.00</td>
</tr>
<tr>
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<td>0.00</td>
<td>440.97</td>
</tr>
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<td>Assessed Value</td>
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<td>1.00</td>
<td>40.00</td>
</tr>
<tr>
<td><strong>One Rating</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population</td>
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<td>0.01</td>
<td>3935.86</td>
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<tr>
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<td>443.66</td>
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</tr>
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<td>7.36</td>
<td>1.00</td>
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<td><strong>Two Ratings</strong></td>
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<td>0.38</td>
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<tr>
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<td>0.01</td>
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<td>Assessed Value</td>
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<td>274954.20</td>
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<td>Years to Maturity</td>
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<td>7.18</td>
<td>1.00</td>
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<tr>
<td><strong>Three Ratings</strong></td>
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<td></td>
</tr>
<tr>
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<tr>
<td>Debt Outstanding</td>
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<td>0.07</td>
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</tr>
<tr>
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<td>47,253.62</td>
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<td>274480.10</td>
</tr>
<tr>
<td>Years to Maturity</td>
<td>18.47</td>
<td>7.34</td>
<td>1.00</td>
<td>40.00</td>
</tr>
<tr>
<td><strong>All Bonds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>156.79</td>
<td>462.11</td>
<td>0.01</td>
<td>4841.85</td>
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<td>Debt Outstanding</td>
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<td>88.25</td>
<td>0.00</td>
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### Appendix B: Chapter 3 Continuous Variables by Government Type

<table>
<thead>
<tr>
<th>Variable</th>
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<th>Std. Dev.</th>
<th>Min</th>
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</thead>
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<tr>
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<td>2,495.96</td>
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### Table 6 - Simultaneous Multivariate Probit Results

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Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
Appendix D: Chapter 4 OLS with Dummy Variables Regression

Table 3 - OLS with Dummy Variables

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*** = significance at the .01 level; ** = significance at the .05 level
* = significance at the .10 level; R² = .4511; n = 461
References


Economics, 91(3-4), 451-479.


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Vita for
Robert A. Greer

Education

MPA, concentration in financial management. University of North Texas (2010)

BA, Trinity University. Majors: Economics and Business Administration with a concentration in Public Policy (2007)

Work Experience

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<th>Period</th>
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<td>Aug. 2010 – Present</td>
<td>Research Assistant, University of Kentucky</td>
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<td>Summer 2011 and 2012</td>
<td>Research Intern, Commerce Lexington (Chamber of Commerce)</td>
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<td>Spring 2009</td>
<td>Financial Management Intern, Texas Woman’s University Office of the Controller</td>
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<tr>
<td>2008 - 2009</td>
<td>Research Assistant, Department of Public Admin at UNT</td>
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<tr>
<td>2007 - 2008</td>
<td>Business Economics Research Associate, Institute for Economic Development at the University of Texas at San Antonio</td>
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<td>2006 - 2007</td>
<td>Planning Intern, San Antonio Skate Park Association</td>
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<td>2005 - 2006</td>
<td>Marketing Intern, Aramark</td>
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<td>Summer 2006</td>
<td>Management Intern, formerly World Savings</td>
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Research Interests

Public finance, municipal securities, state and local government, research methods

Teaching Interests

Public budgeting and finance, research methods, state and local government, public policy, public administration

Dissertation


Honors and Awards

- NASPAA Emerging Scholars Award
- Hatton W. Sumner Scholar Award
- Pi Alpha Alpha Honor Society
- Phi Kappa Phi Honor Society

Organizations and Associations

- 2009 Leadership Team, Public Administration Student Association
- 2004 Vice President of Public Relations, Trinity Economic Society
- Student Member, American Society for Public Administration
Publications and Papers

Forthcoming Book Chapter:

Working Papers:
“Semiparametric Modeling of Municipal Interest Cost: Average Derivative Estimation” (with J.S. Butler)
“A Theory of Vertical Debt Externalities in Overlapping Governments”
“Selection Bias in Types of Local Government Credit Rating Agency Choice: A Nonparametric Approach”
“Does intrastate competition in segmented municipal bond markets affect interest costs?” (with Dwight Denison)

Conference Presentations

“Vertical Debt Externalities in Overlapping Governments” A study of overlapping local governments and the effect of lower level government debt on higher level government interest cost. This paper has been accepted, and will be presented, at the Association for Public Policy Analysis and Management 2012 annual conference. This paper will also be presented at the National Association of Schools of Public Affairs and Administration Emerging Scholars Award panel.

“Does intrastate competition in segmented municipal bond markets affect interest costs?” A co-authored paper with Dwight Denison using preferred habitat and market segmentation theory to examine the effect of total general obligation debt on municipal interest cost. This paper has been accepted, and will be presented, at the Association for Budgeting and Financial Management 2012 annual conference.

“State Competition for Debt Resources” A co-authored chapter with Dwight Denison from the forthcoming book Sustaining the States: The Fiscal Viability of American State Governments. This chapter has been accepted, and will be presented, at the Association for Budgeting and Financial Management 2012 annual conference.

“Semiparametric Modeling of Municipal Interest Cost: An Average Derivative Estimation.” A co-authored paper with J.S. Butler using average derivative estimation to explore linearity in local government tax-backed debt interest costs. This paper has been accepted, and will be presented, at the Midwest Econometrics Group 2012 annual conference.
“Breaking Down the Adoption of Build America Bonds: A Hazard Model Approach”
This study draws upon the causal factors outlined in policy diffusion literature to
ultimately answer the question of why so few local governments used Build America
Bonds. Research in progress. This paper was presented in the poster session of the
Association for Budgeting and Financial Management in October 2011.

“A Bayesian Approach to Empirical Issues in the Measurement of Management Quality
in States.” Dr. Skip Krueger, Dr. Robert W. Walker, and I are co-authoring a paper which
applies a Bayesian approach to the Government Performance Project (GPP) to develop a
new measurement of managerial quality. Research in progress. This paper was presented
at the Midwest Political Science Association Conference held in April 2010.

“Outcomes-based assessment: how it is achieved and what it tells us.” A university Next
Generation (N-Gen) course redesign comparative study with Dr. Robert Insley. Research
in progress. This paper was presented at the 10th Annual Assessment Conference at
Texas A&M University which was held in February 2010.

“Cultural and linguistic influences on student evaluation of teaching effectiveness
(SETE) instruments.” A study of how SETE responses are influenced when completed
by international students with Paula Yaeger and Dr. Robert Insley. Research in progress.
This paper was presented at the 54th Annual Conference of the Comparative &
International Education Society in March 2010.

Teaching and Course Development

University of Kentucky Department of Political Science
Fall 2012 Political Science Research Methods

University of Kentucky Martin School of Public Policy and Administration
Spring 2011 Teaching Assistant for PhD Seminar in Public Finance
Spring 2011 Teaching Assistant for Public Funds Management