

**EXPLORATIONS IN LOCAL PUBLIC FINANCE: PROPERTY TAXATION, LOCAL
INFRASTRUCTURE, OPTIMAL DEBT USE AND EXPENDITURE STABILITY**

by

PING ZHANG

(Under the Direction of J. Edward Kellough)

ABSTRACT

While there have been many studies on public finance at the national and subnational levels, the strikingly large heterogeneity and disparity between localities call for a thorough local-level analysis. This dissertation comprises four essays on local public finance and explores several important issues, including the relationships between housing prices, property tax, local infrastructure investment, countercyclical debt policy, and expenditure stability. Three different data sets are used in the essays: national and state aggregates of local finance data from the U.S. census (1960-2008), Georgia local data (159 counties and 536 municipalities, 1985-2011), and parcel/household level data of 46 counties in Georgia with coverage ranging from 3 to 10 years for assessment and over 40 years for sales.

Specifically, the first essay analyzes the dynamics of housing and land prices. The second essay investigates the relationships among property tax, local infrastructure investment, and housing prices. The third essay examines the optimal debt use for local governments, finding that different localities have distinct debt policies due to differences in fiscal capacities and borrowing costs. Connecting the above three essays, the fourth essay deconstructs both the

revenue and expenditure structures of different types of local governments (counties and municipalities) and estimates the impacts of revenue compositions and infrastructure investment on expenditure stability.

This dissertation contributes to the literature by providing both theoretical frameworks and empirical evidence that: (1) reconcile different perspectives on relationships between the dynamics of housing and land prices, (2) connect local infrastructure to household payment of the property tax and extend previous studies from metro cities to a comparison between urban and rural counties, (3) offer an optimal theoretical path of countercyclical debt use and are among the first to investigate the effects of local fiscal characteristics on countercyclical debt policy, and (4) finally, decompose the impacts of revenue and expenditure structures on local expenditure stability. The results shed light on trends, fluctuations and regional variations in housing prices, help improve the accuracy of property assessment, and contribute effectively to local policy designs regarding economic development and infrastructure investment decisions.

INDEX WORDS: local public finance, property taxation, local infrastructure, optimal debt use, expenditure stability

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A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial
Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

ATHENS, GEORGIA

2014

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August 2014

DEDICATION

To my parents, Siran, and Margaret

ACKNOWLEDGEMENTS

Until I had finished and defended my dissertation, I had not realized that I could complete such a long dissertation. Without crucial guidance and assistance from many people—professors, friends, and family members—this dissertation would never have been possible.

First, my most sincere thanks go to Professor Yilin Hou (侯一麟), who led me into this field, guided me all the way through, and helped me the most to bring this dissertation into completion. I first met Professor Hou when I was at Tsinghua University as a student in the economics master's program. At that time, I did not realize that he would be the most important mentor in my student life, both in terms of academia and career choice. When he moved to the Maxwell School of Syracuse University, thanks to his arrangements, I was able to spend the final year of my Ph.D. program at the Maxwell School while continuing my enrollment at UGA, which was a wonderful life and research experience. I truly appreciate all his efforts to make the process of navigating between the University of Georgia and Syracuse University a smooth one and all his support for every step of my job search. I also want to thank Professor Hou and his wife for their provision of all the consideration they displayed and the support they provided during my four years' of residence in the United States. I also want to thank Professor Lingling Liu (刘玲玲), my advisor at Tsinghua University, who guided and took care of me after I transferred from natural science to the field of economics; equally important, because of her recommendation, I had the opportunity to meet and get acquaintance with Professor Hou, and become a doctoral student of him. I also thank Ms. Maureen Grasso, the former Dean of

Graduate School at UGA, for her help to offering the four consecutive year's graduate assistantship, which made my study smoother and more determinate.

I would like to acknowledge my dissertation committee, J. Edward Kellough, Yilin Hou, Tom Lauth, Deborah Carroll, and David Bradford, for their guidance and support. I am grateful to Professor Kellough for all his help and for agreeing to be my nominal advisor when Professor Hou moved to Syracuse. Professor Lauth, an eminent scholar in public budgeting and finance and the former Dean of the School of Public and International Affairs, provides important guidance and encouragement to younger scholars like me. It was my great honor to have him on my dissertation committee and obtain advice from him, and I really appreciate his encouragement and recommendation letter for my job search. I thank Professor Carroll for her important suggestions and Professor Bradford for his methodological advice. I also want to thank other professors in the Department of Public Administration and Policy for all their help and support through classwork and private consultations. Professor Hal Rainey in particular, as the Ph.D. program director, offers abundant support and guidance to international students like me, and I appreciate his generosity in writing a letter of recommendation for me when I was on the job market.

I want to thank my cohorts and friends at the University of Georgia. My cohorts provided mutual support throughout course work, the comprehensive exam, the prospectus, and finally, the dissertation. My friends—visiting scholars, students, and local residents—made my Ph.D. life pleasant, interesting, and free from major hassles.

Regarding my one year in the Center for Policy Research (CPR) at the Maxwell School, I am grateful to the professors, staff, and my friends for their advice, assistance, and considerateness, which brought substantial improvements into my work and full of joy and

excitement into my daily life. Professors Chihwa Kao, Jerry Miner, and John Yinger offered great support and substantial improvements to my research and helped me believe that the future of a research career will be promising.

I was not alone on the journey to the Ph.D. degree. My wife Siran (鲁思然) and my daughter Margaret (张禹桐) made the journey together with me. They brought me both ample support for my work and much happiness in my life. My parents in China have always been my support ever since I am away from home.

Data is always an essential issue for empirical research. In the process of collecting data, I thank Mr. Jonathan Sharpe in the Georgia Department of Community Affairs for his generosity to provide me with the Report of Local Government Finances (RLGF) data and the Government Management Indicators survey (GOMI) data for each county. The parcel level data was obtained by contacting the Tax Assessor’s Office and/or Tax Commissioner’s Office of each county in Georgia. The creation of this valuable data set would not have been possible without the support of many local officials. Due to the limited amount of space, I will not list all the names, but I have provided the county list below.

Bacon	Charlton	Dougherty	Harris	Oglethorpe
Baldwin	Chattooga	Douglas	Henry	Pickens
Barrow	Cherokee	Fayette	Jackson	Putnam
Berrien	Clarke	Floyd	Jasper	Richmond
Bibb	Cobb	Fulton	Liberty	Spalding
Camden	Columbia	Gilmer	Lincoln	Tift
Candler	Coweta	Greene	Lowndes	Upson
Carroll	Dawson	Gwinnett	Muscogee	Walker
Catoosa	Dooley	Habersham	Oconee	Whitfield

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	v
LIST OF TABLES	xi
LIST OF FIGURES	xiv
CHAPTER	
1. INTRODUCTION	1
1.1 Four Essays on Local Public Finance	1
1.2 Localization of Property Tax.....	4
1.3 Inter-jurisdictional Heterogeneity	6
1.4 Fiscal Federalism and Public Choice	8
1.5 Data	13
2. THE DYNAMICS OF HOUSING AND LAND PRICES IN DIFFERENT CONTEXTS ..	22
2.1 Introduction	22
2.2 Literature Review	24
2.3 Theoretical Framework	27
2.4 Data and Repeat Sales Index.....	31
2.5 Methodology, Models, and Results.....	34
2.6 Conclusion and Discussion	43

3. PROPERTY TAX, INFRASTRUCTURE INVESTMENT, AND HOUSING PRICES	56
3.1 Introduction	56
3.2 Literature Review	58
3.3 Theoretical Framework	62
3.4 Georgia Localities and Estimation Strategy	65
3.5 Data	70
3.6 Results and Discussion	71
3.7 Conclusion	77
Appendixes	92
4. OPTIMAL DEBT USE WITH VOLATILE REVENUES AND STABLE INFRASTRUCTURE NEEDS	104
4.1 Introduction	104
4.2 Literature Review	106
4.3 Theoretical Framework	111
4.4 Data	130
4.5 Methodology and Results	131
4.6 Conclusion and Discussion	141
5. THE EFFECTS OF PROPERTY TAX AND INFRASTRUCTURE INVESTMENT ON LOCAL OWN-SOURCE EXPENDITURE STABILITY	167
5.1 Introduction	167

5.2 Literature Review 169

5.3 Theory and Hypotheses 173

5.4 Data 178

5.5 Methodology and Results 180

5.6 Conclusion and Discussion 186

6. CONCLUSION 201

REFERENCES 205

LIST OF TABLES

	Page
Table 1.1: List of data sources at the aggregated county level	16
Table 2.1: Augmented Dickey–Fuller unit-root tests	46
Table 2.2: Vector error-correction model for housing and land prices.....	46
Table 2.3: Vector error-correction model for different categories	47
Table 2.4: Results of simultaneous equation model	48
Table 2.5: Relationship between housing and land prices for different categories and periods...	49
Table 3.1: Results of different scenarios in <i>homogeneous</i> communities.....	80
Table 3.2: Results of different scenarios in <i>heterogeneous</i> communities	80
Table 3.3: Data sources of variables at the aggregated county level	81
Table 3.4: Descriptive statistics for county level variables	82
Table 3.5: The effect of property tax reliance on infrastructure investment	83
Table 3.6: The effect of property tax reliance on infrastructure investment (rural & urban)	84
Table 3.7: The effect of property tax reliance on infrastructure investment	85
Table 3.8: The effect of per capita local infrastructure investment on housing values (percentage)	86
Table 3.9: The elasticity of local factor prices on different types of infrastructure investment ...	87
Table 4.1: Different amounts of countercyclical debt use	144
Table 4.2: Government revenue and expenditure for each year with countercyclical debt use .	145

Table 4.3: Optimal use of countercyclical debt in the context of relaxed assumptions.....	146
Table 4.4: Simulation of countercyclical debt uses	147
Table 4.5: Net debt increase (above the trend) with countercyclical debt use	148
Table 4.6: Comparison between optimal debt uses with and without interest.....	149
Table 4.7: A list of revenue and expenditure due to optimal countercyclical debt use	150
Table 4.8: Optimal countercyclical debt uses in different scenarios	151
Table 4.9: Summary statistics of values of independent variables	153
Table 4.10: Results of the aggregated analysis of the U.S. totals for different localities	155
Table 4.11: Results of the aggregated analysis of local totals for different regions and states ..	156
Table 4.12: Summary statistics of dependent and independent variables	159
Table 4.13: Determinants of countercyclical debt use for Georgia counties	160
Table 4.14: Determinants of countercyclical debt use for cities.....	161
Table 4.15: The effects of counter-cyclical debt use on expenditure stability	162
Table 5.1: Elasticity of property tax, local sales tax, and state-local transfer on personal income, Georgia counties, by economic cycle.	188
Table 5.2: Summary statistics of all variables	189
Table 5.3: The effects of the revenue structure and expenditure compositions on the expenditure stability for counties (DV: expenditure gap, forward 1 year).....	191
Table 5.4: The effects of the revenue structure and expenditure compositions on the expenditure stability for municipalities (DV: expenditure gap, forward 1 year).....	192
Table 5.5: The effects on the expenditure gap in different scenarios (DV: expenditure gap)	193
Table 5.6: The effects on expenditure stability conditional on property tax reliance (PTR).....	194

Table 5.7: Cross-sectional analysis for counties (DV: coefficient of variation).....	195
Table 5.8: Cross-sectional analysis for municipalities (DV: coefficient of variation)	196

LIST OF FIGURES

	Page
Figure 1.1: The changes of property tax in national total revenues.....	17
Figure 1.2: The inter-jurisdictional (inter-county) heterogeneity of property tax as a percentage of total taxes within each state	18
Figure 1.3: The inter-jurisdictional (inter-county) heterogeneity of per capita direct expenditures within each state.....	19
Figure 1.4: The inter-jurisdictional (inter-county) heterogeneity of per capita education spending	20
Figure 1.5: The distribution of counties of which parcel level data collected.....	21
Figure 2.1: Theoretical framework of the dynamics between land price and housing price	50
Figure 2.2: The distribution of sales data collected in Georgia counties (metro, urban, and rural)	51
Figure 2.3: Comparison of housing price indexes from sample data, Georgia, and the U.S.....	52
Figure 2.4: Housing and land price indexes in metro and non-metro counties	53
Figure 2.5: Housing and land price indexes for urban and rural parcels	54
Figure 2.6: Trends of new sales and repeat sales of vacant land	55
Figure 3.1: Distribution of property tax reliance and per capita infrastructure expenditure in Georgia counties as of 2011.....	88
Figure 3.2: The time trends of per capita infrastructure expenditure and property tax revenue for Georgia average and Fulton County	89

Figure 3.3: Structure of empirical analyses of the impacts of local infrastructure on regional development.....	90
Figure 3.4: Parcel level data collected in Georgia counties.....	91
Figure 4.1: The trend of total debt outstanding for the U.S. local totals for different localities.	163
Figure 4.2: The trend of per capita debt outstanding (real in 2000 dollars) for localities	164
Figure 4.3: The trend of the growth rate of real government expenditure and real income for the U.S. local total.....	165
Figure 4.4: Trends of long-term debt outstanding and total local revenue for two sample localities	166
Figure 5.1: The trends of revenue and expenditure (per capita) for counties and municipalities	197
Figure 5.2: The trends of revenue and expenditure (per capita) in compared categories	198
Figure 5.3: The trends of revenue and expenditure in detailed categories	199
Figure 5.4: Kernel density estimate of expenditure gap with normal distribution	200

CHAPTER I

1. INTRODUCTION

1.1 Four Essays on Local Public Finance

While there have been many studies on public finance at the national and subnational levels, the strikingly large heterogeneity and disparity between localities call for thorough analyses. The household level analysis is especially rarely seen in the literature due to data availability. Based on data at both the county level and parcel level in the State of Georgia, this dissertation tries to provide a comprehensive analysis of important issues of local public finance. Specifically, this dissertation includes four essays that explore local public finance: (1) the dynamics of housing and land prices in different contexts; (2) property tax, infrastructure investment, and housing prices; (3) optimal debt use with volatile revenues and stable infrastructure needs; and (4) the effects of property tax and infrastructure investment on local own-source expenditure stability.

The four separate but connected essays constitutes the main part of this dissertation from Chapters 2 to 5. Chapter 2 (*the first essay*) analyzes the dynamics of housing and land prices. For the relationship between changes in housing and land prices, in the literature, we have found different inferences that rising housing prices lead to an increase in land prices and increased land prices amplified the cost of housing, thus housing prices. The question as to *which is the leading market* remains. While there are many empirical results confirming all the different opinions, there is no fundamental *theory* to illustrate the mechanism of the relationship between land and housing

prices. In this chapter, I propose a theoretical framework indicating that the relationship between changes or dynamics in housing prices and land prices depends on the reasons for the changes in different contexts. In a developed area, it is more likely that housing prices lead to changes in land prices, while in an area in the process of urbanization, the change in land prices is more likely to cause a change in housing prices. Using data of all monthly sales data of housing and vacant land in 39 sampled counties from 1970 to 2011, with both the Granger causality test and the 3-stage least square (3SLS) simultaneous equations model, the search for empirical evidence was also conducted to test the theoretical expectations. Chapter 3 (*the second essay*) investigates the relationship between property tax, local infrastructure investment and housing prices. From the government perspective, this chapter analyzes how the input (government revenue) and output (impacts on housing prices) factors influence the decisions of local infrastructure investment. This chapter assembles a panel data set that includes both county level data and parcel level household data in the state of Georgia and employs a two-stage method with two instruments and GLS estimators. Three issues are addressed: (1) the impact of the revenue structure (focusing on property tax reliance) on infrastructure expenditure; (2) the impact of local infrastructure stock on housing prices (housing and land), across different types of infrastructures and localities; (3) the relationship between the above two impacts and how these two impacts interact in the decision-making process. Chapter 4 (*the third essay*) studies the optimal debt use of local governments. Built upon and extending Hou's (2013) framework, this chapter asks the following questions: Connecting with local infrastructure investment, do local governments use debt counter-cyclically? If some local governments use countercyclical debt, how much can it help in fighting a recession, and what is the difference between the localities that use debt as a countercyclical tool and those that do not? Eventually, an optimal pattern of debt use is

calculated based on a theoretical framework. Also, two different empirical analyses are conducted accordingly to test the countercyclical debt policy, including aggregated analysis based on all U.S. localities from the 1960s and individual locality analysis using a balanced panel data set that includes all counties and municipalities in the state of Georgia from 1985 to 2011. Connecting with the above chapters, Chapter 5 (*the fourth essay*) examines the effects of property tax and infrastructure investment on local own-source expenditure stability. With the compiled balanced panel data set of localities in Georgia, this chapter disentangles the components of expenditure fluctuation and analyzes the impacts of different revenue sources and infrastructure investment on expenditure stability. I further explore how the different types of infrastructure investment influence local expenditure fluctuations.

In the four essays on local public finance, with the tradeoffs embedded in the process, the effects of the local fiscal autonomy of property tax and intergovernmental grants on aspects of local public administration will be disentangled in the estimation. Moreover, since grants actually decreased in economic bust years, during which the grants were in greater demand by local governments (Hou & Moynihan, 2008; Wang & Hou, 2012), the effects will be estimated separately for recession and boom years. Urban and rural distinctions will be made to identify different local public fiscal administrations in diverse economic statuses. Some analyses also try to capture different behaviors and effects for the two main types of (overlapping) local governments in the U.S., i.e., counties and municipalities.

The remaining part of this dissertation is organized as follows. The rest of the first chapter introduces the fiscal background of the local public finance studies. With the localization of property taxation accompanied by the increased inter-jurisdictional heterogeneity, through research on local public finance is in a high demand and becomes a promising area. The fiscal

federalism and public choice theories also call for more improvements to cover the increased heterogeneous scenarios. The following four chapters (chapter 2-5) corresponds to the four connecting essays. Chapter 6, as the final chapter, concludes the whole dissertation. It summarizes the main results, points out the limitations, and attempts to provide a direction for further research.

1.2 Localization of Property Tax

In local public finance, the property tax has been in place since the earliest days of settlement, and it is well accepted (Brunori, Green, Bell, Choi, & Yuan, 2006). Although the property tax has the drawbacks of visibility, unpopularity, and the creation of large disparities between localities, it has the following advantages when administrated by local governments: it provides a reliable and stable revenue source, there is a direct link between taxes and services, and the own-source fiscal power supports local autonomy (Brunori et al., 2006; Mikesell, 2011).

Before the 20th century, the property tax dominated the taxation system and was the main revenue sources for the whole of the United States as well as many other countries (Carlson, 2004; Wallis, 2000).¹ By the end of the 1900s, as the economy became more complex, it was widely believed that the tax system in the United States could not equitably tax the complicated economy; with the introduction of income taxes and sales taxes, the importance of property taxes was diminished (Carlson, 2004), and the property tax underwent a process of localization, i.e., the collection and distribution of property tax gradually moved downward to local governments (Sokolow, 1998). The property tax comprised 42% and 44% of total revenue in 1902 and 1913,

¹ Wallis (2000) points out that in the U.S., the financial system was dominated by local governments and property taxation for about 90 years from 1842 to 1933.

respectively, and sank to 30%, 25%, and 11% in 1936, 1940, and 1950, respectively.² During the Great Depression, with the drop in the property tax collection rates and the creation of homestead exemptions (Carlson, 2004), property tax as a percentage of national total revenue dropped dramatically (Figure 1.1). Since the 1960s, for most states, more than 90% of property tax revenue has gone to local governments. Connolly, Brunori and Bell (2010) concluded that the property tax is the most efficient and effective revenue source to fund local government services, and no other alternative can ensure local government autonomy.

Scholars tend to explain the localization of property tax using the theory of fiscal federalism and the importance of local autonomy, and local dependence on the property tax was attributed to its responsiveness to public demand and stimulation of citizen participation (G. W. Fisher, 1996; Sokolow, 1998). Wallis (2000) attributes the reduction or elimination of state property tax in the early 19th century to the rising levels of asset income, and the virtual disappearance of state property tax in the 20th century to the difficulty to match expenditure beneficiaries of the property tax in a large geographic entity. Besides the introduction of other income sources (mainly sales and income taxes) by state governments, this dissertation argues that the process of property tax localization is also related to the increased *heterogeneity* of localities due to the more complicated economy, which makes it more difficult for states to match the burden and the beneficiaries of property tax. As asserted by Bird (1993, p. 211), “so long as there are *variations* in tastes and costs, there are clearly efficiency gains from carrying out public sector activities in as decentralized a fashion as possible.” Oates (2010) also concludes that local government, from a purely economic perspective, is designed to enhance the performance of overall public sector by allowing variation in the outputs of local services

² For the property tax revenue as a share of overall tax revenue, it was 51% and 59% in 1902 and 1913, respectively (it was 56% as late as 1932), and sank to 39%, 35%, and 14% in 1936, 1940 and 1950, respectively. Data source: the U.S. census.

corresponding to the different tastes and costs. Therefore, the increased inter-jurisdictional heterogeneity calls for the local empowerment of own source revenue, with the property tax as the most important.

Based on the fiscal federalism and public choice theory, localization of property tax has large and wide impacts on every aspect of local public finance. On the theoretical side, there are still many controversies on own-source revenue, such as property tax and sales tax, versus intergovernmental grants. Increased inter-jurisdictional heterogeneity and local fiscal power strengthened or reinforced each other, and finally we get to today's picture of the U.S. local public finance with property tax as the main own-source revenue. Empirically, with the localization of property tax, how has the importance of property tax and other revenue compositions in localities affected the local fiscal/financial administration, such as housing value, infrastructure investment, local debt use, and expenditure stability? As a support and control from the upper levels of government, what is the impact of intergovernmental grants on these fiscal issues? Focusing on the case of Georgia State, this dissertation will investigate these issues and research questions with regard to local public finance administration.

1.3 Inter-jurisdictional Heterogeneity

After World War II, the U.S. economy grew at a significantly high rate accompanied by a more complicated economy and production factors. With the localization of property tax, sales taxes and/or local income taxes were also complemented by local governments to expand and diversify their revenue sources, especially in the context of the sweeping popularity of property tax limitations in late 1970s (Carlson, 2004). While theories indicate that fiscal federalism with local autonomy of revenue collection and services provision is economically efficient within

homogeneous localities (Fischel, 1992; Hamilton, 1975, 1976; Tiebout, 1956), the impacts of local administrated property tax and the composition of local revenues on inter-jurisdictional heterogeneity have not been investigated. From a historical perspective, the inter-jurisdictional heterogeneity with local fiscal autonomy per se should have resulted in a more heterogeneous outcome of tax collection and public expenditure. However, few studies have investigated the impacts of the localization of property taxation on inter-jurisdictional heterogeneity in policy outcomes including per capita tax revenue and per capita direct expenditure.

In the process of interaction between inter-jurisdictional heterogeneities and local authorities in revenue collection and services provision, specifically, intergovernmental grants from federal and state governments were applied as support to and control for local governments. The functions or purposes of grants include promoting national standards, creating greater equalities among states and localities, encouraging provision of certain services (Sjoquist, Stavick, & Wallace, 2007), and covering the vertical externalities of tax and expenditure (Dahlby, 1996). The combination of local autonomy and heterogeneity will generate and enlarge inter-jurisdictional inequalities;³ intergovernmental grants, on the other hand, will tend to decrease inter-jurisdictional inequalities, thus reducing inter-jurisdictional heterogeneity (measured by coefficient of variation) in policy outcomes (Figures 1.2 to 1.4).⁴ With the increased inter-jurisdictional heterogeneity due to complicated economy, local fiscal power also comes with the localization of property tax. Along with this process, theoretically, more local fiscal autonomy will strengthen local power and, thus, enlarge inter-jurisdictional heterogeneity (Niskanen, 1971). Inter-jurisdictional heterogeneity and local fiscal power would strengthen or reinforce each other. After the localization of property tax, with the introduction of other types of

³ Oates (2005) admits that “even ‘uniform’ national programs can have significantly different local outcomes where they are administered locally.”

⁴ Data source: the U.S. Census.

tax revenues, mainly the sales tax, the share of property tax in local revenue still diminishes (Brunori et al., 2006). These changes of revenue compositions may also have potential impacts on different aspects of local fiscal administration.

1.4 Fiscal Federalism and Public Choice

Fiscal federalism theory (Musgrave, 1959; Wallace E. Oates, 1968, 1972) indicates that for the three different functions of government—stabilization, allocation, and distribution—different levels of governments should be responsible for them, and it is more efficient for local governments to provide public goods and services according to different residential preferences (distribution). With the increased inter-jurisdictional heterogeneity and complexity, the localization of property tax (decentralization) can improve the efficiency of governments because local officials have better information to match the preferences of the local population to the package of public goods and services (Tiebout, 1956). From the local level perspective, *demand-revealing behavior* is the movement of residents from community to community. Moving or failing to move reveals the consumer-voter's demand for public goods, similar to the usual market test of willingness to buy a good. As Tiebout (1956) concluded, “[t]here is no way in which the consumer can avoid revealing his preferences in a spatial economy. Spatial mobility provides the local public-goods counterpart to the private market's shopping trip.” However, the heterogeneity of citizens creates numerous problems for the public good provision of the Tiebout model (Alesina, Baqir, & Easterly, 1999; Atkinson, Stiglitz, & Atkinson, 1980; Rubinfeld, 1987a). On the other hand, from the public choice perspective, using a median voter framework, Sjoquist (1981) found that just as in the case of expenditure, the composition of taxes responds to the utility of the median voter model. Thus, the localization of property taxation as a main revenue source can be seen as a public requirement for the

development of heterogeneous residential preferences. The “benefit view” (Fischel, 1992, 2001) of property tax also indicates that the costs of property tax approximate the benefits from public programs. From the “benefit view,” both the inter- and intra-jurisdictional heterogeneities would call for a localization of property tax. Therefore, the fiscal federalism theory and public choice theory together serve as the theoretical basis for the match of localization of property tax and inter-jurisdictional heterogeneity.

1.4.1 Fiscal autonomy and local disparities

While local property tax is the main own revenue source of local governments, it presents some critical issues, including its visibility and transparency, administrative issues such as assessment, an imperfect association between income (ability to pay) and property ownership, and fiscal disparities across jurisdictions. Oates (2001) explicitly addresses these issues.

In his opinion, though its visibility brings unpopularity, a good tax should make people aware of the costs of public services, and in a tax, visibility is “a virtue, not a fault” (Wallace E. Oates, 2001, p. 24). For administrative issues, more modern, accurate, and frequent assessments have greatly reduced the inequities in assessment practices, and the gradual restriction of the tax base to real property simplified the tax and reduced its “intrusiveness.” Furthermore, the introduction of so-called “circuit breakers,” which provide property tax relief for certain economically vulnerable populations, such as the elderly and low-income families, has significantly addressed the problem of an unmatched association between income and property. The last issue, fiscal disparities, actually brings about inter-jurisdictional heterogeneity in policy outcomes. However, Oates (2001) argues that this is not an indictment against the property tax *per se*; rather, it is a case against local taxation in general. McGuire (2001) finds that the

alternatives to the property tax, i.e., local sales tax or income tax, confront the same issue of local disparities. A local sales tax would induce even larger disparities in the local tax base than the property tax, and a local income tax would only very slightly decrease the disparities existing under the property tax (McGuire, 2001). Thus, Oates (2001) insists that the real question is: should we rely on local taxes to finance local public spending? Or, can local governments receive their main revenues in the form of intergovernmental grants from upper levels of government?

In truth, nearly all local finance systems involve some mixture of funds from own sources and inter-governmental grants, and there are considerable variation in the shares, reflecting fundamental differences in the philosophy of local government finance (Wallace E. Oates, 2001). The issues of fiscal disparities for local taxation is regarded as the most important by Oates (2001). Using measures of efficiency for local service provision, Duncombe and Yinger (1998) find that because of the *flypaper effect*, services financed through intergovernmental grants are more efficient than those funded by local taxation. They estimate that “in the average district, a \$1 increase in state aid is associated with a \$0.33 increase in educational expenditure, whereas the expenditure rises by only \$0.10 when district income increases by \$1.” Hines and Thaler (1995) and Inman (1983) have reviewed other studies of the flypaper effect, and Inman (1983) proposes that the flypaper effect is politics and is best seen as “an outcome of political institutions and the associated incentives of elected officials.”

Therefore, for local governments, how the different revenue compositions contribute to the fiscal disparities is an interesting question. Local taxation (fiscal autonomy) will result in local fiscal disparities (inter-jurisdictional heterogeneity). Also, the inter-jurisdictional heterogeneity is advantageous for the rich areas to maintain fiscal power. Intergovernmental

grants, with the purposes designed for cutting fiscal disparities, on the other hand, tend to decrease the inter-jurisdictional inequalities, thus reducing the inter-jurisdictional heterogeneity. As Oates (2001) noted, there is a real tension here between efficiency and equity, i.e., local taxation and intergovernmental grants, in local government finance.

1.4.2 Local own-tax source and intergovernmental grants

While in the U.S., fiscally viable local governments are a “lynchpin” of local public finance (McGuire, 1995, 2001; Wallace E. Oates, 1991), Western European countries are different. Of these countries, including Spain, Norway, Germany and Italy, local governments are financed primarily by grants from the central government. Compared to U.S., local public services in Europe are more adequately provided by fiscally dependent local governments, and also, there is much more uniformity in spending across local jurisdictions (McGuire, 2001). In the U.S., one form of local government, school districts, has been highly relying (dependent) on state grants in recent decades, with California and Michigan as two obvious examples. The primary reason for this development was the property revolts started in the 1970s and the court challenges to the unequal distribution of property value and spending per pupil (Murray, Evans, & Schwab, 1998). The implications of this financing change, including the overall quality of education and the outcomes for students in the poorest district were hotly debated by researchers and have not yet reached a consensus. But, there is no widespread dissatisfaction with largely state-financed local public schools except California (McGuire, 2001). With regard to the difference between U.S. and European countries, Netzer (2001) argues that the local financing method is a reflection of difference between a deferential and a non-deferential tradition: British scholars value taxable property uniformly and completely, and they were not concern with

geographic disparities in effective tax rates or other consequences, while American scholars were heavily involved in the reform efforts and were emphasizing inter-jurisdictional heterogeneities.

Besides school districts, unequal distribution of the property tax base is also one reason for restricting the excessive use of own source revenues in other jurisdictions, including counties and municipalities. In metropolitan areas with a large number of local jurisdictions, the fiscal disparities are larger, because people of similar incomes tend to live in the same jurisdictions with Tiebout sorting (McGuire, 2001; Tiebout, 1956). Thus, the successful financing method, mainly by intergovernmental aid for local governments in many European countries and school districts in the U.S., provides supporting evidences to the restricted access to the property tax and the idea that local governments can perform well without a primary own source revenue (McGuire, 2001). However, Intergovernmental grants increases transaction costs by complicating administrative system, blurring taxing and spending responsibilities, as well as expanding the deadweight loss of taxation (Bröthaler & Getzner, 2011). The determinants of grants without recognizing detailed local conditions also results in the expansion of transaction costs and the inefficiency of intergovernmental grants (R. Borck & Owings, 2003; Chesney, 1994; Grossman, 1994; Volden, 1999).

Moreover, the fiscal autonomy of local governments does possess its rationales. With the own source revenue, local governments can be responsible and accountable to the resident/voter demand (Sjoquist, 1981), can provide efficient levels of public services at the margin for spending decisions (Wallace E. Oates, 1972, 2001), and can match expenditure beneficiaries in a geographic limited entity (McGuire, 2001; Wallis, 2001). Also, Connolly, Brunori and Bell (2010) find that the share of state and local own-source revenues raised by local governments and the degree of local autonomy are strongly correlated; with the fiscal empowerment, the local

autonomy and local accountability are closely related (McCluskey, 1999). For these reasons, it is still desirable to preserve the U.S. version of federalism—including fiscally empowered local governments, and the property tax seems to be the best tool to raise large amounts of revenue at low (efficient) tax rates (McGuire, 2001).

1.5 Data

Three different data sets were collected and analyzed in this dissertation, of which the first two are archive data, and the third data set is the parcel data of counties in Georgia. By contacting the Tax Assessor's Office and/or Tax Commissioner's Office of each county of Georgia to get the raw data and compile them to a usable data set, I collected the data of all parcels from 46 counties for about 3 to 10 years. This section introduces the data sets one by one in the following.

(1) U.S. local finance data

The U.S. local finance data were collected from the US census. The U.S. census provides an archive data set of U.S. local finance from 1960 to 2008. The data include different types of local governments: counties, cities and townships, school districts, and special districts. The localities are not consistent for each year and, thus, unbalanced. However, the aggregated level data exist and are consistent. Finally, based on the local finance data, a balanced national and state aggregated data set is achieved for 50 states and Washington, D.C. for 49 years.

(2) Georgia counties and municipalities

For the aggregated county level data in Georgia, all 159 counties and 536 municipalities were collected. The data sources are listed in Table 1.1. Of these data sources, the Report of Local Government Finances from the Department of Community Affairs (DCA) is a very

valuable data source, which includes most fiscal characteristics of localities. Based on these data sources, I compiled a comprehensive aggregated county level data including all counties and municipalities in Georgia for 22 years (1985-2011).

[Table 1.1 about here]

(3) Georgia parcel data

By contacting the Tax Assessor's Office and/or Tax Commissioner's Office of each county in Georgia, I collected the parcel data for the Georgia counties. Of the 159 counties, the parcel data for 46 counties have been collected. For the collected counties, 30 of them are metropolitan counties (10 metro and 20 urban) and the other 16 are rural counties. For most collected counties, there are consecutive assessment values of parcel data for 3 to 10 years. For sales data of each parcel in 39 counties (8 metro, 18 urban and 13 rural), there exist a long series of data for over 40 year from 1970 to 2011. Figure 1.5 lists the counties of which I have collected the assessment/sales data. Specially, for counties with large population (more than 100,000), of the 5 counties (Fulton, DeKalb, Gwinnett, Cobb, and Clayton) that make up the core of the Atlanta metropolitan area (first defined in 1950), all parcel data were collected. For the 25 counties with population more than 100,000 in Georgia, 18 of them were collected. Therefore, there is a possible over representative of big counties for the parcel level data. Accordingly, the policy implications are mainly for big counties. In some of the estimations, big and small counties are investigated separately.

[Figure 1.5 about here]

The parcel data contains all types of real properties: residential, industrial, commercial, as well as farm land. For the research on property taxation, residential property is the focus of this dissertation. Sometimes, different counties use different software to process the parcel data and we need to match the variables in different counties. Fortunately, however, the Tax Assessor's Offices in more than 90% of the Georgia counties have now converted to using the same software system WinGap, which helps to make variables of parcel data consistent and comparable.⁵ Generally, the data set includes parcel IDs, separated assessed values for land and improvement, and other characteristics of each parcel. For some of the collected counties, sales data are also included.

⁵ As of 2012, 139 of the 149 counties were using WinGap. See <http://www.wingap.com/conversions.htm> for a complete listing of all counties and their dates of conversion.

Table 1.1: List of data sources at the aggregated county level

Data Sources	Years	Remarks
Report of Local Government Finances (Department of Community Affairs (DCA))	1985-2011	City and County level fiscal data: revenue, expenditure, and liability categories
Georgia County Guide	1982-2011	County-level and state data related to agriculture, crime, economics, education, government, health, housing, labor, natural resources, occupations, population, public assistance, transportation, and vital statistics
Tax Digest Consolidated Summary	1990-2011	Aggregated property tax digest for all counties, cities, school districts in Georgia
Government Management Indicators Survey (DCA)	2000-2012	
Tax and Expenditure Data Center for Georgia Local Governments	1985-2011	Detailed revenue and expenditure data at the county level
Statistical Report (Georgia Department of Revenue)	1985-2011	County and state: detailed revenue collections
American Community Survey		
Census of Agriculture		

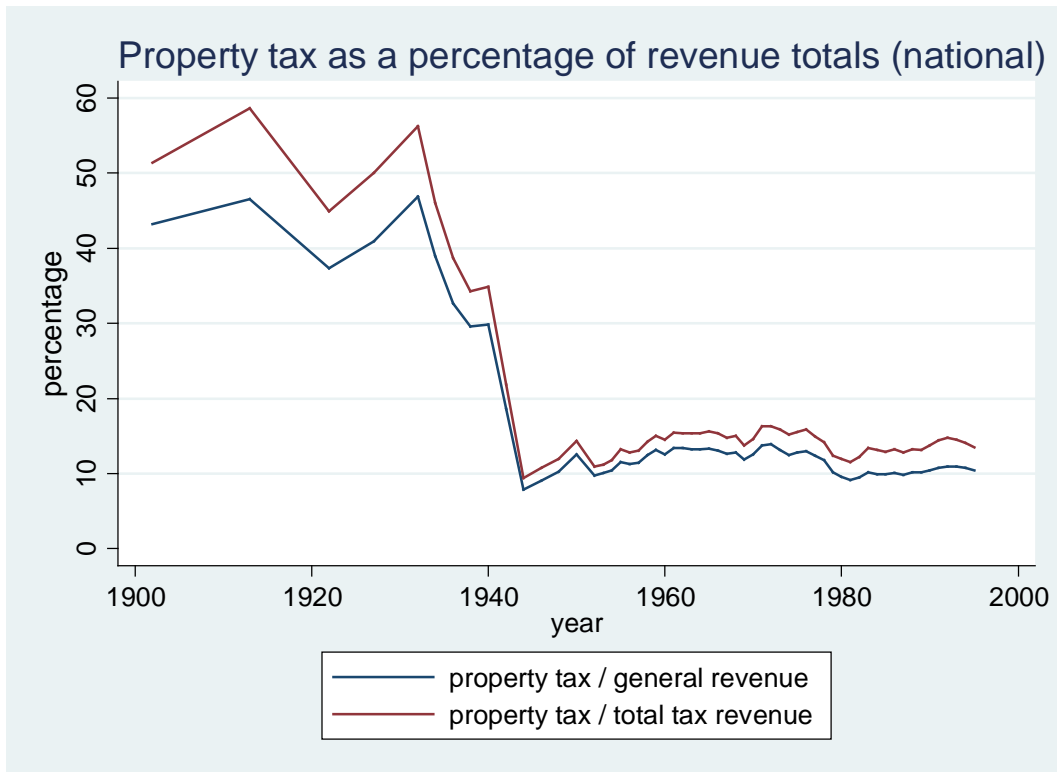
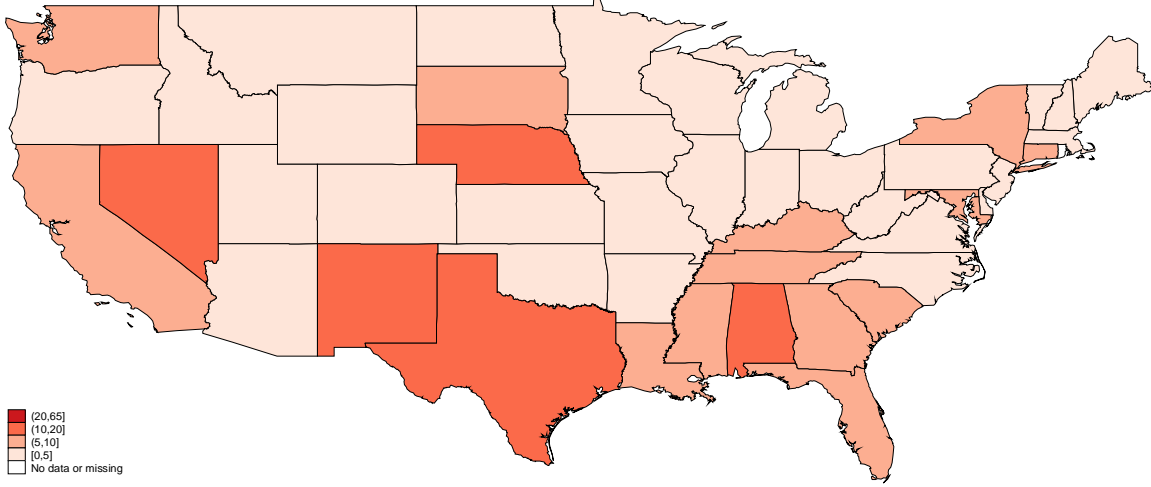


Figure 1.1: The changes of property tax in national total revenues

Coefficient of variation for property tax as percentage of total taxes (1957)



Coefficient of variation for property tax as percentage of total taxes (2000)

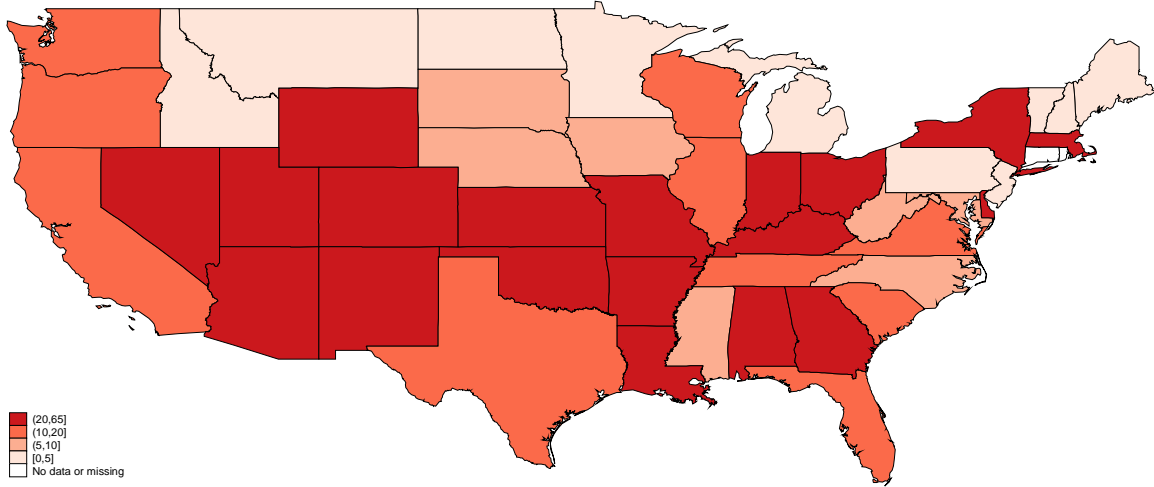
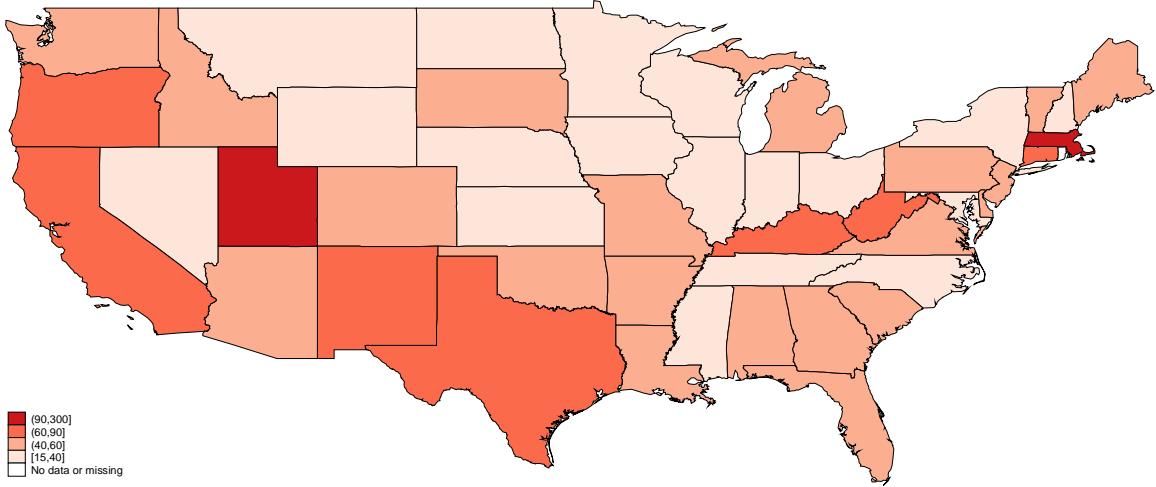


Figure 1.2: The inter-jurisdictional (inter-county) heterogeneity of property tax as a percentage of total taxes within each state

Coefficient of variation for per capita direct expenditure (1957)



Coefficient of variation for per capita direct expenditure (2000)

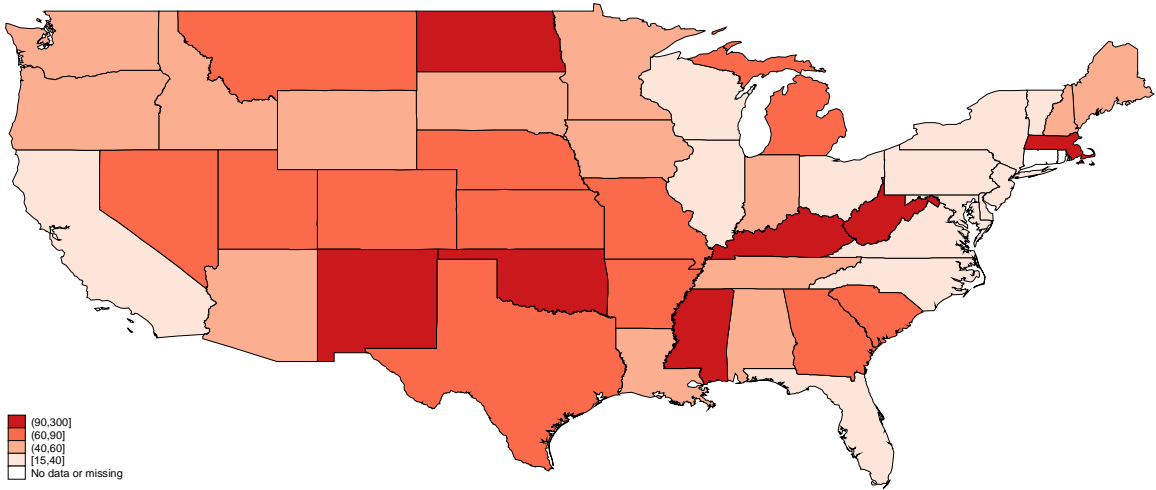
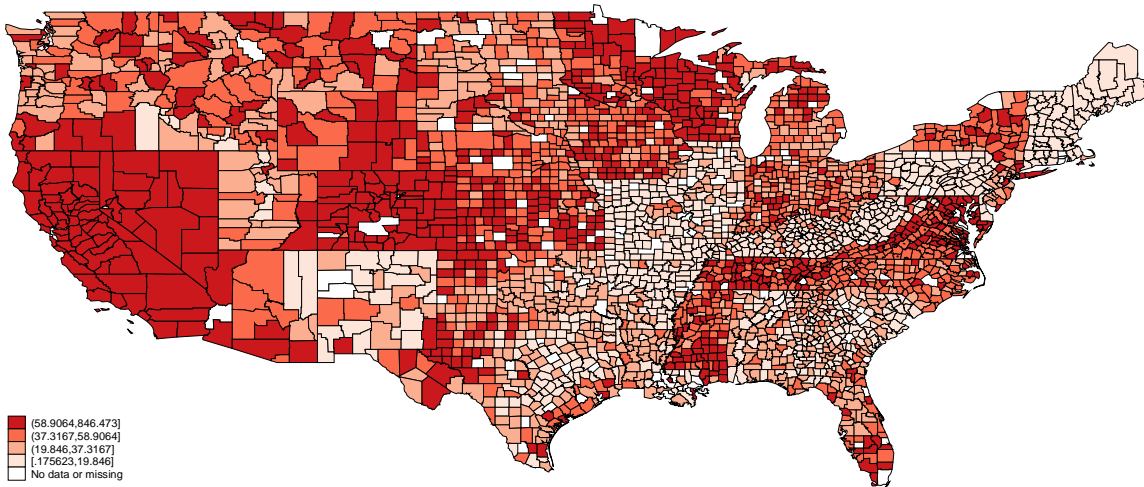


Figure 1.3: The inter-jurisdictional (inter-county) heterogeneity of per capita direct expenditures within each state

Heterogeneity of per capita direct expenditure (1957)



Heterogeneity of per capita direct expenditure (2000)

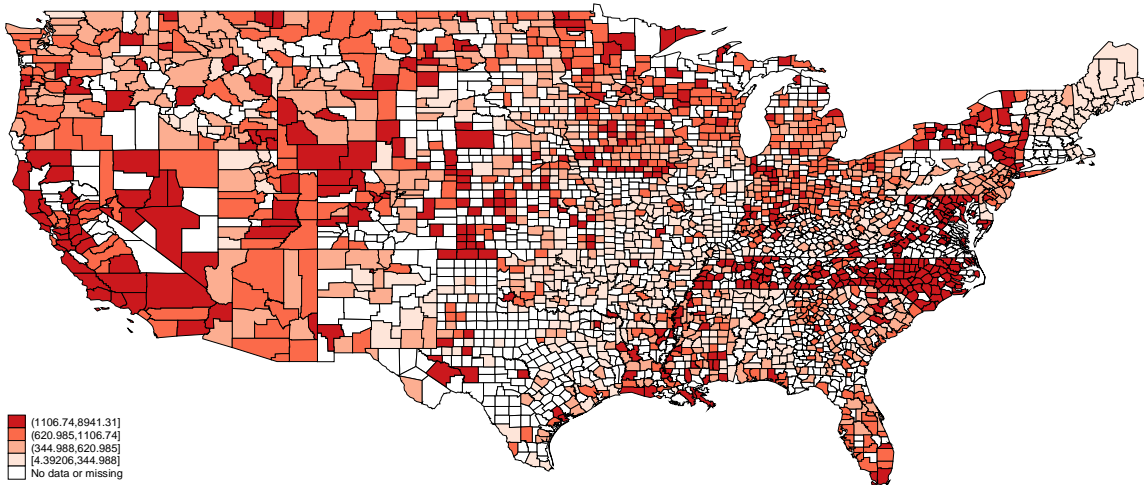
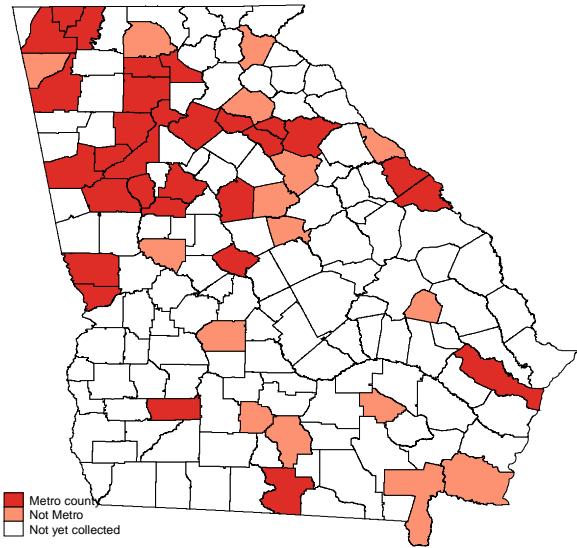


Figure 1.4: The inter-jurisdictional (inter-county) heterogeneity of per capita education spending⁶

⁶ The measurements in the legend are per capita education spending for each county.

Parcel Data Collected in Metropolitan Counties



Sales Data of Counties Collected

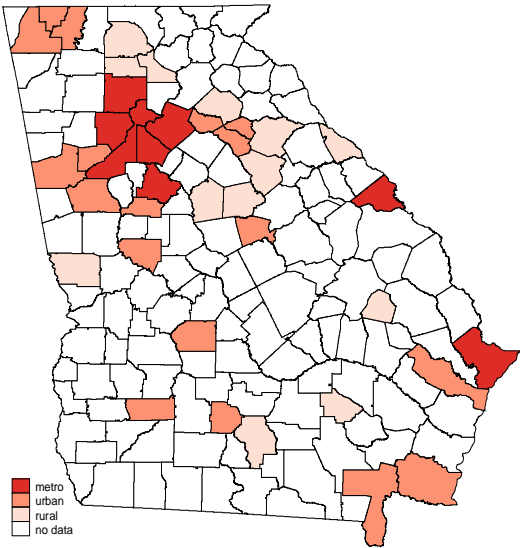


Figure 1.5: The distribution of counties of which parcel level data collected

CHAPTER II

2. THE DYNAMICS OF HOUSING AND LAND PRICES IN DIFFERENT CONTEXTS

2.1 Introduction

The relationship between land prices and housing prices has been a controversial issue for a long time. Three distinct perspectives exist simultaneously (Wen & Goodman, 2013): (1) land prices, as one of the costs of housing prices, contribute to housing prices (the cost-driven perspective); (2) housing prices, decided by the price bid function, affect land prices (the derived demand perspective); and (3) a bidirectional relationship (the mutual causation perspective). The third perspective combines both the supply and demand sides of the housing market. Rising housing prices lead to an increase in land prices, and increased land prices aggregate the cost of housing, thus housing prices. The question as to *which is the leading market* remains.

While there are many empirical results confirming all the different opinions of government departments, real estate developers, and academic scholars, there is no fundamental *theory* to illustrate the mechanism of the relationship between land and housing prices. The three interrelated submarkets (housing, land, and rental markets) proposed by Potepan (1996) represent a good distinction between the land and housing markets. By analyzing the fundamentals of the determinants of both land and housing prices and connecting these fundamentals with the three submarkets, this chapter proposes an integrated theoretical framework describing the interaction of land prices and housing prices. Furthermore, our framework successfully illustrates the different relationships between land prices and housing prices in different scenarios, which can be

potentially used to explain the controversial empirical results. Briefly, as discussed in Capozza and Helsley (1989), the price of *urban* land has four additive components: the value of agricultural land rent, the cost of conversion, the value of accessibility, and the value of expected future rent increases (a growth premium). In a highly developed urban area, the first three components are approximately fixed; thus, only the change of the fourth component (i.e., future rent) will cause or be affected by a change in housing prices. In this scenario, when housing prices change, the magnitude of the change of land prices is determined by the rental market and the proportion of capitalized future rent in land prices. In contrast, in a rural area, especially along the suburban fringes, besides the rent value, the accessibility of land can also be substantially changed due to urban development. At the urban fringe, the spatial characteristics are one of the determining factors of land prices (Chicoine, 1981; Hushak & Sadr, 1979). Thus, these two components of land prices can usually change more significantly as a result of urbanization or the establishment of a certain project. As concluded in Capozza and Helsley (1989), the growth premium may create a large gap between the price of land in a suburban area and the value of agricultural rentals. Therefore, in the suburban/semi-rural scenario, to a large extent, the change in land prices may play a leading role and cause a dramatic change in housing prices.

In this chapter, I propose a theoretical framework indicating that the relationship between changes or dynamics in housing prices and land prices depends on the reasons for the changes in different contexts. In a developed area, it is more likely that the housing prices lead to changes in land prices, while in an area in the process of urbanization, the change in land prices is more likely to cause a change in housing prices. In the empirical section, using the parcel level repeat sales data of both land and housing units in the state of Georgia, I constructed a 3SLS model and the results closely conformed to our theoretical expectations. The rest of this chapter is organized as

follows. The next section provides a theoretical framework by connecting the housing and the land markets. The third section reviews the literature on housing prices and land prices, and especially the relationship between the two. The fourth section introduces the data set and the repeat sales index used in the chapter, describing the trends of housing and land prices in different contexts. The fifth section deals with the empirical analysis and regression results, and the final section concludes this chapter.

2.2 Literature Review

Housing market dynamics in different circumstances have been studied by many scholars (DiPasquale & Wheaton, 1994; Engle, Lilien, & Watson, 1985; Ferreira & Gyourko, 2011). However, very little literature has systematically investigated the housing price mechanism over a significantly long period of time, specifically, across boom and bust years of the economic cycle. A recent chapter by Harding, Rosenthal, and Sirmans (2007) is among the first to decompose real housing price changes into three systematic parts: price inflation, age-related depreciation, and the contribution of maintenance. Partly because of data unavailability, most research fails to control for both maintenance and age-related depreciation. While it is an important issue for housing prices, land prices are fundamentally different. Capozza and Helsley (1989) decomposed the price of *urban* land into four additive components and concluded that, in rapidly growing cities, the growth premium can easily account for half of the average price of land. Shonkwiler and Reynolds (1986) also concluded that the distance to a metropolitan area is directly related to land price, and Colwell and Munneke (1997) found that the rate of price decline with distance from an urban center was overestimated but does exist and is significant. At the urban fringe, property-specific and spatial characteristics are proposed as the determinants of land prices (Chicoine, 1981; Hushak

& Sadr, 1979). Davis and Heathcote (2007) and Davis and Palumbo (2008) analyze the trend of residential land price in the U.S. by separating housing values as replacement costs of physical housing structures (i.e., construction costs). Ahlfeldt and McMillen (2014) provide a spatial history of land values in Chicago from 1919 to 2010. In this stream of literature, scholars assume that land capitalizes the market value of a home's location and find that residential land values have appreciated over a wide range, implying that housing is much more land intensive than it used to be.

Regarding the relationship between the dynamics of housing and land prices, there are three different views in terms of empirical results. In regard to the view that changes in land prices caused changes in housing prices, empirical results were found in the United States (Glaeser, Gyourko, & Saks, 2005), the United Kingdom (Evans, 1987), Hong Kong (Hui, 2004; Peng & Wheaton, 1993), and also China (Bao, 2004; Yang, 2003). However, scholars have also demonstrated both theoretically and empirically that housing demand causes land price changes (Alonso, 1964; Manning, 1988; Muth, 1971, 1972; Witte, 1975). Mutual causation (bidirectional relationship) was also found by scholars examining different data series based on the Granger (1969) causality test (Gao & Mao, 2003; Ooi & Lee, 2004; Song & Gao, 2007) and the simultaneous equations approach and/or 2SLS/3SLS regression methods (Wen & Goodman, 2013; Wu & Zheng, 2011). Some scholars divided the effects into long-term effects and short-term effects, and Kuang (2005) concluded that, in the long run, housing prices determine land prices, but both affect each other in the short run. Based on quarterly data in Finland, Oikarinen (2013) found that although the housing price response is generally slow, new information regarding the market fundamentals is more rapidly reflected in housing prices than land prices, and econometric results indicate that housing price movements cause land price changes. However, in the long run,

housing prices, instead of land prices, will adjust toward the equilibrium between housing and land prices and construction costs. Consistently, Du, Ma, and An (2011) found that in the four independent municipalities of China, in the short term, housing prices are Granger caused by land prices, while there exists a long-term equilibrium between the two.

An example from Davis and Palumbo (2008) shows that in 1998, for the single-family home's values in San Francisco and Milwaukee, the land in San Francisco represented 81% of total home value and house 19%, while the land in Milwaukee represented only 33% of total home value and house 67%. From 1999 to 2004, the land price in both cities increased 90%, and house prices (construction costs) increased 5% in San Francisco and 8% in Milwaukee. Thus, the actual increase in home prices is 74% ($0.81*0.9+0.19*0.05$) for San Francisco and 35% ($0.33*0.9+0.67*0.08$) for Milwaukee. Finally, the share of land value in total home value increased significantly, especially for Milwaukee. The land price increases at the same percentage, but tells different stories about home value changes. This example sheds some light on how the relationships between land and housing prices can have a large impact on the price dynamics of different localities. An obvious inference is that in a more developed area, land value occupies a higher proportion of total home value. Thus, a comparison of the relationships between land value proportion and indicators of development in different areas can provide an implication of comparative price in land price, i.e., relative to other areas, whether the land price appropriately reflects the development and public service provision or at least partly because of other speculative behaviors.⁷

⁷ Note that this is not a reference of absolute land price but a relative comparison. It is a topic for another chapter which will not be extended further.

2.3 Theoretical Framework

In this section, based on the contribution of existing literature, I construct a theoretical framework combining the linkages between markets for housing and land (urban and rural).

Potepan (1996) derived a theoretical framework of the metropolitan housing market, indicating the simultaneous determination of rent, housing prices, and undeveloped land prices, and Oikarinen (2013) refined this model to analyze the differences between urban land prices and housing price adjustments.

Briefly, the housing prices (P_H) and vacant land prices (P_L) should be at equilibrium in the following two equations:

$$P_H = P_H(P_L, C, D)$$

$$P_L = P_L(P_H, C, S)$$

where C is construction cost, D denotes variables/characteristics that influence housing demand, and S stands for the factors that determine land supply. Intuitively, housing prices and land prices are independent of each other, and thus, the housing rental price level equation is:

$$R = R(P_H, P_L, C, D, S).$$

A large amount of empirical research based on this framework has investigated the interrelationship between housing prices and land prices, but the results are inconsistent and even controversial. In this chapter, I argue that inconsistency is because most research takes the status of land as static, that is, either in an urban or rural status. Therefore, it fails to account for a very important component of land characteristics.⁸ Here, I use L to indicate land characteristics, and the land price equation changes to:

$$P_L = P_L(L, P_H, C, S).$$

⁸ When calculating the land price index, some studies control for basic land characteristics, such as the land size and the distance to the Central Business District (CBD), but from the knowledge of the authors, none of them controls for urban and rural differences.

As indicated in Capozza and Helsley (1989), the price of *urban* land can be divided into four additive components: the value of agricultural land rent, the cost of conversion, the value of accessibility, and the value of expected future rent increases (a growth premium). Thus, the location of a certain piece of land is a significant factor determining the land's price. The conversion costs can be different, and the urban-rural difference would cause great variation in the value of accessibility. The land characteristics, thus, should include land location, the urbanization index of the located area, and accessibility to amenities (Diamond, 1980). Putting these land characteristics into the equation may considerably increase the explanatory power for land prices.

As this point, however, the theoretical framework still cannot tell the direction of the relationship between housing prices and land prices. Actually, it is unambiguous that the *absolute* values of housing and land are mutually dependent on each other, and the controversial point among most existing studies is the relationship between the *changes* in housing prices and land prices, and who is playing the leading role. In this perspective, the reasons for the changes are very important and deserve due attention. However, most studies fail to identify the fundamental reasons for the housing/land price changes.

I assume that the changes are induced by external shock(s) denoted by A ; the change in the external factors of housing prices and land prices are all functions of the external shocks,

$$\Delta D = \Delta D(A)$$

$$\Delta L = \Delta L(A)$$

$$\Delta S = \Delta S(A).$$

The changes in these factors are determined by the features of the shocks. Demand shocks usually have a direct impact on the housing market, while supply shocks on land. As shown in Figure 2.1, I extend the analyses of Capozza and Helsley (1989) that not only *urban* land, but also

the value of most *residential* land in urban and rural areas has four additive components: the value of agricultural land rent, the cost of conversion, the value of accessibility, and the value of expected future rent increases (a growth premium). For the house value, I follow Davis and Heathcote (2007) and Davis and Palumbo (2008) in assuming that house values are equal to the replacement costs of its physical structure (construction costs). Thereby, other elements including public services and neighborhood characteristics are all capitalized into land values. When the supply or demand changes, the supply always starts from land while demand starts from house. Land price and house price are linked with each other; however, the change of demand has a direct effect on house while supply stands on the land side.

[Figure 2.1 about here]

There are two sides of land supply changes. One is urbanization which increases the amount of feasible land to be developed, and the other is the process of lower-value land (e.g., rural land in suburban areas) entering in the market due to policy relaxation of land restriction. If changes occur mostly in the process of urbanization, which greatly changes (decreases) cost of conversion and (increases) value of accessibility for certain lands, the price changes can account for a large proportion of the whole land price. These shocks increase the supply of urbanized land and increase the average land prices within a certain area. In this scenario, land price increases will lead to housing price increase. If the other side happens more (i.e., much lower-price land enters into the market), land price will decrease. Therefore, from the demand side, housing price changes always have a positive relationship with land price changes; however, from the supply side, the relationship is unclear about how land supply changes will affect house price changes. The direction is inconclusive since more supply tends to decrease land price while more

urbanization tends to increase the land value. Take China as an instance for the urbanization process, during times of rapid development, when some land was auctioned at a very high price, the price of housing units near this land rose immediately to reflect the higher land price (expected more urbanized amenities, thus more value of accessibility):

$$A \rightarrow \Delta P_L \rightarrow \Delta P_H.$$

On the other hand, sometimes, the shocks change the housing demand in the market. If external shocks happen in a well-developed area and cause an inflow of population, inducing an increase in the housing demand, housing price changes will lead to land price changes:

$$A \rightarrow \Delta P_H \rightarrow \Delta P_L.$$

Based on the above discussion, I have the following two consecutive hypotheses/propositions, and the second hypothesis is grounded on the first one.

H1: *The relationship between dynamics of housing prices and land prices depends on the effect of the external shock.*

- (1) When the external shock mainly changes housing demand, housing price changes will lead to land price changes, especially if land is in short supply;*
- (2) When the external shock mainly changes land characteristics or land supply due to urbanization or policy restriction, land price changes will lead to housing price changes;*
- (3) When the external shock changes both, the relationship will be bidirectional, and the magnitude will be dependent on the intensity/magnitude of the external shocks in each direction.*

H2: In a developed area, it is more likely that changes in housing prices lead to changes in land prices, while in an area under an urbanization process, the changes in land prices is more likely to cause changes in housing prices.

Note that if much new lower-price land enters into the market, it will help stabilize and even lower land prices, thus housing prices. Therefore, the causal direction is inconclusive.

2.4 Data and Repeat Sales Index

In this chapter, I use a repeat sales panel data set from 1970 to 2011 for 39 Georgia counties (strongly balanced), of which 8 are metro counties, 18 are urban counties and 13 are rural counties. In this chapter, counties with more than 200,000 population are defined as metro counties, counties with more than 70% urban population are defined as urban counties⁹, and the rest are rural counties. For these sampled counties, the data covers all sales data of housing and vacant land from 1970. This data set includes detailed information including the exact date of each sale, and more valuably, most sales are identified by a categorical variable indicating whether they were sold as housing units or just vacant land and whether they were fair market sales or not. I cleaned this data set and compiled it into monthly and quarterly data, including both housing unit sales and vacant land sales. Figure 2.2 describes the distribution of sales data collected in Georgia counties.

[Figure 2.2 about here]

2.4.1 Data

This data set is different from the commonly used repeat sales data in several ways. First, while most studies used solely housing data *or* land data, this set includes the data for both housing

⁹ The urban/rural population data is retrieved from http://www2.census.gov/geo/ua/PctUrbanRural_County.xls. The 2012 ACS estimates are the first to include tabulations for the 2010 Census Urban Area definitions and Urban/Rural classification. See more detail in U.S. census: <http://www.census.gov/geo/reference/ua/urban-rural-2010.html>.

and vacant land. Especially, the data for land sales are often scarce, since urban land is traded infrequently. Partly for this reason (Ooi & Lee, 2004), research on the relationship between land and housing prices have started only in recent years, and all of the studies have used the hedonic equation method to construct a land price index. Given the huge importance of the location of land, the hedonic method is subject to a large possibility of omitted variable bias. Our data set, however, is among the first to use the repeat sales data of land to conduct related research. Second, the existing research mostly uses data from Metropolitan Statistical Areas (MSA) in the U.S. or data from a specific city/county which represent only metro areas, or just one specific region and thereby is subject to limited generalizability. In contrast, as illustrated below, this data set is a very good representation of the state of Georgia and includes several dozen counties in the metro, suburban, and rural areas (categories); it allows for the investigation of local-level differences in the same market environment (state-level). Third, this data set covers a relatively long period, from 1970 to 2011 (42 years), a duration which includes five full economic cycles (1970-1976, 1977-1984, 1985-1992, 1993-2001, and 2002-2011). The data set helps us to investigate the interaction of housing prices and land prices in different circumstances of economic change. For instance, for the impact on housing and land prices, the recent Great Recession was quite different from previous economic downturns, since it was directly related to or even caused by the drop in the housing market. Finally, the biggest advantage of this data set is that it is a repeat sales data set. Since the location and spatial characteristics of land are determining factors of land prices, it is very important to control for these factors to investigate price changes. Because location and spatial characteristics are complicated and sometimes data are not available, we can never include all of the important characteristics. Thus, using repeat sales data is the best way to have all these characteristics controlled. Due to the lack of data mainly in vacant land sales, I have not seen any

previous study using repeat sales data to examine the relationship between housing prices and land prices.

2.4.2 Price index

I construct price indexes using the same methodology as that employed with repeat sales data, a methodology first developed by Bailey, Muth, and Nourse (1963), later popularized by (K. E. Case and Shiller (1987), 1989)), and widely used in scholarly research and practical applications (B. Case & Quigley, 1991; Harding et al., 2007; Rosenthal, 2013).¹⁰ The standard repeat sales model supposes that the prices of a house sold twice in periods t and $t + \tau$ are denoted as (Harding et al., 2007):

$$P_t = e^{\gamma_t} f(\mathbf{X}_t; \boldsymbol{\beta}_t), \text{ and}$$

$$P_{t+\tau} = e^{\gamma_{t+\tau}} f(\mathbf{X}_{t+\tau}; \boldsymbol{\beta}_{t+\tau})$$

where $f(\mathbf{X}; \boldsymbol{\beta})$ is an unknown function of the structural and neighborhood characteristics of housing (\mathbf{X}) and the corresponding coefficients ($\boldsymbol{\beta}$). As the typical repeat sales model assumes that both \mathbf{X} and $\boldsymbol{\beta}$ are unchanged between periods t and $t + \tau$, we can get

$$\ln(P_{t+\tau}) - \ln(P_t) = \gamma_{t+\tau} - \gamma_t + \mu_{t+\tau}$$

where $\mu_{t+\tau}$ is the error term, and the term $f(\mathbf{X}; \boldsymbol{\beta})$ is cancelled out in the equation. For each pair i of transactions (initial/first sale and repeat/second sale), the model becomes¹¹

$$\ln\left(\frac{P_{t+\tau,i}}{P_{t,i}}\right) = \sum_{t=1}^{\tau_i} \gamma_t D_{t,i} + \mu_{t,i}$$

¹⁰ This methodology has been used in practice as S&P/Case-Shiller home price indices (Source: <http://us.spindices.com/index-family/real-estate/sp-case-shiller>).

¹¹ Some properties were sold more than twice. I divided these transactions into different pairs of repeat sales. For instance, for sales happening in Periods 1, 2, and 3, the transaction pairs (1, 2) and (2, 3) can be used in the calculation of the index.

where $D_{t,i}$ takes the value -1 if for transaction i , period t is the period of the initial sale, +1 if the period of the repeat sale, and 0 if otherwise for each pair of transactions.¹² With the assumption that both the characteristics of housing units and the corresponding coefficients are unchanged between the two transaction periods, as indicated in K. E. Case and Shiller (1989), the variance of noise may increase with the interval between sales, mainly due to age-related housing depreciation and housing maintenance (Harding et al., 2007). In this chapter, I also control for age-related depreciation with a non-linear depreciation function. Note that I do not control for maintenance investment as in Harding et al. (2007); however, instead of decomposing the components of housing price changes, I investigate the relationship between changes in housing prices and land prices. Without accounting for maintenance, the housing price index will not have a significant influence on our conclusion. Therefore, the final format of the housing price index equation is as follows:

$$\ln\left(\frac{P_{t+\tau,i}}{P_{t,i}}\right) = \sum_{t=1}^{\tau_i} \gamma_t D_{t,i} + \beta \ln(\tau_i) + \mu_{t,i}$$

where β is the elasticity of housing price changes with respect to the interval between two sales (τ_i). As mentioned above, with the possession of repeat sales data for both housing and land, I calculate both indexes based on the repeat sale model to avoid omitted variable bias.

2.5 Methodology, Models, and Results

As illustrated in the literature review, due to the mutual relationship between land prices and housing prices, many studies conducted the Granger causality test to investigate the relationship, and some used simultaneous equation models. In this chapter, I apply both to

¹² Specifically, in two periods t and t' , this equation can be illustrated as follows:

$\ln\left(\frac{P_{t',i}}{P_{t,i}}\right) = \sum_{t=1}^{\tau_i} \gamma_t D_{t,i} + \mu_{t,i}$, where $t = 0, 1, \dots, \tau - 1$, and $t' = 0, 1, \dots, \tau$.

respective data sets as mutual robustness checks. Based on the above repeat sales index, I first calculate the price indexes of housing and land in different contexts and provide some intuitive descriptions. Then, I design the models and conduct necessary econometric tests, with the results and analyses that follow.

2.5.1 Descriptive analyses

Our sales data set includes 39 counties in the state of Georgia. To confirm the validity and generalizability of our research, I checked whether our data could represent, at least, the state of Georgia. Figure 2.3 provides the monthly price index of our data set in comparison with the Freddie Mac House Price Index (FMHPI) for Georgia and the United States.¹³ I found that the index of our data set closely approximated the Freddie Mac index for Georgia, indicating that the sample of 39 counties is very representative of Georgia.¹⁴

[Figure 2.3 about here]

As hypothesized in the theoretical framework, in a developed area, housing prices are more likely to lead to changes in land prices, since the value of accessibility was already included in the land value. For undeveloped rural areas, on the other hand, in the process of urbanization, the change in land accessibility can account for a large proportion of land values, thus promoting higher land prices. Figure 2.4 compares the different trends between the housing price index and land price index in metro counties and non-metro counties.¹⁵ The trends of

¹³ Source of the Freddie Mac House Price Index: <http://www.freddiemac.com/finance/fmhpi/>.

¹⁴ I also calculated the quarterly price index of our data set and compared it with the quarterly report from the Federal Housing Finance Agency (FHFA) (<http://www.fhfa.gov/Default.aspx?Page=87>); similarly, the sample data set from the 39 counties is a good representation of Georgia.

¹⁵ The trends of land price indexes are more volatile due to the lower frequency of land sales compared to housing sales.

housing price indexes are similar in metro and non-metro counties. In metro counties, the land price index obviously lags behind the housing price index, while in non-metro counties, the land price index shows a very similar trend to the housing price index, indicating a greater incremental value embedded in the land. These results accurately capture our propositions about the changes in housing prices and land prices. Note that the land price index in metro counties does not increase much is partly due to the fact that the data I used here is newly added *vacant* land sales which should be mainly in urban fringes.¹⁶

[Figures 2.4 and 2.5 about here]

The change in the accessibility value of land usually comes from a switch from rural parcels to urban parcels as a result of urbanization or urban sprawl. To illustrate this effect in detail, Figure 2.5 compares the trends of the housing price index and the land price index for urban and rural parcels with fixed parcel classes, that is, either urban or rural. In this case, the trends capture only the value changes within urban or rural parcels, ruling out the value changes from switching rural parcels to urban parcels. In this case, both trends show similar results—that changes in land price indexes lag behind changes in housing price indexes. Figures 2.4 and 2.5 demonstrate that changes in land prices in rural counties, to a large extent, come from the urbanization of rural parcels, in which the changes lie in the third component of land value in Capozza and Helsley (1989): the value of accessibility. Figure 2.6 provides further evidence that there are much greater new sales of vacant land than repeat sales during the period of a rapid increase in the land price index (1998-2007), while the two sales are approximately similar during other periods. According to theory, this trend happens most often at the urban fringes,

¹⁶ The land price index here is not exactly the land share of home as defined but the vacant land price index, however, it also captures the trend of land prices but more on less or newly developed areas, which underestimate the magnitude of land price changes.

which is consistent with the conclusion in the literature (Davis & Heathcote, 2007; Davis & Palumbo, 2008) that, from 1984 to the end of 2004, the value of residential land as a ratio of the total market value of housing increased from 32 percent to about 50 percent.

[Figure 2.6 about here]

2.5.2 *The Granger causality test*

I used the cointegration analysis and Granger causality test to examine the relationship between housing prices and land prices (Du et al., 2011; Ooi & Lee, 2004) and analyze both the long- and short-term dynamics. A general Granger causality test includes an examination to determine if the housing price index and the land price index are stationary and cointegrated. Thus, I first conduct the unit-root tests on both the two indexes and the first differenced series of the indexes. After the unit-roots are determined, I evaluate whether there is a long-term relationship between housing price and land price indexes. The following cointegration regressions are run with the data sets for both the urban and the rural county groups:

$$HP_t = \alpha_1 + \beta_1 LP_t + u_t$$

$$LP_t = \alpha_2 + \beta_2 HP_t + v_t$$

where HP_t and LP_t are price indexes for housing and land, respectively. The error term u_t and v_t are also called error correction terms for HP_t and LP_t , correspondingly (Du et al., 2011). If both housing and land prices are cointegrated, these error terms will be stationary.

However, as also mentioned in Ooi and Lee (2004), a linear combination of two non-stationary series may also be stationary, and if such a stationary linear combination exists, the two non-stationary series are said to be cointegrated (Engle & Granger, 1987). The stationary linear combination (i.e., the cointegrating equation) is interpreted as a long-term equilibrium

relationship between the two series. For the two cointegrated series, the error correction terms are needed in the Granger causality test to prevent model misspecification and loss of information about the long-term contemporaneous relationship (Eng, 1994; Fung & Isberg, 1992). The error correction models are as follows:

$$\Delta HP_t = \alpha + \sum_{i=1}^m \alpha_i \Delta HP_{t-1} + \sum_{j=1}^n \beta_j \Delta LP_{t-1} + \gamma \hat{u}_{t-1} + \eta_t$$

$$\Delta LP_t = \tilde{\alpha} + \sum_{i=1}^p \tilde{\alpha}_i \Delta LP_{t-1} + \sum_{j=1}^q \tilde{\beta}_j \Delta HP_{t-1} + \delta \hat{v}_{t-1} + \xi_t$$

where ΔHP_t and ΔLP_t are the first differences in housing and land prices. \hat{u}_{t-1} and \hat{v}_{t-1} are predicted values of the lagged error correction terms from the cointegration regressions. The optimal periods of lags (m, n, p, q) are determined based on the Akaike Information Criterion (AIC) (Du et al., 2011; Ooi & Lee, 2004).

According to the results in Table 2.1, the null hypothesis (i.e., there is a unit root) cannot be rejected for both housing and land prices. Therefore, we can conclude that the series of housing and land prices are not stationary. However, based on the results for the first differences of the two series, the null hypotheses are both rejected at the 1% level. The first differences of housing and land prices are both stationary. From the Johansen (1988) cointegration test, the eigenvalue and trace statistic both indicate that there is one cointegrating equation between the series of housing and land prices, implying a long-term equilibrium relationship between the two markets. The stability test, with 2 eigenvalues less than one, also confirms the stability of the bivariate model.

[Table 2.1 about here]

In 1990, The HOME Investment Partnership Program (HOME Program) was created by the National Affordable Housing Act.¹⁷ In 1997, the Multifamily Housing Finance and Development Program was organized by the Georgia Department of Community Affairs.¹⁸ These acts provided funds to support affordable housing initiatives or rental programs, which increased the demand for vacant lands and provided more land supply for housing in the market. Thus, taking into account the business cycles covered in the data periods, I divided the data into two subsets, one before 1992 (inclusive), the other after 1992 (exclusive).

[Table 2.2 about here]

The results in Table 2.2 show that in the full sample period (1970-2011, column 1), the housing and land price series have mutual (bidirectional) causal relationships. The coefficient of lagged difference of land price on difference of housing price (β_j) is around 0.06 and the coefficient of lagged difference of housing price on difference of land price ($\tilde{\beta}_j$) is around 0.52; both are significant at the 5% level. The results imply that overall the land price changes cause 6% of housing price changes in the following year while housing changes cause 52% land price change. It is very reasonable that it needs a long time for the land value to spread into home value due to the long construction cycle, while the land value itself often reflects *expected* value of certain location. From 1970 to 1992, the relationship is not significant. From 1993 to 2011, the change in housing prices has very clearly caused a change in land prices, in which 64% of the housing price increase will disseminate into the land price. However, the land price change did

¹⁷ Source: <http://www.dca.state.ga.us/housing/housingdevelopment/programs/HOMERental.asp>. The HOME Investment Partnership Program (HOME Program), created by the National Affordable Housing Act of 1990, provides funds to state and local governments to support affordable housing initiatives. The Georgia Housing and Finance Authority (GHFA) is the Participating Jurisdiction (PJ) and recipient of the State of Georgia's allocation of funds from the federal HOME Investment Partnership (HOME) program. GHFA contracts with the Georgia Department of Community Affairs (DCA) to administer the programs funded by this HOME allocation.

¹⁸ Source: <http://www.dca.state.ga.us/housing/housingdevelopment/programs/OAH.asp>.

not cause the housing price change because of the new development of vacant land (new sales), which increased the land supply and canceled out the effect of land price on housing price. As described in Figure 2.6, during the period 1998-2007, there are much greater amount of new sales of vacant land than repeat sales entering into the market.

I also analyze the relationship based on different subsets for metro/non-metro counties and urban/rural parcels. As shown in Table 2.3, the results for urban and rural parcels after 1992 (column 3) clearly illustrate that for urban parcels, changes in housing price lead/cause land price changes, while for rural parcels, changes in land prices lead to housing price changes. These results conform very well with the proposed hypotheses in Section 2. For urban parcels, in the long run, partly due to the fixed supply of both land and housing, the relationships between them are often bidirectional (i.e., there are mutual causal relationships between housing and land prices).

[Table 2.3 about here]

Besides the housing programs from the 1990s (decreasing housing prices), another stream in the housing market is the decrease in the mortgage interest rates, especially since 2001, and the popularity of owning a house (increasing housing prices). Thus, the net effect of the relationship between housing and land prices can be arbitrary. As proposed in the theory, the effects will be based on the characteristics of external shocks. The increased demand for personally-owned housing units with low down payment requirements and low interest rates promoted the housing prices of the late 1990s and early 2000s. The uncommon housing demand also explains why the housing prices were not as predicted by Mankiw and Weil (1989) to decline as much with the aging of the baby boomer's generation (the housing demand

distribution on age indicates that a larger proportion of younger population goes with a higher demand on housing).

2.5.3 *Simultaneous equations model*

In this section, I conduct analyses with the simultaneous equations model. The model is as follows:

$$HP_t = \alpha_0 + \alpha_1 LP_t + \alpha_2 HP_{t-1} + \gamma_1 X_1 + \varepsilon_t$$
$$LP_t = \beta_0 + \beta_1 HP_t + \beta_2 LP_{t-1} + \gamma_2 X_2 + \mu_t$$

where HP and LP are housing and land prices. For both price series, the log format is used; thus, the coefficients α_1 and β_1 indicate elasticity. X_1 and X_2 are two vectors of exogenous factors influencing housing prices and land prices, respectively.

In the above two equations, an increase in the error term (for instance, ε_t) in one equation will cause an increase in an explanatory variable in the other equation, which means that the assumption of no correlation between the error term and the explanatory variable is violated. Therefore, the simultaneous equations model should be introduced in which two models are usually used: (1) limited information methods including two-stage least squares (2SLS); (2) full information methods or system methods, including three-stage least squares (3SLS). For the 2SLS method, the first stage is to regress each endogenous variable on all the exogenous variables using ordinary least squares (OLS) and to get the fitted values of the endogenous variables. The second stage is to use the exogenous variables and *fitted values* of endogenous variables to regress the original equations in the first step to yield consistent estimators. This two-stage estimation is consistent but inefficient if we do not take into account the correlation across equations and the exogenous variables from other equations. 3SLS is an extension of

2SLS, and it estimates all coefficients of different equations to form a weight matrix and re-estimates the models using the estimated matrix. So, the first two stages are the same as in 2SLS, and the third stage involves the application of feasible generalized least-squares (FGLS) for all equations. The advantage is that the 3SLS accounts for the correlations cross equations and, thus, improves the large sample efficiency.

In the simultaneous equation model, just as in the Granger causality test, real housing and land prices are used as dependent variables. For the land price equation, the exogenous variables include real interest rates, property tax as a ratio of own source revenue, intergovernmental grants as a ratio of total revenue, per capita total expenditures, and infrastructure expenditures as a ratio of total expenditures. For the housing price equation, the exogenous variables include those in the land price equation and three other variables indicating housing demand: per capita personal income, unemployment rate, and population growth. Based on the availability of the exogenous variables, I use data from 1985 to 2011. In Table 2.4, for each equation, I compare the results of different methodologies (OLS, 2SLS, and 3SLS). The results are similar and, sometimes, have different standard errors.

[Table 2.4 about here]

The results indicate that in the entire period (1985-2011), generally, the housing price dynamics lead/cause the changes in land prices, while the land prices follow housing prices. This can be explained by the trend on population growth and cropland area changes: In Georgia, the population living in cities has a more than 40% increase from around 2.8 million in 1990 to 4.0 million in 2011; however, the cropland area reduced only around 18% (urbanization process tends to erode cropland) from 8.7 million acres in 1997 to 7.1 million acres in 2012. These

statistics indicate that the increase of population was accompanied by the increase of density instead of by the exploration/development of rural land, which mostly happened in rapidly developing countries such as China.¹⁹ Thus, the price changes are mostly from the demand side; for various reasons, the housing demand shows a big jump during this period, especially after the late 1990s as part of the nationwide housing bubble. In Table 2.5, I divide the data into two periods, before 1997 (inclusive) and after 1997 (exclusive). There are big differences between the two periods and between metro and non-metro counties. Before 1997, the coefficients of the housing price are mostly insignificant; while after 1997, the coefficients are significant, and the elasticity of housing prices on land prices is around 2, implying the significant impact of housing demand increases on land prices, particularly when the land supply is limited.

As illustrated in the theoretical framework, another reason why land prices did not lead the home price changes is that, as described earlier, after 1998, many more new sales of vacant land entered the market, which partly lowered the land prices in the context of increased housing demand. Especially for metro counties, the coefficient of the land prices is negative, which means that if there is no extra land supply, the housing prices will be much higher than they are now because of the high demand. From 1985 to 1997, the effect of housing prices on land prices is also positive for non-metro counties. This may be the result of a dwindling supply of land during this period.

[Table 2.5 about here]

2.6 Conclusion and Discussion

Regarding contradictory opinions on the relationship between dynamics of housing and land prices, empirical research examining the linkage between the two is still scarce. This

¹⁹ The population data is from the U.S. Census and the cropland data is from USDA Census of Agriculture.

chapter proposes a theoretical framework that allows these different perspectives to be reconciled. In the empirical part, based on the data set from the state of Georgia, I investigate the dynamics of housing and land prices using both the Granger causality test and the simultaneous equation approach. Taking advantage of representativeness of and the length of time covered by the data set, I analyze the relationship within metro counties and non-metro counties for different time periods. In conclusion, in the long run, there is a cointegrating long-term equilibrium between housing prices and land prices. In the short term, conforming to the theoretical hypotheses, I find that the relationship between dynamics of housing prices and land prices really depends on the contexts, which include social-economic changes such as urbanization and the characteristic of external shocks: shocks on the housing market or the land market and demand shock or supply shock. Generally, in metro counties, since the land supply is more limited, the increased housing demand makes housing prices lead to changes in land prices. The elasticity of housing prices on land prices is approximately 1.5 and as high as 2.2. In non-metro counties, when land supply increases quickly, the new land supply contributes largely to the stability of land prices and, thus, housing prices. For rural land in a fast-urbanization area, land prices can increase tremendously due to big changes in the value of accessibility in the land (not tested in this chapter, but needs further research).

Therefore, instead of determining the relationship between the dynamics of housing and land prices, this chapter is among the first to propose that the linkage is a *depend-on* issue. This may also be one of the reasons for the existing contradictory empirical results. The policy implication is very important for the relationship between housing and land prices. The results shed light and help us to understand the fundamentals of trends, fluctuations and regional variation in housing prices. Because the link depends on different contexts, policy makers in

different areas should attach more importance to local characteristics rather than just learning from other successful patterns. For local development policy, changes in land prices and housing prices are usually very significant factors influencing the impact of certain policy. Property tax design is another policy field that may need to take these results into consideration. While the ratio of property tax revenue has different impacts on housing prices and land prices over different periods in our sample, it signifies the different amounts/types of capitalization of public services on housing and land. Infrastructure investment has a much greater important impact on land prices than on housing prices, and the impacts are larger in rural areas than in urban areas. More empirical results are needed to justify or falsify the proposed theoretical hypotheses in this chapter.

Table 2.1: Augmented Dickey–Fuller unit-root tests

Time series	Level	First Difference
Housing price Index	-1.559	-13.043***
Land price index	-3.396	-21.322***

Notes: *** denotes significant at the 1% level with a critical value of -3.487.

Table 2.2: Vector error-correction model for housing and land prices

	(1) All years	(2) 1970-1992	(3) 1993-2011
Housing			
L._cel	0.0081 (0.0074)	-0.0021 (0.0085)	-0.0742* (0.0447)
LD.housing	-0.0277 (0.0768)	-0.3656*** (0.1020)	0.1397 (0.1220)
LD.land	0.0591** (0.0241)	0.0168 (0.0219)	0.0178 (0.0591)
Constant	1.2165*** (0.3429)	1.9532*** (0.3270)	0.2679 (0.5998)
Land			
L._cel	-0.2503*** (0.0645)	-0.7971*** (0.1377)	-0.2228* (0.1179)
LD.land	-0.3581*** (0.0725)	-0.1178 (0.1030)	-0.3879*** (0.1237)
LD.housing	0.5230** (0.2315)	0.4073 (0.4805)	0.6426** (0.2553)
Constant	-0.1143 (1.0329)	0.0174 (1.5404)	0.1124 (1.2554)
Observations	169	89	76
R^2			

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.3: Vector error-correction model for different categories

		All	1970-1992	1993-2011
Metro counties	L/H	0.0567*** (0.0190)	0.0328* (0.0171)	0.0694 (0.0476)
	H/L	0.2960 (0.3152)	-0.7209 (0.6366)	0.6924** (0.3153)
Non-metro counties	L/H	0.0173 (0.0225)	0.0120 (0.0317)	-0.0348 (0.0343)
	H/L	0.0418 (0.2223)	-0.3334 (0.2923)	0.7125** (0.3621)
Urban parcels	L/H	0.0477** (0.0223)	0.0178 (0.0211)	0.0103 (0.0540)
	H/L	0.5675** (0.2539)	0.4579 (0.5187)	0.7181*** (0.2617)
Rural parcels	L/H	-0.0007 (0.0514)	-0.036 (0.0745)	0.1649* (0.0887)
	H/L	-0.0173 (0.1057)	-0.0213 (0.1313)	-0.0350 (0.1731)

Notes: L/H indicates the effect of land price on housing price, and H/L indicates the effect of housing price on land price.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2.4: Results of simultaneous equation model

Variables	Housing price equation			Land price equation		
	OLS	2SLS	3SLS	OLS	2SLS	3SLS
land price	0.0359 (0.0230)	-0.0047 (0.1302)	-0.0087 (0.1306)			
housing price				1.2813*** (0.1784)	1.4162*** (0.2030)	1.4162*** (0.1949)
housing price (lag)	0.8828*** (0.0479)	0.9501*** (0.2320)	0.9551*** (0.2168)			
land price (lag)				0.2459*** (0.0896)	0.1945** (0.0979)	0.1945** (0.0940)
real interest rate	-0.0030* (0.0018)	-0.0031* (0.0018)	-0.0032* (0.0017)	0.0004 (0.0063)	0.0023 (0.0066)	0.0023 (0.0063)
property tax/own source revenue	-0.1923* (0.1079)	-0.1292 (0.1867)	-0.1131 (0.2307)	0.9193*** (0.3305)	1.1779*** (0.4130)	1.1779*** (0.3967)
grant/total revenue	-0.1283 (0.2348)	-0.0191 (0.3568)	0.0119 (0.4214)	1.5086** (0.7333)	1.8502** (0.9097)	1.8502** (0.8737)
per capita total expenditure, in 1000	-0.1894* (0.1099)	-0.2358 (0.1574)	-0.2394 (0.1848)	-0.7311*** (0.1998)	-0.8595*** (0.2505)	-0.8595*** (0.2406)
infrastructure/total expenditure	0.0736 (0.1452)	0.1172 (0.2079)	0.1164 (0.1958)	1.0975* (0.5989)	1.0658* (0.6066)	1.0658* (0.5826)
per capita personal income, in 1000	10.7036 (6.5848)	9.7552 (6.8558)	8.8184 (7.0217)			
unemployment rate	-0.4129 (0.3282)	-0.4905 (0.3312)	-0.5423 (0.4149)			
population growth	0.0050 (0.0042)	0.0054 (0.0043)	0.0056 (0.0043)			
Constant	0.5954** (0.2833)	0.4478 (0.7082)	0.4711 (0.5211)	-3.8263*** (0.6708)	-4.3551*** (0.7786)	-4.3551*** (0.7478)
Observations	104	104	104	107	104	104
R ²	0.969	0.968	0.968	0.847	0.835	0.835

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.5: Relationship between housing and land prices for different categories and periods

		All	1985-1997	1998-2011
All	L/H	-0.0087 (0.1306)	0.1946 (0.1746)	0.2708 (0.3269)
	H/L	1.4162*** (0.1949)	-0.2348 (0.8424)	1.9946*** (0.3859)
Metro counties	L/H	0.4965 (0.6562)	-0.2828 (0.2842)	-1.0504*** (0.3797)
	H/L	1.4366*** (0.1921)	0.5469 (0.7070)	1.5877*** (0.3113)
Non-metro counties	L/H	-0.0786 (0.3885)	-2.2642 (4.4366)	-0.8985 (1.1375)
	H/L	1.7570*** (0.2854)	3.7997** (1.6243)	2.1958*** (0.3530)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Notes: L/H indicates the effect of land price on housing price, and H/L indicates the effect of housing price on land price.

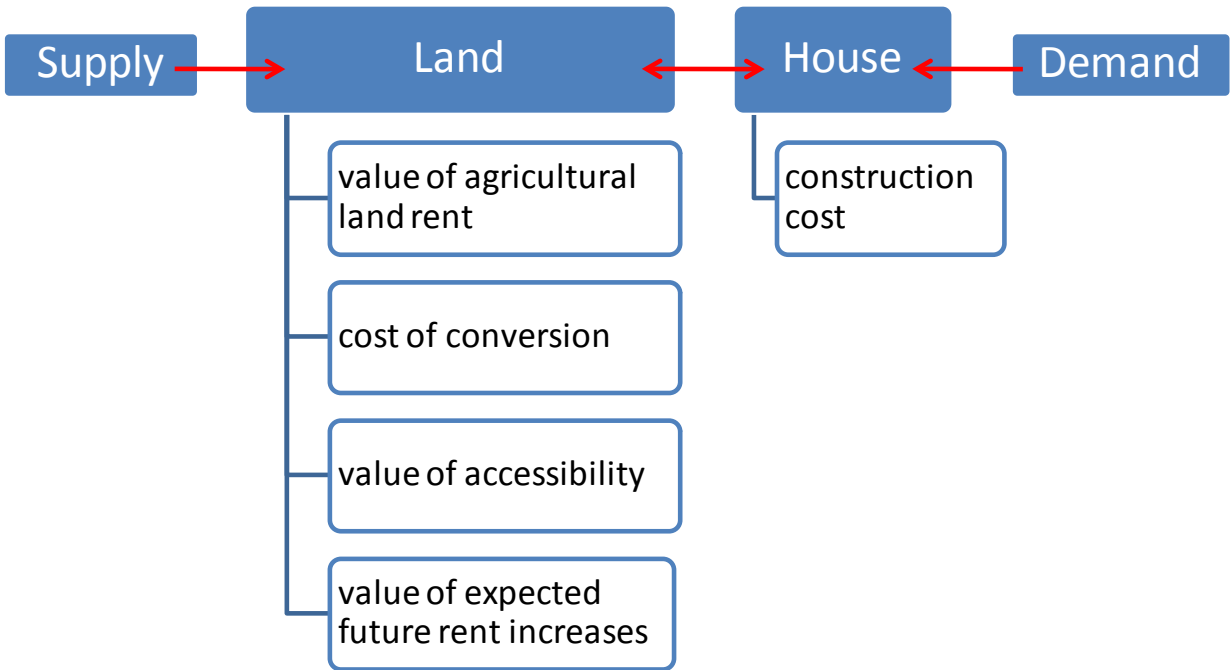


Figure 2.1: Theoretical framework of the dynamics between land price and housing price

Sales Data of Counties Collected

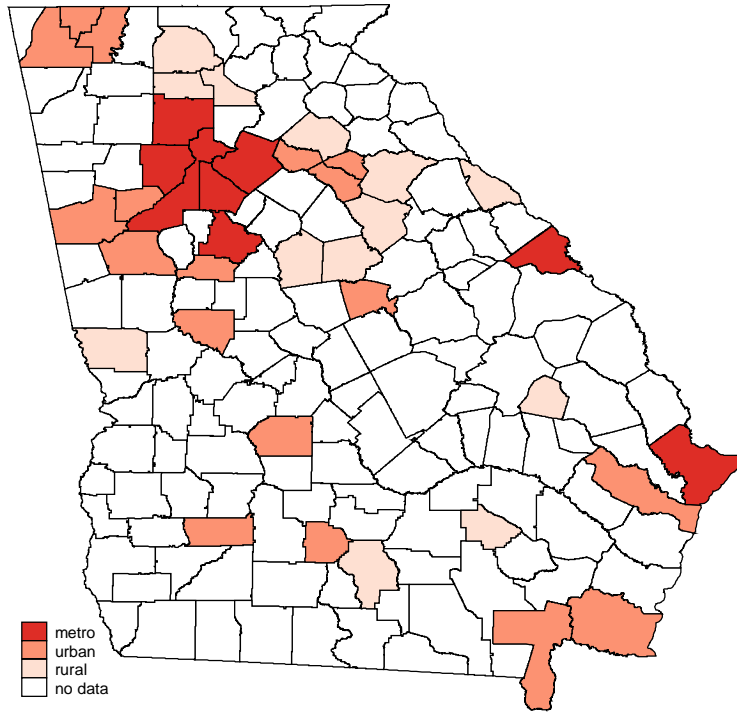


Figure 2.2: The distribution of sales data collected in Georgia counties (metro, urban, and rural)

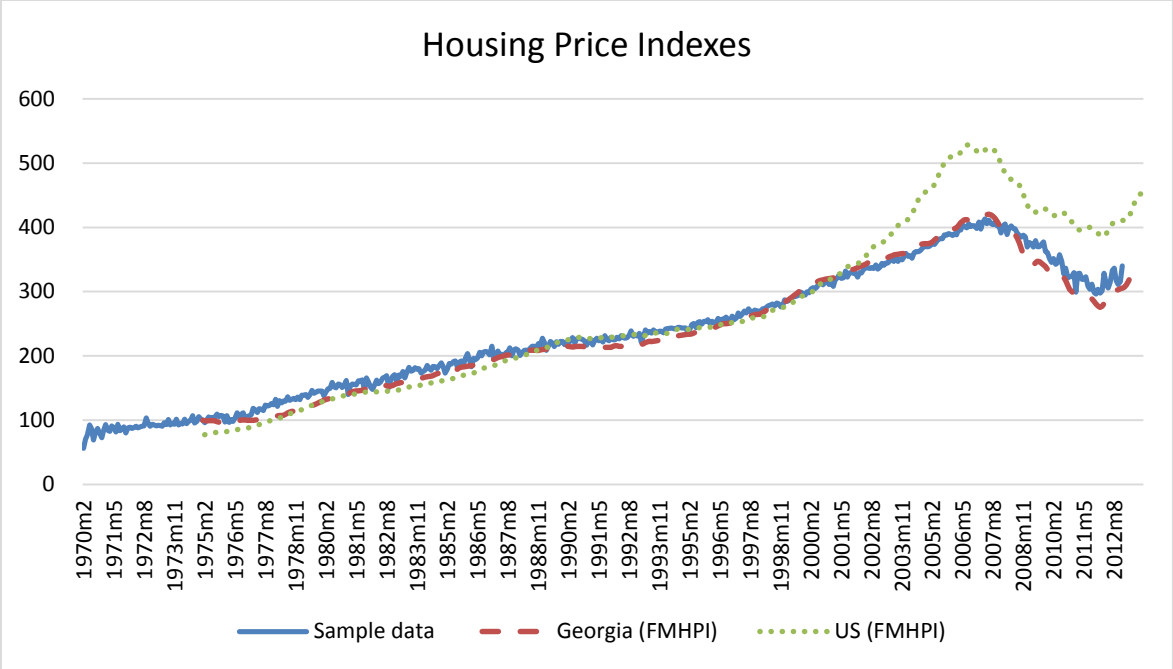


Figure 2.3: Comparison of housing price indexes from sample data, Georgia, and the U.S.

Notes: Housing unit sales with price increases higher than 20 times or decreases more than 60 percent are deleted.

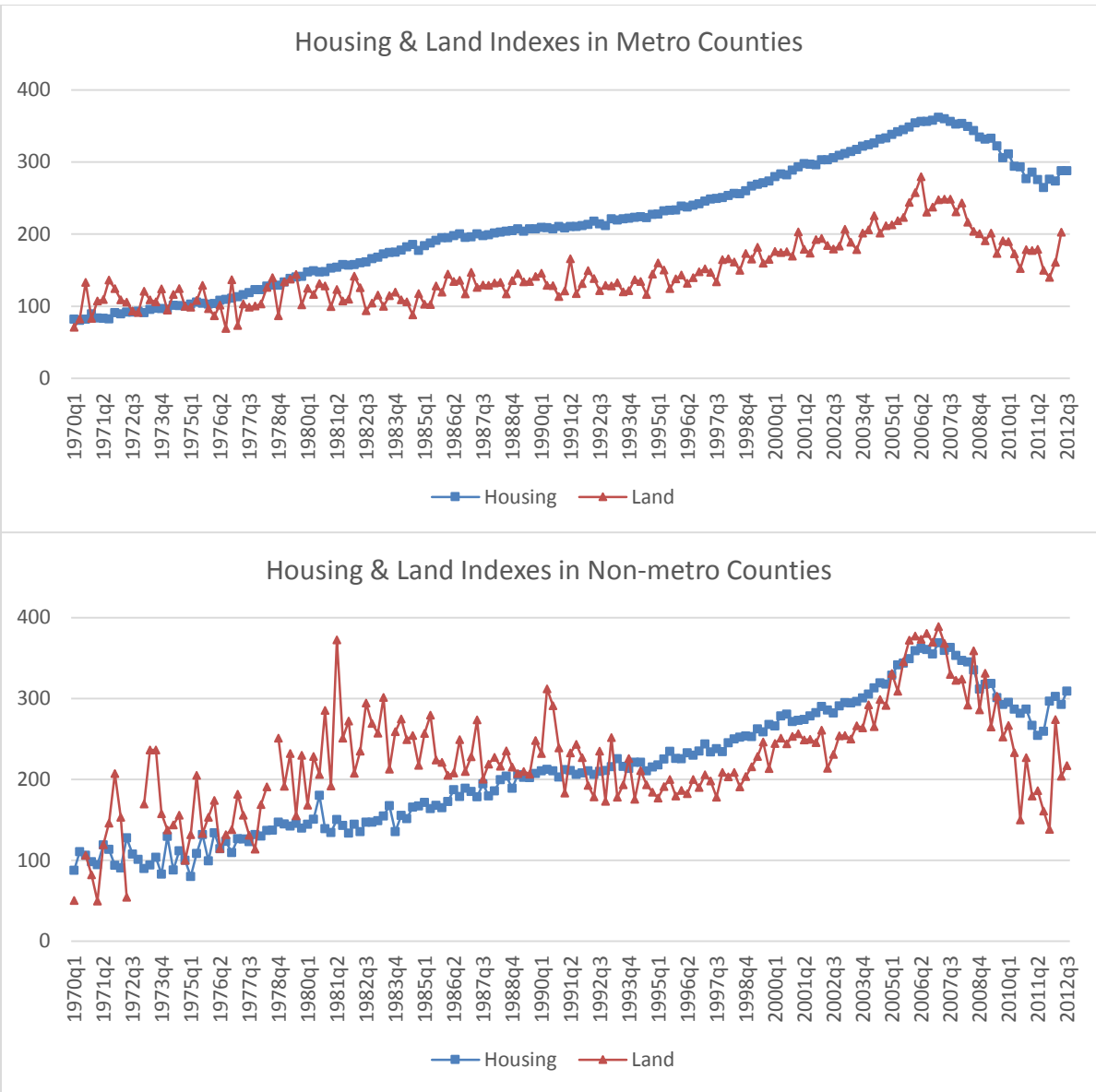


Figure 2.4: Housing and land price indexes in metro and non-metro counties

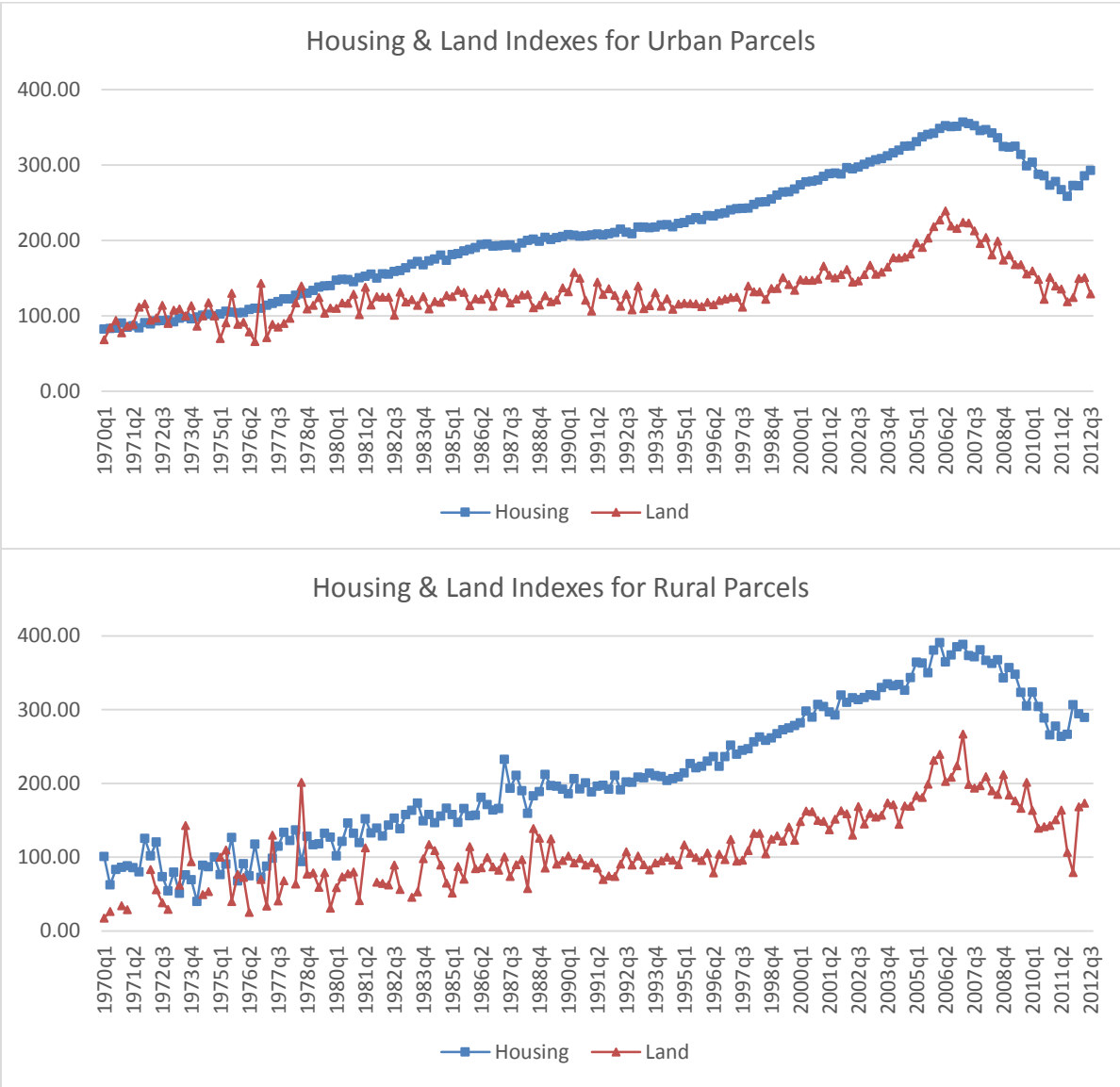


Figure 2.5: Housing and land price indexes for urban and rural parcels



Figure 2.6: Trends of new sales and repeat sales of vacant land

CHAPTER III

3. PROPERTY TAX, INFRASTRUCTURE INVESTMENT, AND HOUSING PRICES

3.1 Introduction

Infrastructure investment is needed to provide basic services anywhere, especially for newly developed parts of urban areas, and it is also essential for the economic productivity of localities (Peterson, 2009). The effects of public capital on regional development (Deno, 1988), local employment (Wasylenko & McGuire, 1985), and personal income (Duffy-Deno & Eberts, 1991; Helms, 1985) have been investigated by scholars. The impacts differ across types of public capital and across types of region (Deno, 1988). Different infrastructure facilities have very different impacts on areas in different development levels/stages. For instance, sewer and water public capital have the largest impact on output supply in growing regions, while highway capital does the same in declining regions. Eberts (1990) found that public capital outlays are more likely to affect regional development in *cities* that experienced their growth before 1950. The effects of public capital on local development even have short-term and long-term differences. Deno (1988) argued that, in the short term, public capital has a direct effect on the production activities of private industry, while in the long term, public capital will induce structural changes in the region, which is more important for less developed regions. Another perspective concerns local infrastructure's due roles for localities in firm production technologies and household consumption (Haughwout, 2002). Thus, local infrastructure investment can promote production efficiency and regional economic development; moreover, some investment also serves as public services (such as water and sewers) for local residents.

While the effects of local infrastructure investment on both regional development and personal income (and also other possible impacts) will be capitalized into property values, scholars have found that when regions (localities) are profit and utility takers, those nontraded regional traits, including infrastructure stock, will be fully reflected in local factor prices (Blomquist, Berger, & Hoehn, 1988; Gyourko & Tracy, 1991; Roback, 1982; Rosen, 1979). However, as pointed out by Haughwout (2002), most dominant methods of analyzing infrastructure productivity fail to control for part of the value of public capital reflected by regional factor prices. Basing his analyses on spatial equilibrium, Haughwout (2002) examined the effects of local infrastructure on local factor prices (infrastructure's social value) by identifying the due roles of public capital. While most studies have primarily focused on only the productivity component of local infrastructure's effects, Haughwout (2002) investigated three dimensions for the values of public capital simultaneously: (1) productivity, (2) the consumption value as public services, and (3) the location of economic activity.

Different from most research that treats public capital stocks as exogenously determined (Haughwout, 2002), this chapter, from the government perspective, analyzes how the input (government revenue) and output (impacts on housing prices) factors influence the decisions of local infrastructure investment. This investigation is very important and can reveal the effects of public capital investment from a specific angle, across different types of public capital and across regions. Property tax is the main own-source revenue for local governments, and property tax reliance varies a great deal among localities; differences between urban and rural counties are significant. Furthermore, since the expenditure structure could be very different in urban and rural areas, the local infrastructure investment behavior for local governments in urban and rural areas will vary (Haughwout, 2002; Holtz-Eakin & Rosen, 1989). For instance, fast-growing

cities face substantial demands for new infrastructures when they are relatively young (Brueckner & Saavedra, 2001).

This chapter addresses three issues: (1) the impact of revenue structure (focusing on property tax reliance) on infrastructure expenditure; (2) the impact of local infrastructure stock on housing prices (housing & land), across different types of infrastructure and localities; (3) the relationship between the above two impacts, and how these two impacts interact in the decision-making process. The rest of this chapter is organized as follows. The next section briefly reviews the literature on local infrastructure investment. The third section provides a theoretical framework. The fourth section describes the characteristics of Georgia localities and the estimation strategy. The fifth section introduces the data and the sixth section presents the results and discussion. The final section concludes and offers policy implications.

3.2 Literature Review

Several studies have found that local infrastructure investment (public capital) has a significant effect on production decisions at the regional level (Deno, 1988; Eberts, 1986, 1990). Since public investment influences personal income through its effect on the marginal product of labor, and personal income determines the level of public investment (described by a median voter model), Duffy-Deno and Eberts (1991) used a simultaneous equations approach to estimate the effects of local infrastructure on personal income.²⁰ They found that public investment and public capital stock have separate effects on personal income, and the impact of public investment on personal income results primarily from a construction of public capital stock (replacement or net additions). For the public capital stock, its effect on economic growth clearly

²⁰ They used data from a sample of 28 standard metropolitan statistical areas (SMSAs) during the first half of the 1980s.

“outlasts its initial construction phase” (Duffy-Deno & Eberts, 1991). As proposed, they also found a positive and statistically significant contemporaneous effect of personal income on local public investment. Finally, they concluded that to promote regional economic development, public capital stock is an important input and has long-term consequences.

Since most of the nonmilitary capital (88 percent of the structures and 71 percent of the equipment in 1991) is owned by state and local governments, Gramlich (1994) argued that infrastructure investment is more of a state and local problem than a federal problem. For infrastructure capital, in addition to the difficulty in measuring rates of depreciation and utilization, it is also difficult to relate infrastructure investment to its goals, or changes in those goals. Gramlich (1994) further discussed econometric problems in estimating production functions and raised several policy considerations about local infrastructure investment, including federal grants and user fees. He also argued that while there has been far too much attention given to the details of macro production studies, far too little attention has been given to the more disaggregated studies (of which few exist), and that there are few studies on the impact of different types of policy changes. With systematic investigation of specification, Garcia-Milà, McGuire, and Porter (1996) found no evidence of a positive linkage between public capital and private output within the aggregate production function framework. They also argued that the analysis implies that the causal effect of public capital on output in the previous estimates may reflect a spurious correlation (Tatom, 1993).

Since the mid-1970s, the growth rate of public capital and the per capita quantity of public capital have declined sharply for state and local governments, especially for the two biggest components of infrastructure capital—highways and streets and educational facilities. Some scholars associate these changes with demographic reasons and a rise in the prices of public

capital goods relative to private capital goods (Gramlich, 1994; Hulten & Peterson, 1984; Tatom, 1991); other scholars attribute the changes to myopic decision-making by politically motivated government officials (Inman, 1983). (Holtz-Eakin and Rosen (1989)) tested these two conflicting views using a panel data set from New Jersey. They concluded that for the entire sample, they could not reject the hypothesis that capital spending “follows a path consistent with forward-looking, rational municipal planning” (p. 534). However, they found that capital spending behavior differs greatly between suburban and non-suburban communities and between small and large communities: The rational and forward-looking view cannot be rejected for suburbs and relatively small communities but can easily be rejected for non-suburbs and large communities. Based on the results, the apparent heterogeneity across different communities suggests that caution is required when pooling data together, and it deserves more investigation to determine why certain communities are more likely to be “rational” than others and how their reactions may differ in response to permanent or transitory grants (Holtz-Eakin & Rosen, 1989). From the theoretical perspective, Schwab and Oates (1991) also found that the composition of the community plays an important role in determining the amount of public goods provision including local infrastructure such as public safety. A trade-off arises between the gains from homogeneity in demands and the gains from heterogeneity in the supply/production.

Regarding the budgetary effects on local infrastructure investment, comparing U.S. states that maintain separate budgets for capital and operating expenditures with states that employ unified budgets, Poterba (1995) found that states with capital budgets do spend more on capital projects than other states. The pay-as-you-go (PAYG) requirement has a negative effect on public capital investment; thus, for those states that do not require PAYG to finance capital projects, the effects of separate capital budgets are even larger. While local infrastructure is often

financed from three sources—operating savings, grants from higher levels of governments, and borrowing (Peterson, 2009), Peterson (2009) argued that, with the decentralization of fiscal responsibility, local governments are asked to finance the capital budget from their own resources and their revenues are not sufficient to service debt expansion. Faced with this problem, since land values are highly sensitive to local infrastructure investment, Peterson (2009) examined capturing land value gains for public investment as an additional option for local infrastructure finance.

While there has been far too much attention given to the details of macro production studies,²¹ very little attention has been given to the more disaggregated studies (of which few exist), and there are few studies on the impact of different types of policy changes. This chapter will focus on the state of Georgia to investigate the historical trend of public capital at the local level and analyze the effects of influencing factors on public capital investment. From the micro data perspective, this chapter contributes to the existing literature in the following ways. First, it extends Haughwout’s (1999) findings from metropolitan municipalities to a comparison between urban and rural areas; second, different from studies that were based on municipalities in different states and that only use fixed effect to control district-specific heterogeneity (Duffy-Deno & Eberts, 1991; Haughwout, 2002), focusing on counties in the same state allows us to place the analysis in a controllable context²² and further differentiate the impacts on urban and rural parcels; third, while most existing studies apply sales data *or* survey data at household level, the results from both sales data and all parcel data provide an valuable opportunity to compare the difference.

²¹ Gramlich (1994) insists that aggregated analysis “can never answer the relevant policy questions very well.”

²² Holtz-Eakin and Rosen (1989) pointed out that municipalities in different states may operate in quite different institutional and legal contexts and pooling them together may produce inconsistent estimates; Chakrabarti and Roy (2012) illustrates several advantages of within-state local data over national cities.

3.3 Theoretical Framework

Hulten and Schwab (1997) analyzed the actual division of the responsibility for providing public capital in the United States. Local infrastructure investment might be funded from current local revenues, intergovernmental aid from higher levels of government, new debt or, most commonly, by some combination of these. The Tiebout model did not discuss the supply side of public good provision, and Inman (1979) described a production function with the input including public capital stock and community population.²³ While most studies have focused on residents and have not been “completely satisfactory” (Rubinfeld, 1987b, p. 595), and normative models of public good supply often have limited relevance to “how governments actually behave” (Oakland, 1987, p. 533), I develop a theoretical framework to describe the equilibriums for both residents and local governments in different scenarios with respect to funding sources and community types. The framework unfolds with three scenarios related to funding sources: (a) property tax as the only revenue source; (b) property tax + local sales tax; and (c) property tax + local sales tax + intergovernmental grants. I analyze these scenarios in circumstances of homogeneous and heterogeneous communities. In the framework, I consider/assume only residential properties and property owners without renters in the community, with no problems of rental as opposed to owner-occupied housing and the shifting of the property tax from residential to non-residential property.²⁴

The property tax

Despite the decreased share of property taxes in total local revenues, U.S. local governments continue to rely on property taxes as their main tax revenue (around 75% of tax

²³ The distinction between the study of the local public sector and the general theory of public goods is the possibility of migration among local jurisdictions (Rubinfeld, 1987b).

²⁴ See appendix for a review of existing theories of public goods provision and demand.

revenue as of 2008) and an important revenue source (around 30% of the total revenue as of 2008). For the sake of simplicity, I build our model based on the scenario that property tax is the only revenue source for local governments. Then, the assumption of framework is relaxed to add more revenue sources—local sales taxes and intergovernmental grants.

Our framework

Following the bidding and sorting model (Yinger, 1982), households care about the following consumptions: housing (H); other private goods (C , a numeraire good with the price normalized to be equal to 1); and public services (S), which are represented by the utility function $U(H, C, S)$ (Chung, 2012; Yinger, 1982, 2009).²⁵ Households face a budget constraint:

$$Y = C + PH + \tau V = C + PH + \tau \frac{PH}{r} = C + PH(1 + \tau^*)$$

where C is private consumption of goods except housing (H) and P is the annual price of per unit of housing H . The property tax payment is τV , where τ is the effective tax rate, $V = PH/r$ is property value, r is the discount rate, and $\tau^* = \tau/r$.

With property tax as the only revenue source, when (I assume) residents are identical in both taste and income, each individual bears the same share of the cost for public good provision.

The supply function is determined by

$$PH\tau^* = [C(N)/N]G$$

Thus,

$$C = Y - PH - [C(N)/N]G$$

where $C(N)$, borrowed from Henderson (1979), is the average cost of a unit of public good G . If the public good is a pure public good, $C'(N) = 0$; if the public good has congestion in

²⁵ See Ross and Yinger (1999) for a comprehensive review.

consumption or other private good characteristics, then $C'(N)$ is positive (Rubinfeld, 1987b).

The first order condition is $[(\partial U/\partial H)/(\partial U/\partial C)] = P(1 + \tau^*)$.

For both homogeneous and heterogeneous communities, the additional revenue sources of local sales tax and intergovernmental grants will have some “crowd out” effects to decrease the effective proper tax rate (τ) and increase the housing price. We assume that the crowd out effects are not *perfect* but *partial*, which means that as long as there is an extra revenue source for public good provision, the amount of public goods will increase. The amount of change will depend on the scale of the crowd out effect.

If we relax the assumption, then residents have different income and tastes regarding housing consumption. For each individual, the tax share is $PH_i\tau^*$, and the benefit of public goods is $C(N)g = C(N)N^{-\alpha}G$. In each community, the supply function of public goods is determined by

$$\sum_i^N PH_i\tau^* = C(N)G = C(N)N^\alpha g$$

Assuming altruistic local governments, their goal being to maximize residents’ utilities,²⁶ in the case of the Cobb-Douglas utility function, to maximize utilities is to maximize $U(C, H, g) = c_1 \ln(C) + c_2 \ln(H) + c_3 \ln(g)$. Based on the above, for both homogeneous and heterogeneous communities, I will discuss three scenarios related to funding sources: (a) property tax as the only revenue source; (b) property tax + local sales tax; and (c) property tax + local sales tax + intergovernmental grants.²⁷

Tables 3.1 and 3.2 show the results of different scenarios for homogeneous and heterogeneous communities. We can summarize the results as the following: when the local

²⁶ The other goals of local governments such as budget maximization (Niskanen, 1971) are beyond the scope of this chapter and are not considered.

²⁷ See appendix for a detailed illustration for each scenario for homogeneous and heterogeneous communities.

government uses only property taxes for public good provision, the results are efficient. Adding alternative revenue sources, such as local sales tax and intergovernmental grants, provides more options for homogeneous communities by adding more choices for residents with different preferences. Compared to homogeneous communities, heterogeneous communities oversupply public goods even when property taxes are the only revenue source. Since residents consider that their choices in housing consumption within a certain community do not influence their benefit of public goods (which is close to the reality), after adding other revenue sources for public good provision, it aggravates the oversupplies and enlarges the inefficiencies.

[Tables 3.1 and 3.2 about here]

3.4 Georgia Localities and Estimation Strategy

I use counties in the state of Georgia for empirical analyses. Some specific characteristics of Georgia localities enhance inter-county variation and thus the robustness of the empirical results. Georgia has 159 counties, each having its own *county* school district. Additionally, there are 20 public *city* school districts, so Georgia overall has 179 public school districts. Therefore, except the city school districts, the boundaries of counties and school districts overlap. This is helpful for the analyses since in this way we can control the effects of school districts within each county.

Georgia's 159 counties provide enough variation for a within-state analysis. For instance, as of 2011, the property taxes as ratios of total tax revenue range from less than 20% to higher than 80% (Figure 3.1), implying very different revenue structures in Georgia localities. The average ratios are 47% and 42% for urban and rural counties, respectively. For property reassessment, Georgia state government does not mandate a revaluation schedule (the limit is 3

years, but some counties make reassessments each year);²⁸ the interval between reassessments varies from county to county. As shown in the second panel of Figure 1, there is also significant variations for the per capita local infrastructure expenditure for both urban and rural counties. Figure 2 describes the time trends of per capita infrastructure expenditure and property tax revenue for Georgia average and Fulton County. Apparently, the two variables do not share the same time trend, and sometime, they even change in the opposite directions.

[Figures 3.1 and 3.2 about here]

Figure 3 illustrates a structure of analyses on local infrastructure. While most studies examine certain parts of the impacts, a full picture is very important and deserves attention. All the effects on each different perspective may be important in contributing to the full picture.²⁹

[Figure 3.3 about here]³⁰

3.4.1 The impacts of revenue structure on local infrastructure investment

Focusing on the within-state data, differ from most previous research that treats public capital stocks as exogenously determined (Haughwout, 2002), this chapter first analyzes the determining factors of local infrastructure investment, especially focusing on the effects of revenue structure (mainly property tax reliance) on local infrastructure investment. The estimation model is as follows:

$$\ln(infras_{jt}) = prop_{jt} + pratio_{jt} + A_{jt} + RV_{jt} + \beta_2 C_j * T_t + \beta X + \varepsilon_{jt}$$

²⁸ The Georgia counties annually review the values on the digest compared to sales data and if property values are determined to be either too low or too high then values are updated. Source: <https://etax.dor.ga.gov/ptd/adm/faq/real.aspx>

²⁹ In terms of revenue sources for local infrastructure investment, Georgia is different that besides property tax, there are other sources such as special local optional sales tax (SPLOST) and education local option sales tax (ELOST). I appreciate Dr. Lauth raising this important point.

³⁰ In Deno (1988), different types of public capital include (1) roads, highways and bridges (HWY), (2) sanitary and storm sewers and sewage disposal facilities (SEW), and (2)water supply and treatment facilities (WAT).

where $prop$ is per capita property tax revenue, $pratio_{jt}$ is the share of property tax revenue in total tax revenue, and A_{jt} is the share of intergovernmental grants (federal/state) in total local revenue, respectively. \mathbf{X} indicates a vector of control variables of county district characteristics. RV_{jt} is revenue volatility, a measurement to determine the extent of actual revenue differing from expected revenue, which was developed by White (1983) and further elaborated and used in several recent studies (Carroll, 2009; Carroll & Stater, 2009). The revenue growth trend is described as:

$$R_{it} = \exp(\alpha + \beta_1 t + \beta_2 i) \text{ or } \ln(R_{it}) = \alpha + \beta_1 t + \beta_2 i$$

where total general revenue R_{it} is modeled as a function of a time variable year t and $n-1$ dichotomous variables identifying each local government i . The absolute deviations of the residuals from this regression equation serve as a measurement of revenue volatility. Each absolute value of residuals represents the difference between the actual revenue for county i in year t and the predicted revenue based on the county's unique expected growth trend.

3.4.2 The effects of infrastructure stock on housing prices

The second step of our estimation is to investigate the impacts of local infrastructure stock on housing prices, across different types of infrastructure and across counties. Partly due to “data availability,” Deno (1988) divided public capital into three types. Our investigation analyzes four categories of local infrastructure separately: (1) highways and streets, (2) sheriff, police, and fire departments, (3) parks and recreation, and libraries, and (4) drainage, and garbage and trash disposal (landfill). At least two reasons justify the above division. First, based on the literature, public capital of these four categories may have different impacts across

localities that are in different stages of economic development. Second, residents in different income groups have different preferences for each category of the four types of public capital.

While in the first step I estimate the impact of revenue structure on local infrastructure *investment/expenditure*, in this step, accounting for the lumpy nature of capital investment, I am examining the effect of infrastructure *stock*. Without a direct measure of capital stock in Georgia counties, using the data of annual capital expenditure starting in 1985, I calculate the capita stock for each county year. Based on the model in Wang, Duncombe, and Yinger's (2011) chapter that built from the models of (Holtz-Eakin and Rosen (1989), 1993)), Balsdon, Brunner, and Rueben (2003), with spending data starting from 1985, the capita stock is described as $Flow_{jt} + \lambda \cdot Stock_{jt-1}$, where $Flow_{jt}$ is capital expenditure in the current year and $Stock_{jt-1}$ an estimate of the value of the capital stock in the previous year multiplied by a parameter λ (equal 1 as baseline). I calculate the capital stock as the depreciated infrastructure investment over the past 10 years.³¹ Similar to the depreciation rate (δ) calculated by the U.S. Bureau of Economic Analysis (BEA), a depreciation of 10 percent is used for capital stock in the fire department and a depreciation rate of 2 percent is used as the baseline for other capita stock.³² To examine the sensitivity of the model to values of parameters, I also allow values of depreciation rate δ ranging from 1 to 3 percent and values for λ ranging from 0.6 to 1.4.

In urban economics, the housing demand equation is described as $V = \frac{P(u,A)H(X)}{r}$, where u is commuting cost, A is neighborhood amenities, and X is housing characteristics. Goodman (1998) is the first to regress V based on this equation. The hedonic equation has now been

³¹ The calculation formula is $Stock_t = \sum_{i=t-10}^t I_i(1 - \delta)^i$, where I_i is the investment expenditure in year i , and δ is annual depreciation of the stock of public capital. As a robustness check, I also calculate the capital stock using 15 years of capital spending data.

³² Source: U.S. Bureau of Economic Analysis, "BEA Depreciation Estimates," <http://www.bea.gov/National/FA2004/Tablecandtext.pdf>

popularly used to examine the effects on housing prices. There are two levels of data here: parcel level and aggregated county level. To facilitate explanation, similar to Haughwout (2002), I use a two-stage method to estimate the impact of infrastructure stock on housing prices:

Stage 1:

$$\ln(HV_{ijt}) = \beta_1 HQ_{ijt} + \beta_2 (C_j * T_t) + \varepsilon_{ijt}$$

Stage 2:

$$\hat{\beta}_{2,jt} = \gamma_0 + \gamma_1 infras_{jt} + \beta X_{jt} + \mu_{jt}$$

where HV_{ijt} is house and/or land value for parcel i in county j and year t , and $infras_{jt}$ is per capita local infrastructure *stocks* of different types. C_j and T_t are vectors indicating county and time dummy variables respectively; their interaction allows estimation of county–year specific fixed effects in housing prices. HQ_{ijt} is a vector of housing/land characteristics with i as the housing subscript. X_{jt} is a vector of control variables of county characteristics. ε_{ijt} and μ_{jt} are residual terms. β_2 is a vector of coefficients for each county and year from the first stage, which captures the county specific factors influencing housing prices and is used as dependent variable in the second stage.

3.4.3 *The relationship between the two impacts*

How do the input (government revenue) and output (impacts on housing prices) factors influence the decisions of local infrastructure investment? After obtaining the results of the two impacts (government revenue on infrastructure expenditure and infrastructure stock on housing prices), I pair the impacts for both of different types of public capital and counties. By looking at whether local governments are investing more on local infrastructures which have larger impacts on local housing values, we may find out whether the decisions about local infrastructure

expenditure are “rational and forward-looking” (Holtz-Eakin & Rosen, 1989) and how they differ across localities.

If local governments spend more on the types of local infrastructure having greater impacts on local factor values, is it a coincidence or intentional behavior? For instance, preliminary results imply that urban counties are spending more of their own source revenue on basic services and rural counties are on highways and streets, of which comparing with other types of local infrastructures, each having a higher impact on housing prices in respective regions. Whether this is “forward-looking” behavior by local governments or a reflection of median preferences deserves more investigations.

3.5 Data

As described above, two levels of data were collected for this chapter – the aggregated county level and the parcel/household level. The data sources of county level variables are listed in Table 3.3. Our Georgia county data set covers all 159 counties for 27 years (1985-2011), which includes three full economic cycles (1985-1992, 1993-2001, and 2002-2011). Table 3.4 provides summary statistics of these variables.

[Tables 3.3 and 3.4 about here]

The parcel data in Georgia counties were collected by contacting the Tax Assessor’s Office and/or Tax Commissioner’s Office of each county in Georgia. Of the 159 counties, the parcel data for 46 counties have been collected, of which 30 are metropolitan counties (10 metro

and 20 urban) and the other 16 are non-urban (rural) counties.³³ Figure 3.4 lists the counties and years for the parcel data. For most collected counties, there are parcel data for 3 to 10 years. Specially, for counties with large population (over 100,000), of the 5 counties (Fulton, DeKalb, Gwinnett, Cobb, and Clayton) that make up the core of the Atlanta metropolitan area (first defined in 1950), all parcel data were collected. For the 25 counties with population more than 100 thousand in Georgia, 18 of them were collected.

[Figure 3.4 about here]

3.6 Results and Discussion

As described above, estimation is done for both metro (urban) and non-metro (rural) counties. In this section, I first investigate in detail the methodological issues encountered in the models and then present the results and discussion. For all regressions of each model specification, I conduct a Ramsey RESET tests to check the null hypothesis that the model has no omitted variables bias. The assumptions for Multiple Linear Regression (MLR) models (Wooldridge, 2012), including multicollinearity, zero conditional mean, and homoscedasticity, are also tested. The model specification test indicates that we have omitted variables, but the unobserved variables have a fixed value over time for each county. The Ramsey test cannot reject the null hypothesis after controlling for county fixed effects.

Because property tax revenues are determined each fiscal year by local budgetary requirements and other available revenue sources, local infrastructure expenditure and effective property tax rates are endogenous. To address this issue, Wong (1998) raised three instruments in

³³ The definition of metro/non-metro counties is based on the data from the 2010 Census Urban/Rural classification. I define counties with more than 40% urban population as urban counties. Source: <http://www.census.gov/geo/reference/ua/urban-rural-2010.html>.

the state of New York's context. In this chapter, based on the circumstances of Georgia, since each county has an option to maintain the state standard homestead exemption *or* increase it to a higher level and an option for the frequency of reassessment, I use homestead exemptions (or dummy indicating whether it is increased) and reassessment frequency as instruments for the effective property tax rates.³⁴ Necessary instrument tests are conducted and the results imply that both of them are good instruments. Therefore, two instrumental variables are used to estimate the relationship between property tax revenue and local infrastructure investment.³⁵

For the two-stage method estimating the impact of infrastructure on housing prices, the first stage regressions were estimated using ordinary linear squares (OLS); in the second stage, the residuals are heteroskedastic since the dependent variables $\hat{\beta}_{2,jt}$ are estimates that are correlated with the error terms. Also, because of the presence of lagged dependent variables, the regression has a serially correlated error term. To address the two problems, generalized least squares (GLS) is the best way being applied using the inverse of $\hat{\beta}_2$'s sampling variances as weights.

3.6.1 Property tax and local infrastructure

With regard to the relationship between property tax revenue and local infrastructure investment, Haughwout (1999) has found that in central cities, every extra dollar of property tax revenue will return to residents only about 60 cents in local public works investment. Our results on local government revenue and infrastructure are shown in Table 3.5. Following the categories

³⁴ There is not a state mandated revaluation schedule; the counties annually review the values on the digest compared to sales data and if property values are determined to be either too low or too high then values are updated. Source: <https://etax.dor.ga.gov/ptd/adm/faq/real.aspx>.

³⁵ Results of instrument tests are available upon request. In Wong (1998), deviations in the endogenous variable (from a city's own average) and variable identifying above-median values (grouping method) were also considered as instruments for effective property tax rates, these can also be tried in the context of this chapter. I will do this in future research as a robustness check.

created by Georgia DCA, I divide both rural and urban counties into groups based on population size: small, medium, and large. Consistent with Haughwout's findings, in medium and large urban counties, our results indicate that every extra dollar of property tax revenue increases local infrastructure expenditures by approximately 60 cents. However, for rural and small urban counties, an increase of one dollar of property tax burden can return to residents only around 40 cents in local infrastructure expenditure.

[Table 3.5 about here]

Switching the focus to different types of local infrastructures, I find that for both rural and urban counties, local governments use most property tax revenue to pay for police and fire services. For the property tax revenue used in local infrastructure, around 50 percent or more is used on/for this type, which belongs to the category of basic service for residents. For the other coefficients and significant levels of different types of local infrastructure, when spending their own source revenue from property tax, rural and large urban counties focus more on highways and streets, while medium size urban counties focus on parks and libraries. These results are consistent with conclusions in the literature that highway capital is more effective in declining regions (large urban counties) and the early stage (rural counties) of developing regions.

[Tables 3.6 and 3.7 about here]

Tables 3.6 and 3.7 provide a detailed illustration of the effects of different revenue sources on different types and categories of local infrastructure investment. As expected, while property tax revenue is mainly used for police and fire services, for both urban and rural counties, intergovernmental transfers from the state government play a very important role in

promoting investment in highways and streets. Property tax revenues are mostly used for current operations and the purchase of equipment, land, and structures; construction is often supported by state transfers. Federal transfers mostly go to infrastructure investment in highways in rural counties and parks and libraries in urban counties. The coefficients of the ratios of property taxes to total tax revenues are negative and consistently significant for most types and categories of local infrastructure. This corresponds well to the conclusion of the theoretical framework that in heterogeneous communities, other revenue sources besides property tax induce local governments to provide oversupplies of public goods since residents do not take into account the full cost of the public good provision.

3.6.2 Housing prices and infrastructure stock

Haughwout (2002) pointed out that the dominant methods of analyzing infrastructure productivity fail to control for part of the value of public capital reflected by regional factor prices. This issue is examined in this section. First, I estimate the effects of local infrastructure investment on housing values. As different types of local infrastructure are financed by different revenue sources, it is interesting to estimate the effects on housing prices (parcel values including both housing and land) from different types of local infrastructures.

[Table 3.8 about here]

Based on the results in Table 3.8, in metropolitan counties (urban areas), especially medium size urban areas, local infrastructure investment has the most significant effect on housing values. This conclusion can be explained by the fact that the medium-level urban areas are usually in the fast-developing stage in which the investment has a big spillover effect to

promote development in other fields, and finally, to increase housing values. Based on R-squared, without housing characteristics, the infrastructure investment can explain the biggest proportion of variation in housing prices in small metro counties. This is within the expectation, because in the first stage of development, the local infrastructure is often an indicator of the extension and depth of possible progress. In rural areas, on the other hand, the local infrastructure investment even has negative effects on housing values, implying that the expenditures on the local infrastructure in these areas might have forced out other more necessary public services.

[Table 3.9 about here]

To investigate the mechanism in more detail, as mentioned above, I divide the local infrastructure investment into four categories and examine their effects on housing prices including both housing and land values. For the elasticity of housing prices on total local infrastructure investment, the elasticity is much larger for land only than for parcels including both land and housing. The elasticity for land is 0.8, while the elasticity for parcels is only around 0.5. The results remind us of Peterson's (2009) argument that land values are highly sensitive to local infrastructure investment, and extend the argument that it mainly happens for rural parcels. I examine the elasticity for urban and rural parcels separately. For rural parcels, it is found that the effects of local infrastructure investment on parcel values are dominated by land (over housing) in rural counties with the elasticity of land value on infrastructure capital at 1.4, implying a "spillover" effect of local infrastructure making these regions more attractive to industrial investment. However, this impact on land values can often be effective in the long-run. In the short run, the effect on housing values in these regions is even negative, and the effect on

parcel values is not significant (maybe due to a temporary shortage of other necessary local services). For urban parcels, local infrastructure investment has positive effects on both housing and land.

In terms of different types of local infrastructure, the investment in basic services (police and fire) and development oriented infrastructures (highways and streets) plays an important role in increasing housing prices. The difference between urban and rural parcels is also obvious. For rural parcels, the effect of highways and streets is high (with elasticity at 1.2) and significant in promoting land values; on the other hand, for urban parcels, the basic services including parks and libraries are very important for increasing housing prices, and the impact of highways and streets lies more on housing units than on lands.

3.6.3 Forward looking vs. residential preferences

When considering the results from the above sections together, I find that for regions that the local infrastructure has larger effects on housing prices; they distribute more property tax revenue in infrastructure investment. Furthermore, they even “smartly” distribute more spending in those types of infrastructure which have larger elasticity on housing prices.

With the conclusion that local infrastructure investments in urban areas, especially in medium size urban areas, have a larger effect on housing values, the results from Table 3.9 further indicate that per capita property tax has the largest impact on local infrastructure investment. The connections between the local infrastructure and housing values and between property taxes and local infrastructure conform to each other’s direction. For instance, of medium size of urban areas in the fast developing stage, the local infrastructure is more effective in promoting regional development, and local governments are distributing a larger proportion of

property tax revenue to the local infrastructure instead of other services. They use around 0.65 on the local infrastructures for every dollar collected from property taxes. For rural areas and larger counties, on the other hand, the state transfer plays an important role in local infrastructure expenditure.

An interesting concern is that whether this is a “forward-looking” behavior by local governments or just a reflection of residential preferences. A possible explanation is that to make decisions about local infrastructure investment which require a large amount of money, urban areas with less tight budget constraints tend to feel free and autonomous to provide those necessary services for residents, while urban areas, more often than not, need intergovernmental grants to initiate the investment in a large project, with many of the grants designed as development oriented grants. This may explain why, in the infrastructure investment, urban regions spend more on basic services and rural regions more on highways and streets, both of which are most effective in increasing housing prices in respective contexts. This may also explain why in central cities the benefits of a growing public capital stock are likely enjoyed primarily by households (Haughwout, 2002). Based on the above results, if we make predictions and extend the results to rural areas, the benefits of the infrastructure investment, in the short run, are more likely to be enjoyed by producers and then spread to households after a period of time (in the long run). This is another interesting question deserving further investigation into the division of rural and urban regions.

3.7 Conclusion

While both local infrastructure and property taxation have been adequately examined by scholars, the connection between them is still not very clear. Different types of local

infrastructure are known to have different impacts on localities, and the impacts also differ with respect to different stages of development. These impacts are finally capitalized into housing prices including land and housing values. With the property tax as the main own-source revenue, do local governments *intentionally* distribute capital spending on different types of infrastructure according to their impacts on local factors based on local conditions and stages of the local economy? Applying both the aggregated county level data and parcel level household data in the state of Georgia, this chapter attempts to connect the two parts in local public finance.

Regression results indicate that for rural and small urban counties, an increase of one dollar in property tax revenue can only return to residents around 40 cents in local infrastructure expenditure; while in medium and large urban counties, it is 60 cents. Both the theoretical framework and empirical results also show that in heterogeneous communities, revenue sources other than property tax aggravate the public good provision including infrastructure.

Our results indicate that the impacts of local infrastructure on local factor prices are higher for urban parcels than for rural ones and that urban counties are consistently using a greater proportion of their property tax revenues in local infrastructure investment. This could be “forward-looking” behavior by local governments if they clearly know the relative impacts of local infrastructure and other public spending on housing prices. As found by (Holtz-Eakin and Rosen (1989)), however, capital spending behavior differs greatly between suburban and non-suburban communities and between small and large communities, and the rational and forward-looking behaviors also differ. After further investigation of the impacts of different types of infrastructure, I argue that these behaviors are probably induced by residents’ preferences for urban regions and by budget constraints facing rural regions.

With a much more detailed investigation of the impacts connecting the two parts in local government finance, I conclude that even local governments may not know exactly the impacts of capital spending and the several types of infrastructure on local development. The median preference reflected election system and budget constraints may finally help local governments work toward a rational and forward-looking way to distribute their expenditures to those areas where the impacts are the most efficient for local development.

Table 3.1: Results of different scenarios in *homogeneous* communities

Parameters		C	H	g	$\tau^*(\tau)$	$P(g, \tau^*, t)$
Funding source(s)						
Property tax		C_0	H_0	g_0	$\tau_0^* = \frac{c_3}{c_2}$	P_0
Property tax + local sales tax	Sales tax for operating cost	$C_1 < C_0$	$H_1 > H_0$	$g_1 = g_0$	$\tau_1^* = \tau_0^*$	$P_1 < P_0$
	Sales tax for public good	$C_1 < C_2 < C_0$	H_2	$g_2 \geq g_0$	$\tau_2^* < \tau_0^*$	$P_2 > P_1$
Property tax + IG grants		$C_3 > C_0$	$H_3 < H_0$	$g_3 > g_0$	$\tau_3^* > \tau_0^*$	$P_3 > P_0$
Property tax + sales tax + IG grants		$C_4 > C_2$	$H_4 > H_3$	$g_4 \geq g_3$	$\tau_4^* < \tau_3^*$	$P_4 > P_2$

Table 3.2: Results of different scenarios in *heterogeneous* communities

Parameters		C	H	g	$\tau^*(\tau)$	$P(g, \tau^*, t)$
Funding source(s)						
Property tax		$C_5 < C_0$	$H_5 < H_0$	$g_5 > g_0$	$\tau_5^* = \frac{c_3}{c_2 - c_3}$	$P_5 > P_0$
Property tax + local sales tax	Sales tax for operating cost	$C_6 < C_5$	$H_6 > H_5$	$g_6 = g_5$	$\tau_6^* = \tau_5^*$	$P_6 < P_5$
	Sales tax for public good	$C_7 = C_6$	H_7	$g_7 \geq g_5$	$\tau_7^* < \tau_5^*$	$P_7 > P_6$
Property tax + IG grants		$C_8 = C_5$	$H_8 < H_5$	$g_8 > g_5$	$\tau_8^* = \tau_5^*$	$P_8 > P_5$
Property tax + sales tax + IG grants		$C_9 = C_6$	$H_9 < H_8$	$g_9 > g_8$	$\tau_9^* = \tau_7^*$	$P_9 > P_8$

Table 3.3: Data sources of variables at the aggregated county level

Variables	Source(s)
property tax digest	Tax Digest Consolidated Summary (Georgia Department of Revenue)
per capita infrastructure expenditure	Report of Local Government Finances (Georgia Department of Community Affairs)
per capita property tax	
per capita IG transfer from state	
per capita IG transfer from federal	
property tax/total tax revenue	
IG transfers/total revenue	
Police & Fire	
Highway & Street	
Park & Library	
Drainage & Landfill	
population	U.S. Bureau of Economic Analysis (BEA)
Per capita personal income	U.S. Bureau of Economic Analysis (BEA)
employment rate	emp/pop (BEA)
CPI (consumer price index)	U.S. Bureau of Labor Statistics (BLS)
population density	pop/area (BEA & GeorgiaInfo), retrieved from http://georgiainfo.galileo.usg.edu/gacountiesbyarea.htm
government forms	County Form of Government Survey 2002 & 2007 (ICMA, International City/County Management Association); Association County Commissioners of Georgia (ACCG) Forms of Government 2010, retrieved from http://www.accg.org/library/Forms_of_Government_2010.pdf
political variables	cypress.com
parcel level data	Tax Assessor/Commissioner's Office of each county

Table 3.4: Descriptive statistics for county level variables

Variable	N	Mean	SD	Min	Max
<i>Rural</i>					
fips	2403	13176.01	97.82	13001	13319
year	2403	1998	7.79	1985	2011
per capita infrastructure expenditure	2370	180.16	97.49	0	1043.27
per capita property tax	2371	163.23	100.29	0.01	884.14
per capita local sales tax	2371	115.89	72.6	0	403.52
per capita IG transfer from state	2376	35.68	43.12	0	808.79
per capita IG transfer from federal	2375	7.71	29.49	-0.31	672.14
per pupil expenditure	1423	7358.13	1883.3	4074.2	17266.97
property tax/total tax revenue	2371	47.35	12.21	0	93.73
IG transfers/total revenue	2375	11.89	8.69	0	100
population from BEA	2403	18123.29	12792.29	1699	72881
per capita personal income (1,000)	2403	18.68	5.88	7.42	38.43
population density	2403	49.39	35.33	7.47	183.65
government form	2403	2.6	0.92	1	4
Police & Fire	2372	65.53	47.37	0	581.26
Highway & Street	2376	86.13	55.72	0	911.96
Park & Library	2373	16.55	19.25	0	197.42
Drainage & Landfill	2376	12.04	16.55	0	165.37
<i>Urban</i>					
fips	1890	13143.03	82.91	13007	13321
year	1890	1998	7.79	1985	2011
per capita infrastructure expenditure	1855	212.95	126.31	0	963.01
per capita property tax	1849	163.27	96.99	0.01	623.96
per capita local sales tax	1849	139.27	102.88	0	1101.01
per capita IG transfer from state	1856	27.01	28.42	-0.4	271.64
per capita IG transfer from federal	1856	7.96	17.98	0	314.81
per pupil expenditure	1120	6966.87	1639.24	3661.5	14515.07
property tax/total tax revenue	1849	42.57	13.68	0.02	98.71
IG transfers/total revenue	1855	9.24	6.61	0	64.6
population from BEA	1890	89187.56	147000	2266	950000
per capita personal income (1,000)	1890	22.01	8.32	7.55	61.96
population density	1890	283.73	435.05	5.38	2583.58
government form	1890	2.75	0.85	1	4
Police & Fire	1855	98.83	71.42	0	412.74
Highway & Street	1856	77.97	47.56	0	377.34
Park & Library	1855	27.06	33.11	0	487.59
Drainage & Landfill	1855	9.14	15.6	0	227.63

Table 3.5: The effect of property tax reliance on infrastructure investment

DV: per capita local infrastructure investment

Types	(1)	(2)	(3)	(4)	(5)
	Rural (small)	Rural (large)	Urban (small)	Urban (medium)	Urban (large)
Local infrastructure total	0.3955*** (0.1307)	0.3692** (0.1662)	0.3245** (0.1271)	0.6290*** (0.1495)	0.6637** (0.2428)
Police & Fire	0.2770** (0.1175)	0.1631* (0.0838)	0.2313*** (0.0712)	0.3859*** (0.0916)	0.2954** (0.1298)
Highway & Street	0.0996* (0.0528)	0.1389* (0.0732)	0.0581 (0.0513)	0.1183 (0.0705)	0.2315** (0.1109)
Park & Library	0.0320* (0.0177)	0.0813 (0.0711)	0.0390 (0.0356)	0.1212** (0.0502)	0.1239** (0.0488)
Drainage & Landfill	-0.0132 (0.0157)	-0.012 (0.0284)	-0.0051 (0.0209)	0.0035 (0.0345)	0.0128 (0.0146)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Standard errors in parentheses. County characteristics and unobserved fixed effects are controlled.

Table 3.6: The effect of property tax reliance on infrastructure investment (**rural & urban**)

DV: per capita local infrastructure investment in *different types*

	(1)		(2)		(3)		(4)	
	Police & Fire		Highway & Street		Park & Library		Drainage & Landfill	
	rural	urban	rural	urban	rural	urban	rural	urban
per capita property tax	0.2704** (0.1029)	0.2610*** (0.0561)	0.1186** (0.0465)	0.1150*** (0.0412)	0.0414** (0.0174)	0.0731*** (0.0236)	-0.0121 (0.0136)	0.0058 (0.0137)
per capita IG transfer (state)	0.0301 (0.0298)	0.1848** (0.0867)	0.5736** (0.2459)	0.3645*** (0.1178)	-0.0208 (0.0136)	0.1495** (0.0658)	-0.0093 (0.0165)	0.1058** (0.0436)
per capita IG transfer (federal)	0.0310 (0.0396)	0.2145 (0.1679)	0.1759* (0.1042)	0.0057 (0.0720)	-0.0118 (0.0122)	0.1862* (0.1056)	-0.0030 (0.0225)	-0.0277 (0.0390)
property tax/total tax revenue	-0.4944* (0.2693)	-0.7105*** (0.2028)	-0.5153*** (0.1869)	-0.7513*** (0.2025)	-0.2016** (0.0799)	-0.4104*** (0.1454)	-0.0251 (0.0598)	-0.0723 (0.0742)
IG transfers/total revenue	0.1467 (0.1705)	-0.6250* (0.3524)	-0.4910 (0.7068)	-0.1455 (0.4052)	0.1621** (0.0692)	-0.4344* (0.2394)	0.0683 (0.1029)	-0.1668 (0.1233)
population from BEA	-0.0010 (0.0009)	-0.0005*** (0.0002)	0.0002 (0.0016)	-0.0002 (0.0001)	0.0007 (0.0007)	-0.0001 (0.0002)	0.0004 (0.0010)	0.0001 (0.0000)
per capita personal income (in 1000 dollars)	2.2035** (0.9496)	2.8602*** (0.6508)	1.3055** (0.6065)	1.0605** (0.4209)	0.8072*** (0.2075)	0.5869** (0.2842)	0.4309** (0.2089)	-0.1129 (0.1109)
population density	0.7060* (0.4015)	0.2589*** (0.0695)	-0.0726 (0.5941)	0.1048* (0.0568)	0.1242 (0.2284)	0.0974 (0.0699)	-0.2687 (0.3031)	-0.0248* (0.0138)
Constant	-21.6569 (18.7607)	32.5132* (16.4936)	65.7195*** (15.5902)	13.9224 (18.1085)	-16.2006*** (5.3975)	-44.9590* (22.5463)	31.0989*** (6.0926)	23.4565*** (4.9504)
Observations	2367	1847	2370	1848	2368	1847	2370	1847
R^2	0.707	0.715	0.404	0.289	0.323	0.321	0.014	0.032

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Standard errors clustered by county in parentheses. Government form and county fixed effects are also controlled (not shown in this table).

Table 3.7: The effect of property tax reliance on infrastructure investmentDV: per capita local infrastructure investment in *different categories*

	(1)		(2)		(3)	
	Operation		Purchase		Construction	
	Rural	Urban	Rural	Urban	Rural	Urban
per capita property tax	0.3672*** (0.1078)	0.3394*** (0.0797)	0.0689*** (0.0148)	0.0416** (0.0170)	-0.0169 (0.0529)	0.0767 (0.0463)
per capita IG transfer from state	0.0543 (0.0844)	0.4139*** (0.1197)	-0.0019 (0.0215)	0.1168* (0.0611)	0.5214* (0.2960)	0.2724* (0.1386)
per capita IG transfer from federal	0.0318 (0.0737)	0.3369 (0.2260)	-0.0224 (0.0169)	0.0277 (0.0409)	0.1833 (0.1138)	0.0126 (0.0867)
property tax/total tax revenue	-0.8982*** (0.3006)	-0.8158*** (0.2404)	-0.3236*** (0.0752)	-0.1901** (0.0728)	-0.0167 (0.1961)	-0.9430*** (0.2239)
IG transfers/total revenue	0.5339 (0.3803)	-0.8885* (0.4692)	0.3253*** (0.1053)	-0.2463 (0.1824)	-0.9713 (0.8720)	-0.2287 (0.4761)
population from BEA	-0.0007 (0.0022)	-0.0007*** (0.0002)	-0.0001 (0.0005)	-0.0000 (0.0001)	0.0012 (0.0008)	-0.0001 (0.0003)
per capita personal income (in 1000 dollars)	4.1165*** (1.0187)	2.9302*** (0.9034)	0.4375* (0.2523)	0.0470 (0.1644)	0.1655 (0.5526)	1.3949*** (0.4587)
population density	0.2620 (0.7177)	0.3252*** (0.0703)	0.0570 (0.2126)	0.0322 (0.0304)	0.1720 (0.3102)	0.0783 (0.1299)
Constant	49.4262** (21.0086)	27.9032* (14.6759)	20.6962*** (6.6800)	-2.9042 (16.8676)	-11.2215 (12.9972)	-2.5837 (17.3895)
Observations	2369	1847	2368	1847	2367	1847
R^2	0.691	0.715	0.145	0.105	0.207	0.202

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Standard errors clustered by county in parentheses. Government form and county fixed effects are also controlled (not shown in this table).

Table 3.8: The effect of per capita local infrastructure investment on housing values (percentage)

	Rural		Metro					
			Small counties		Median		Large	
Infrastructure investment	0.0003*** (0.0001)	-0.0017*** (0.0001)	0.0019*** (0.0000)	0.0021*** (0.0000)	0.0020*** (0.0001)	0.0052*** (0.0001)	0.0035 (0.0032)	0.0029* (0.0016)
Housing Characteristics	No	Yes	No	Yes	No	Yes	No	Yes
Observations	184671	184671	401607	401607	402531	402531	578961	578961
R^2	0.12	0.638	0.286	0.506	0.098	0.69	0.085	0.779

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Standard errors clustered by county in parentheses.

Table 3.9: The elasticity of local factor prices on different types of infrastructure investment

Types	All		Urban		Rural	
	Parcel	Land	Parcel	Land	Parcel	Land
Local infrastructure total	0.4931*** (0.1220)	0.8005*** (0.2632)	0.9407*** (0.1352)	0.5663** (0.2363)	0.3304 (0.2104)	1.4219** (0.5783)
Police & Fire	0.2362*** (0.0888)	0.4905*** (0.1843)	0.6830*** (0.0904)	0.6464*** (0.1524)	0.0326 (0.1451)	0.8423** (0.3957)
Highway & Street	0.3044*** (0.1016)	0.6465*** (0.2101)	0.5063*** (0.1253)	0.2426 (0.1938)	0.3472** (0.1640)	1.2689*** (0.4516)
Park & Library	0.1407* (0.0750)	0.0784 (0.1588)	0.3450*** (0.0903)	0.1200 (0.1392)	(0.0595) (0.1091)	0.1655 (0.3082)
Drainage & Landfill	0.1379*** (0.0313)	0.0354 (0.0725)	0.0807* (0.0440)	-0.0750 (0.0633)	0.1358** (0.0525)	-0.2411 (0.1530)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Standard errors in parentheses. County characteristics and unobserved fixed effects are controlled.

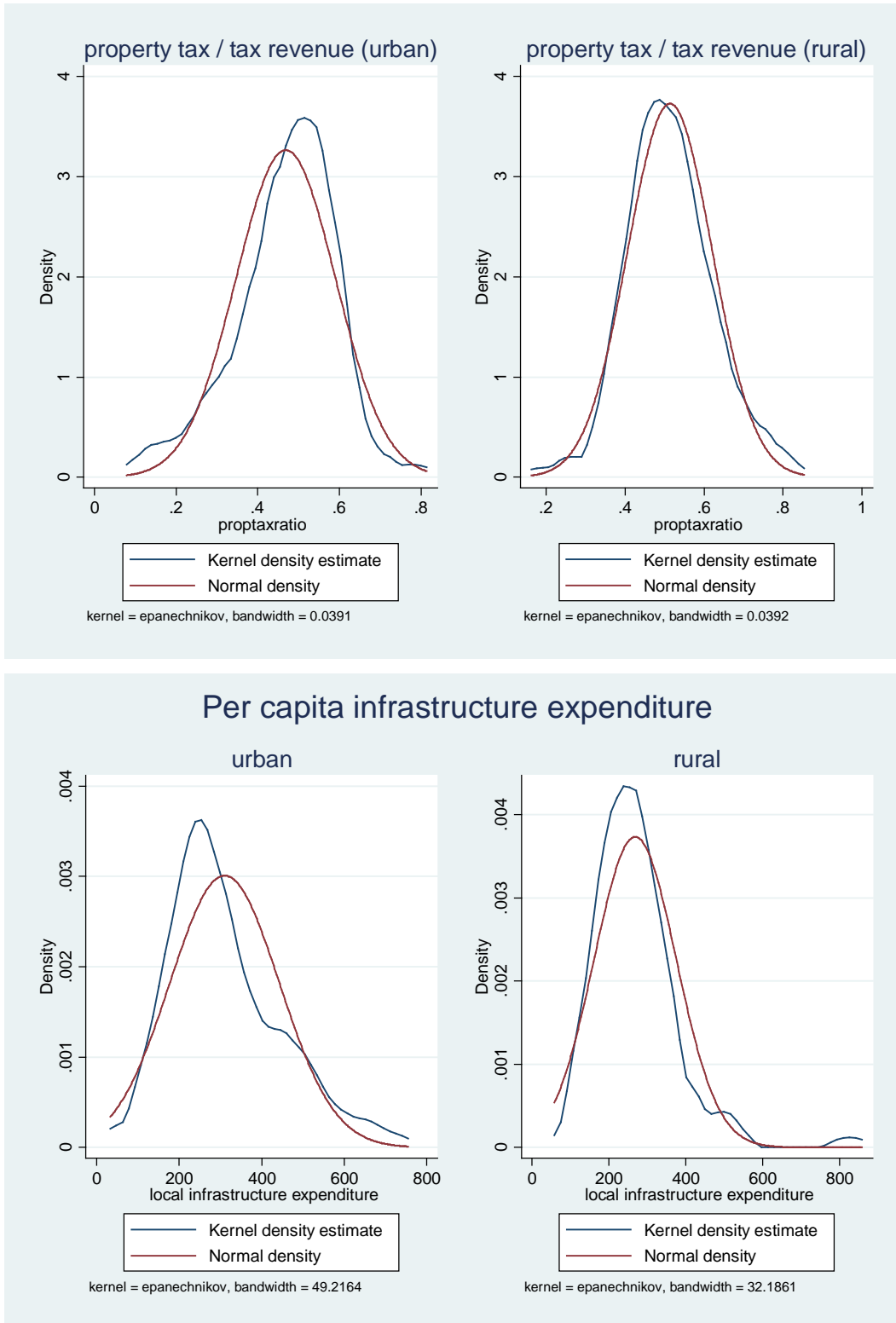


Figure 3.1: Distribution of property tax reliance and per capita infrastructure expenditure in Georgia counties as of 2011

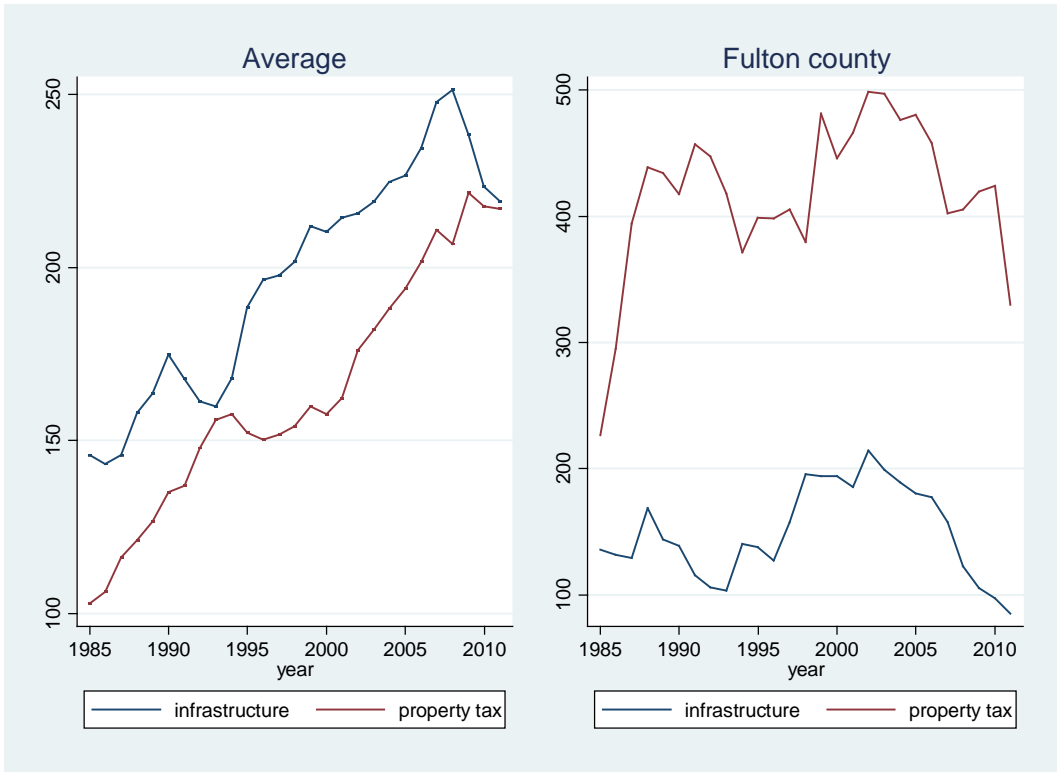


Figure 3.2: The time trends of per capita infrastructure expenditure and property tax revenue for Georgia average and Fulton County

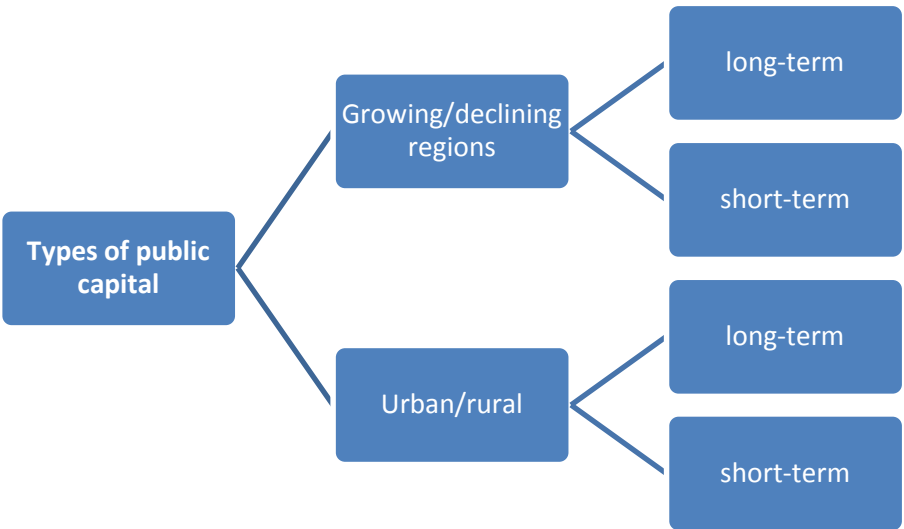


Figure 3.3: Structure of empirical analyses of the impacts of local infrastructure on regional development

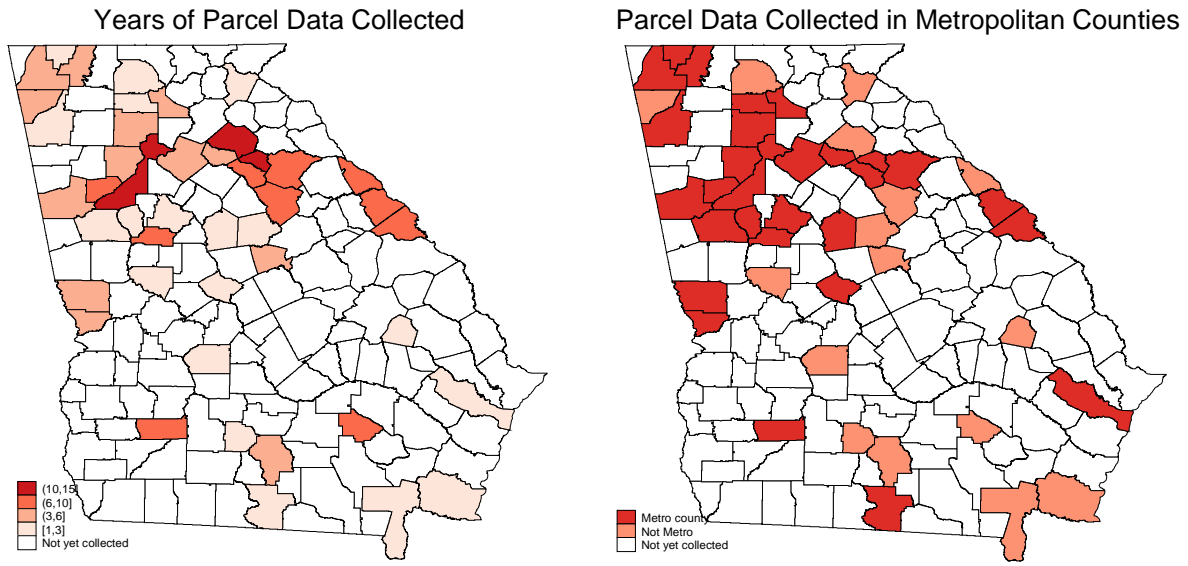


Figure 3.4: Parcel level data collected in Georgia counties

Appendixes

Appendix 1: A review of existing theories

The provision of public goods has been one of the dominant areas of study in public finance (Rubinfeld, 1987b). Based on Bewley (1981), local provision of goods and services is most likely to be efficient when the goods are private in nature. Public goods, however, possess the characteristics of nonexclusion and jointness of consumption, compared to private goods. Empirically, studies have assumed that personal assumption (g) of public goods and services is related to total provision (G) as follows (Blankart & Borck, 2005):

$$g = N^{-\alpha}G$$

where N is the number of people sharing the public good, and α is a congestion parameter; if $\alpha = 0$, the public good is a Samuelsonian pure public good (Paul A. Samuelson, 1954), and each individual consumes the entire amount provided; if $\alpha = 1$, as for private goods, each individual consumes the fraction of $1/N$ of the total amount of the public goods. This approach was used in two influential papers, one by Borchering and Deacon (1972) and the other by Bergstrom and Goodman (1973).³⁶ They both found that α is close to 1, implying quasi-private public goods.

While publicly provided goods have been found to be quasi-private by many studies, a consensus has yet to be reached (Blankart & Borck, 2005). Oates (1988) argued that larger towns incur higher expenditures, probably because they provide a greater variety of services rather than because these services are congested. The measurement of congestion should also account for the turnout, which rises with income and falls with population (Rainald Borck, 2002).

For individuals, Bergstrom and Goodman (1973) supposed that the unit cost of the private good is p , the unit cost of the public good is q , and the tax share of a consumer i is γ_i . The budget constraint is

$$C_i + \gamma_i q G \leq Y_i$$

i.e., $C_i + \gamma_i q N^\alpha g \leq Y_i$.

Thus, the price of public goods for consumer i is $\gamma_i q N^\alpha$. If we further suppose that there are constant price elasticity δ and income elasticity ϵ for the public good g , the demand function for g is of the form

$$c[\gamma_i q N^\alpha]^\delta Y_i^\epsilon.$$

The demand function of G is N^α times the demand function of g as

$$N^\alpha * c[\gamma_i q N^\alpha]^\delta Y_i^\epsilon = c q^\delta \gamma_i^\delta Y_i^\epsilon N^{\alpha(1+\delta)}.$$

Therefore, the coefficient of the total demand for public good G with respect to population N is $\alpha(1 + \delta)$.

For mixed communities, the Lindahl equilibrium of public goods provision is:

$$\frac{\alpha * P_{public}}{P_{else}} = MRS_1$$

$$\frac{(1 - \alpha) * P_{public}}{P_{else}} = MRS_2$$

The marginal rate of transformation thus is:

$$MRT = MRS_1 + MRS_2 = \frac{P_{public}}{P_{else}} = \frac{MC_{public}}{MC_{else}}$$

³⁶ Fernald (1999) employs a similar strategy.

The *bidding and sorting* model (Yinger, 1982, 2009; Chung, 2012) assumes that households care about the following consumptions: housing (H), other goods (C , a numeraire good with the price normalized to be equal to 1), and public services (S), which are represented by the utility function $U(H, C, S)$ (see Ross and Yinger (1999) for a comprehensive review). Households face a budget constraint:

$$Y = C + PH + \tau V = C + PH + \tau \frac{PH}{r} = C + PH(1 + \tau^*)$$

where C is private consumption of goods except housing (H) and P is the annual price of per unit of housing H . The property tax payment is τV , where τ is the effective tax rate, $V = PH/r$ is property value, r is the discount rate, and $\tau^* = \tau/r$.

Built on the above theories, our framework unfolds in both homogeneous and heterogeneous communities with three scenarios related to funding sources: (a) property tax as the only revenue source, (b) property tax + local sales tax, and (c) property tax + local sales tax + IG grants (in Appendix 2).

Appendix 2: Theoretical framework for both homogeneous and heterogeneous communities in different scenarios

1. Homogeneous communities

a. Property tax

Maximize: $U(C, H, g)$

Subject to: $C + PH(1 + \tau^*) = Y$, and $PH\tau^* = [C(N)/N]G = C(N)N^{\alpha-1}g$

Assuming P and τ^* are exogenous, thus residents search from different Homogeneous communities. Since $P(g, \tau^*) = \frac{C(N)G}{NH\tau^*} = \frac{C(N)gN^{\alpha-1}}{H\tau^*}$ and $g(P, \tau^*) = N^{-\alpha}G = PH\tau^*N^{1-\alpha}/C(N)$, solving the above functions gets the first-order conditions: PING IS THE BEST!

$$U_C = \lambda$$

$$U_H = \lambda P(1 + \tau^*)$$

$$U_g = \lambda H(1 + \tau^*) \cdot \frac{\partial P}{\partial g}$$

$$\frac{\partial P}{\partial \tau^*} H(1 + \tau^*) + PH = 0 \quad \Longrightarrow \quad \frac{\partial P}{\partial \tau^*} = -\frac{P}{1 + \tau^*}$$

To maximize the total utility, the ratio of marginal utilities on housing and public goods/services should equal the ratio of prices:³⁷

$$U_H/U_g = P(1 + \tau^*)/[C(N)N^{\alpha-1}]$$

In the case of the Cobb-Douglas utility function, $U(C, H, g) = c_1 \ln(C) + c_2 \ln(H) + c_3 \ln(g)$, thus $U_g = \frac{c_3}{g}$, and $U_H = \frac{c_2}{H} + \frac{c_3}{g} \cdot P\tau^*N^{1-\alpha}/C(N)$. Substituting U_g and U_H into the above equation and first-order conditions, we get

$$\tau^* = \frac{c_3}{c_2}$$

³⁷ Based on the characteristics of public goods, the unit price of g is calculated by $\frac{C(N)G}{[Ng]} = \frac{PH\tau^*}{g} = C(N)N^{\alpha-1}$.

$$\text{Since } \frac{U_H}{U_C} = \frac{\frac{c_2+c_3}{H+g} \cdot P\tau^* N^{1-\alpha} / C(N)}{\frac{c_1}{C}} = P(1 + \tau^*),$$

$$C = \frac{c_1}{c_1 + c_2 + c_3} Y$$

$$H = \frac{(c_2 + c_3)C}{c_1 P(1 + \tau^*)} = \frac{c_2 C}{c_1 P} = \frac{c_2 Y}{(c_1 + c_2 + c_3)P}$$

$$g = \frac{PH\tau^*}{C(N)N^{\alpha-1}} = \frac{c_3 C}{c_1 C(N)N^{\alpha-1}} = \frac{c_3 Y}{(c_1 + c_2 + c_3)C(N)N^{\alpha-1}}$$

Based on the above results, the intuitive conclusion is that in a homogeneous community, if all property tax revenue is used for public good provision, residents' choice of housing does not depend on the cost of public good provision ($C(N)$), tax burden (τ^*), or community population (N). Instead, it is related to the total income (Y), annual price of housing possession (P), and the relative preference for housing ($\frac{c_2}{c_1+c_2+c_3}$). The consumption of public goods (g) is then determined correspondingly. The formula for τ^* ($\tau^* = \frac{c_3}{c_2}$) implies that people will choose Homogeneous communities with the relative preference for public goods and housing ($\frac{c_3}{c_2}$) equaling the effective tax rate divided by the discount rate ($\tau^* = \frac{t}{r}$). The more congested the public good, the smaller the amount each resident can consume.

b. Property tax + local sales tax

Besides the property tax, the local sales tax is also an important alternative tax source. If we assume the local sales tax rate is t in a Homogeneous community:

Maximize: $U(C, H, g)$

Subject to: $C(1 + t) + PH(1 + \tau^*) = Y$, and

$$(1) PH\tau^* = [C(N)/N]G = C(N)N^{\alpha-1}g$$

$$(2) PH\tau^* + Ct = [C(N)/N]G = C(N)N^{\alpha-1}g$$

I assume two different conditions for local sales tax. The difference between conditions (1) and (2) is that the first condition does have a link between local sales tax and public good provision, while the second uses both the property tax and local sales tax for public good provision.

Scenario (1):

Assuming the decision making processes of t and τ are independent of each other, the first-order conditions are:

$$U_C = \lambda(1 + t)$$

$$U_H = \lambda P(1 + \tau^*)$$

$$U_g = \lambda H(1 + \tau^*) \cdot \frac{\partial P}{\partial g}$$

To maximize the total utility, the ratio of marginal utilities on housing and public goods/services is equal to the ratio of prices:

$$U_H/U_g = P(1 + \tau^*)/[C(N)N^{\alpha-1}]$$

Since $PH\tau^* = \left[\frac{C(N)}{N}\right]G = C(N)N^{\alpha-1}g$, assuming the Cobb-Douglas utility function, $U_g = \frac{c_3}{g}$ and $U_H = \frac{c_2}{H} + \frac{c_3}{g} \cdot P\tau^*N^{1-\alpha}/C(N)$. Substituting U_g and U_H into the above equation and first-order conditions, we get

$$\tau^* = \frac{c_3}{c_2}$$

$$\frac{U_H}{U_C} = \frac{\frac{c_2 + \frac{c_3}{g} \cdot P\tau^*N^{1-\alpha}/C(N)}{\frac{c_1}{C}}}{\frac{c_1}{C}} = \frac{P(1+\tau^*)}{1+t}, \text{ thus}$$

$$C = \frac{Y}{(c_1 + c_2 + c_3)(1+t)}$$

$$H = \frac{(c_2 + c_3)C(1+t)}{c_1P(1+\tau^*)} = \frac{c_2C(1+t)}{c_1P} = \frac{c_2Y}{(c_1 + c_2 + c_3)P}$$

$$g = \frac{PH\tau^*}{C(N)N^{\alpha-1}} = \frac{c_3C}{c_1C(N)N^{\alpha-1}} = \frac{c_3Y}{(c_1 + c_2 + c_3)C(N)N^{\alpha-1}}$$

Based on the above deductions, if local sales tax is not used to support public goods (but instead, for example, to provide administrative costs), the only difference in this scenario from the property tax as the only revenue source is that residents' consumption of private goods will decrease. Because of extra local sales tax, housing prices decrease, and thus, the consumption of housing will increase. The introduction of a local sales tax will not influence the public good provision in this scenario. Exactly the same relationship applies to the same scenario in heterogeneous communities (see the related analysis in the following).

Scenario (2):

In this scenario, the same condition, that the ratio of marginal utilities on housing and public goods/services is equal to the ratio of prices, applies:

$$U_H/U_g = P(1+\tau^*)/[C(N)N^{\alpha-1}]$$

Given $PH\tau^* + Ct = [C(N)/N]G = C(N)N^{\alpha-1}g$, assuming the Cobb-Douglas utility function, $U_C = \frac{c_1}{C} + \frac{c_3}{g} \cdot \frac{\partial g}{\partial C} = \frac{c_1}{C} + \frac{c_3}{g} \cdot \frac{t}{C(N)N^{\alpha-1}}$, and $U_H = \frac{c_2}{H} + \frac{c_3}{g} \cdot P\tau^*N^{1-\alpha}/C(N)$. Substituting U_g and U_H into the above equation and first-order conditions, we get

$$U_H/U_g = \frac{\frac{c_2}{H} + \frac{c_3}{g} \cdot P\tau^*N^{1-\alpha}/C(N)}{\frac{c_3}{g}} = P(1+\tau^*)/[C(N)N^{\alpha-1}]$$

Thus,

$$\tau^* = \frac{c_2PH\tau^* + c_2Ct}{c_3PH - c_2Ct} = \frac{c_3}{c_2} - \frac{Ct}{PH} < \frac{c_3}{c_2}$$

Substituting $PH = \frac{Y-C(1+t)}{1+\tau^*}$ into the above equation, we get

$$C = \frac{(c_3 - c_2\tau^*)Y}{c_3(1+t) + c_2(t + \tau^*)}$$

From the first-order condition

$$\frac{U_H}{U_C} = \frac{\frac{c_2}{H} + \frac{c_3}{g} \cdot P\tau^*N^{1-\alpha}/C(N)}{\frac{c_1}{C} + \frac{c_3}{g} \cdot \frac{t}{C(N)N^{\alpha-1}}} = \frac{P(1 + \tau^*)}{1 + t}$$

we can derive another expression of C based on the following equation:

$$\frac{(c_2 + c_3)CPH\tau^* + c_2C^2t}{(c_1 + c_3)CHt + c_1PH^2\tau^*} = \frac{P(1 + \tau^*)}{1 + t}$$

Therefore, we can expect that in this scenario, since the local government also uses sales tax revenue for public good provision, the consumption of private good C will be greater than that in scenario (1) ($C = \frac{c_1}{(c_1+c_2+c_3)(1+t)} Y$). The value of g depends on the relationship between t and τ^* . In most U.S. states, local sales tax has been at least partly used as a method to relieve the property tax burden. Therefore, local sales tax rates and effective property tax rates are often correlated rather than independent of each other. In this case, $t = t(\tau^*)$. If all the sales tax revenue is used to roll back the property tax (smaller τ^*), g will be the same as in Scenario (1). If at least part of the sales tax is used to add an extra expenditure for the public good provision, g will be larger. Because $U_H = \lambda P(1 + \tau^*)$, the amount of H depends on the dominant part of the changes ($\Delta\tau^*$ vs. ΔP) in τ^* and P (which increases due to a larger g and smaller τ^*).

c. Property tax + local sales tax + intergovernmental grants

For local governments, especially fiscally constrained municipalities, intergovernmental grants from higher levels of government are very important revenue sources for the provision of public goods and services. Denoting A as the total amount of aid to a local municipality, the municipal budget constraint is then

$$PH\tau^* + Ct + A/N = [C(N)/N]G = C(N)N^{\alpha-1}g$$

The first-order conditions are still as follows:

$$\begin{aligned} U_C &= \lambda(1 + t) \\ U_H &= \lambda P(1 + \tau^*) \\ U_g &= \lambda H(1 + \tau^*) \cdot \frac{\partial P}{\partial g} \end{aligned}$$

If we assume property tax and intergovernmental grants are the revenue sources of local governments (*property tax + intergovernmental grants*), the municipal budget constraint is then:

$$PH\tau^* + A/N = [C(N)/N]G = C(N)N^{\alpha-1}g$$

The first-order conditions are:

$$\begin{aligned} U_C &= \lambda \\ U_H &= \lambda P(1 + \tau^*) \\ U_g &= \lambda H(1 + \tau^*) \cdot \frac{\partial P}{\partial g} \end{aligned}$$

To maximize the total utility, the ratio of marginal utilities on housing and public goods/services is equal to the ratio of prices:

$$U_H/U_g = P(1 + \tau^*)/[PH\tau^*/g] = P(1 + \tau^*)/[C(N)N^{\alpha-1} - A/(Ng)]$$

Since $PH\tau^* + A/N = C(N)N^{\alpha-1}g$, assuming the Cobb-Douglas utility function, $U_g = \frac{c_3}{g}$ and $U_H = \frac{c_2}{H} + \frac{c_3}{g} \cdot P\tau^*N^{1-\alpha}/C(N)$. Substituting U_g and U_H into the above equation and first-order conditions, we get

$$U_H/U_g = \frac{c_2g}{c_3H} + \frac{P\tau^*}{(PH\tau^* + A/N)/g} = \frac{P(1 + \tau^*)}{PH\tau^*/g}$$

i.e.,

$$\frac{1}{\tau^*} + 1 - \frac{c_2}{c_3} = \frac{PH\tau^*}{PH\tau^* + \frac{A}{N}} < 1$$

$$\tau^* > \frac{c_3}{c_2}$$

If there are three revenue sources (property tax, local sales tax, and intergovernmental grants) for local governments, to maximize the total utility, the ratio of marginal utilities on housing and public goods/services is equal to the ratio of prices:

$$U_H/U_g = P(1 + \tau^*)/[(PH\tau^* + Ct)/g] = P(1 + \tau^*)/[C(N)N^{\alpha-1} - A/(Ng)]$$

Since $PH\tau^* + Ct + A/N = C(N)N^{\alpha-1}g$, assuming the Cobb-Douglas utility function, $U_g = \frac{c_3}{g}$ and $U_H = \frac{c_2}{H} + \frac{c_3}{g} \cdot P\tau^*N^{1-\alpha}/C(N)$. Substituting U_g and U_H into the above equation and first-order conditions, we get

$$U_H/U_g = \frac{c_2g}{c_3H} + \frac{P\tau^*}{(PH\tau^* + Ct + A/N)/g} = \frac{P(1 + \tau^*)}{(PH\tau^* + Ct)/g}$$

i.e.,

$$\frac{PH\tau^*}{PH\tau^* + Ct + A/N} = \frac{PH(1 + \tau^*)}{PH\tau^* + Ct} - \frac{c_2}{c_3} < \frac{1}{\tau^*} + 1 - \frac{c_2}{c_3}$$

We can conclude that τ^* is smaller than in the above situation when only property tax and intergovernmental grants belong to local revenue sources. However, whether τ^* is larger or smaller than $\frac{c_3}{c_2}$ is not determined. It depends on the effects of both local sales tax (will decrease τ^*) and intergovernmental grants (will increase τ^*).

The extra revenue source of intergovernmental grants will increase the public good provision (g) and, thus, decrease the marginal utility of public goods. To maximize the total utility, with no effects of intergovernmental grants on the price of private goods, the consumption of private goods (C) will also be larger than in the previous two scenarios. For the consumption of housing (H), there are two opposite effects: a decreased marginal utility and an increased price due to an increased τ^* . Given the constant income, the consumption of private good increases, and the consumption of housing decreases.

$$\frac{MU_C}{1 + t} = \frac{MU_H}{P(1 + \tau^*)} = \frac{MU_g}{(PH\tau^* + Ct)/g}$$

2. Heterogeneous communities

For heterogeneous communities, residents maximize their personal utility and governments maximize the total utility.

In the above analysis, residents are searching from different Homogeneous communities. Thus, different P s and H s imply different communities and have direct impacts on the level of public good provision. In heterogeneous communities, however, residents can choose different H s within communities. Thus, in this scenario, we can assume that the choice of H_i and C_i for any particular resident will not change the level of public good provision.

a. Property tax

For each resident i (demand),

Maximize: $U(C_i, H_i, g)$

Subject to: $C_i + PH_i(1 + \tau^*) = Y_i$

For local government budget constraint (supply),

Maximize: $\sum_i^N U(C_i, H_i, g)$,

Subject to: $\sum_i^N PH_i\tau^* = C(N)G = C(N)N^\alpha g$

Since $PH_i\tau^* + \sum_{j \neq i}^N PH_j\tau^* = C(N)N^\alpha g$, $P = \frac{1}{H_i\tau^*} [C(N)N^\alpha g - \sum_{j \neq i}^N PH_j\tau^*]$. The first-order conditions of general equilibrium for residents are:

$$U_{C_i} = \lambda$$

$$U_{H_i} = \lambda P(1 + \tau^*)$$

$$U_g = \lambda H(1 + \tau^*) \cdot \frac{\partial P}{\partial g}$$

Since the choice of H for any particular household will not change the level of public good provision, the price of public goods for each household is different from that in a Homogeneous community. In this circumstance, a household enjoys the same level of public goods as others, but only the household's own share of property tax payment will count toward the unit price of the public good g :

$$P_g = C(N)N^\alpha \cdot \frac{H_i}{\sum_i^N H_i}$$

To make the ratio of marginal utilities on housing and public goods/services equal to the ratio of prices:

$$U_{H_i}/U_g = P(1 + \tau^*)/[C(N)N^\alpha \cdot \frac{H_i}{\sum_i^N H_i}]$$

If we assume the Cobb-Douglas utility function $c_1 \ln(C_i) + c_2 \ln(H_i) + c_3 \ln(g)$, then $U_g = \frac{c_3}{g}$ and $U_{H_i} = \frac{c_2}{H_i} + \frac{c_3}{g} \cdot P\tau^*/[C(N)N^\alpha]$. Substituting U_g and U_{H_i} into the above equation and the first-order conditions, we get

$$\frac{c_2 g}{c_3 H_i} + \frac{g}{\sum_i^N H_i} = \frac{P(1 + \tau^*)g}{P\tau^* H_i}$$

i.e.,

$$H_i = \left(\frac{1}{\tau^*} + 1 - \frac{c_2}{c_3} \right) \sum_i^N H_i$$

If we assume there are many residents such that the choice of H_i for any particular resident will not change the level of public good provision, i.e., $\frac{H_i}{\sum_i^N H_i} \rightarrow 0$, $g'(H_i) = 0$ and

$$U_{H_i} = \frac{c_2}{H_i}, \text{ then } U_{H_i}/U_g = \frac{c_2 g}{c_3 H_i} = \frac{P(1+\tau^*)}{PH_i \tau^*/g}, \text{ i.e.,}$$

$$\tau^* = \frac{c_3}{c_2 - c_3}.$$

From the first-order condition

$$\frac{U_{H_i}}{U_{c_i}} = \frac{\frac{c_2}{H_i}}{\frac{c_1}{c_i}} = P(1 + \tau^*),$$

we further get

$$C_i = \frac{c_1}{c_1 + c_2} Y_i$$

$$H_i = \frac{c_2 C_i}{c_1 P(1 + \tau^*)} = \frac{(c_2 - c_3) C_i}{c_1 P} = \frac{(c_2 - c_3) Y_i}{(c_1 + c_2) P}$$

$$g = \frac{\sum_i^N PH_i \tau^*}{C(N) N^\alpha} = \frac{c_3 \sum_i^N Y_i}{(c_1 + c_2) C(N) N^\alpha}$$

For comparison purposes, I copy the results of Homogeneous communities as follows:

$$\tau^* = \frac{c_3}{c_2}$$

$$C = \frac{c_1}{c_1 + c_2 + c_3} Y$$

$$H = \frac{(c_2 + c_3) C}{c_1 P(1 + \tau^*)} = \frac{c_2 C}{c_1 P} = \frac{c_2 Y}{(c_1 + c_2 + c_3) P}$$

$$g = \frac{PH \tau^*}{C(N) N^{\alpha-1}} = \frac{c_3 C}{c_1 C(N) N^{\alpha-1}} = \frac{c_3 Y}{(c_1 + c_2 + c_3) C(N) N^{\alpha-1}}$$

Based on the above equations, in heterogeneous communities, the effective tax rate is higher than that in a homogeneous community. The consumptions of private consumption and housing are smaller. Because the choice of H_i for any particular resident will not change the level of the public good provision, households tend to decrease the private consumption and housing size to live in a better community. If the level of public good provision in homogeneous communities is efficient, we can conclude that there is an oversupply of public good because of heterogeneity. This gap can be explained by the share of households with higher preference for public goods compared to others at their income level. Also, because of their higher preference, they can bear a higher effective tax rate. Compared to the optimal levels, this inefficiency causes the distortion of less consumption of private goods and housing.

b. Property tax + local sales tax

For heterogeneous communities, after adding local sales tax as another alternative revenue source of local governments, similar to the analysis for Homogeneous communities, if

local sales tax is not used to support public goods, the only difference in this scenario from the property tax as the only revenue source (Scenario *a*) is that residents will decrease the consumption of private goods (C_i) and increase the consumption of housing H_i (due to the decreased housing price P). The results are as follows.

$$C_i = \frac{c_1}{(c_1 + c_2)(1 + t)} Y_i$$

$$H_i = \frac{c_2 C_i (1 + t)}{c_1 P (1 + \tau^*)} = \frac{(c_2 - c_3) C_i}{c_1 P} = \frac{(c_2 - c_3) Y_i}{(c_1 + c_2) P}$$

$$g = \frac{\sum_i^N P H_i \tau^*}{C(N) N^\alpha} = \frac{c_3 \sum_i^N Y_i}{(c_1 + c_2) C(N) N^\alpha}$$

On the other hand, if the local sales tax is also used for public good provision, the situation will be rather different from that for Homogeneous communities, though the first-order conditions are still the same.

$$U_{C_i} = \lambda(1 + t)$$

$$U_{H_i} = \lambda P(1 + \tau^*)$$

$$U_g = \lambda H(1 + \tau^*) \cdot \frac{\partial P}{\partial g}$$

For each resident i (demand),

Maximize: $U(C_i, H_i, g)$

Subject to: $C_i(1 + t) + P H_i(1 + \tau^*) = Y_i$

For local government's budget constraint (supply),

$$\sum_i^N (P H_i \tau^* + C_i t) = C(N) G = C(N) N^\alpha g$$

The unit price of the public good g is

$$P_g = \frac{P H_i \tau^* + C_i t}{g} = C(N) N^\alpha \cdot \frac{P H_i \tau^* + C_i t}{\sum_i^N (P H_i \tau^* + C_i t)}$$

If we assume the Cobb-Douglas utility function $c_1 \ln(C_i) + c_2 \ln(H_i) + c_3 \ln(g)$, then $U_g = \frac{c_3}{g}$ and $U_{H_i} = \frac{c_2}{H_i} + \frac{c_3}{g} \cdot P \tau^* / [C(N) N^\alpha]$. Substituting U_g and U_{H_i} into the above equation and the first-order conditions, we get

$$\frac{c_2 g}{c_3 H_i} + \frac{P \tau^*}{[C(N) N^\alpha]} = \frac{P(1 + \tau^*) g}{P H_i \tau^* + C_i t}$$

i.e.,

$$\frac{c_2}{c_3} + \frac{P H_i \tau^*}{\sum_i^N (P H_i \tau^* + C_i t)} = \frac{P H_i (1 + \tau^*)}{P H_i \tau^* + C_i t}$$

As assumed above, there are many residents such that the choice of H_i and C_i for any particular resident will not change the level of public good provision, i.e., $\frac{P H_i \tau^* + C_i t}{\sum_i^N (P H_i \tau^* + C_i t)} \rightarrow 0$, thus,

$$\tau^* = \frac{c_3}{c_2 - c_3} - \frac{c_2 C_i t}{P H_i (c_2 - c_3)} < \frac{c_3}{c_2 - c_3}$$

From the first-order condition

$$\frac{U_{H_i}}{U_{C_i}} = \frac{\frac{c_2}{H_i}}{\frac{c_1}{C_i}} = \frac{P(1+\tau^*)}{1+t},$$

we further get

$$\begin{aligned} C_i &= \frac{c_1}{(c_1 + c_2)(1+t)} Y_i \\ H_i &= \frac{c_2 C_i (1+t)}{c_1 P (1+\tau^*)} = \frac{(c_2 - c_3) C_i}{c_1 P} = \frac{(c_2 - c_3) Y_i}{(c_1 + c_2) P} \\ g &= \frac{\sum_i^N (P H_i \tau^* + C_i t)}{C(N) N^\alpha} = \frac{c_3 \sum_i^N Y_i}{(c_1 + c_2) C(N) N^\alpha} + \frac{c_1 \sum_i^N Y_i}{(c_1 + c_2)(1+t) C(N) N^\alpha} \end{aligned}$$

When only property tax as the revenue source,

$$\frac{MU_C}{1} = \frac{MU_H}{P(1+\tau^*)} = \frac{MU_g}{P H_i \tau^* / g},$$

Now it is:

$$\frac{MU_C}{1+t} = \frac{MU_H}{P(1+\tau^*)} = \frac{MU_g}{(P H_i \tau^* + C_i t) / g},$$

and τ^* is smaller. Because the levels of consumption in private good or housing by households in heterogeneous communities will not affect the level of public good provision, households will not increase their private consumption compared to the scenario in which local sales tax is not used for a public good provision ($C_i = \frac{c_1}{(c_1+c_2)(1+t)} Y_i$). The change of g and H_i are the same as in Homogeneous communities. The value of g depends on the relationship between t and τ^* . The amount of H depends on the dominant part of changes ($\Delta\tau^*$ vs. ΔP) in τ^* and P (which increases due to a larger g and a smaller τ^*). The final results should depend on the extent of the capitalization of taxes and public services. From the marginal utility perspective, with the increased level of public goods, if g and H increases, the consumption of private good may also increase to match the decreased marginal utilities.

c. *Property tax + local sales tax + intergovernmental grants*

For heterogeneous communities, when local governments have property tax, local sales tax, and intergovernmental grants as revenue sources to provide public goods, the budget constraint is:

$$\sum_i^N P H_i \tau^* + \sum_i^N C_i t + A = C(N) G$$

Similarly, if we first consider that property tax and intergovernmental grants are the revenue sources of local governments (*property tax + intergovernmental grants*), the municipal budget constraint is then:

$$\sum_i^N P H_i \tau^* + A = C(N) G = C(N) N^\alpha g$$

The first-order conditions are:

$$U_C = \lambda$$

$$U_H = \lambda P (1 + \tau^*)$$

$$U_g = \lambda H (1 + \tau^*) \cdot \frac{\partial P}{\partial g}$$

To maximize the total utility, the ratio of marginal utilities on housing and public goods/services is equal to the ratio of prices:

$$U_H/U_g = P(1 + \tau^*)/[PH_i\tau^*/g] = P(1 + \tau^*)/[PH_i\tau^* \frac{C(N)N^{\alpha-1}}{\sum_i^N PH_i\tau^* + A}]$$

Since $\sum_i^N PH_i\tau^* + A = C(N)N^\alpha g$, assuming the Cobb-Douglas utility function, $U_g = \frac{c_3}{g}$ and $U_{H_i} = \frac{c_2}{H_i} + \frac{c_3}{g} \cdot P\tau^* N^{1-\alpha}/C(N)$. Substituting U_g and U_{H_i} into the above equation and first-order conditions, we get

$$U_{H_i}/U_g = \frac{c_2 g}{c_3 H_i} + \frac{P\tau^*}{(\sum_i^N PH_i\tau^* + A)/g} = \frac{P(1 + \tau^*)}{PH_i\tau^*/g}$$

i.e.,

$$\frac{1}{\tau^*} + 1 - \frac{c_2}{c_3} = \frac{PH\tau^*}{\sum_i^N PH_i\tau^* + A}$$

The case is the same as above, when there are many residents such that the choice of H_i and C_i for any particular resident will not change the level of public good provision, i.e., $\frac{PH\tau^*}{\sum_i^N PH_i\tau^* + A} \rightarrow 0$, thus,

$$\tau^* = \frac{c_3}{c_2 - c_3}$$

From the first-order condition

$$\frac{U_{H_i}}{U_{C_i}} = \frac{\frac{c_2}{H_i}}{\frac{c_1}{C_i}} = P(1 + \tau^*),$$

we further get

$$C_i = \frac{c_1}{c_1 + c_2} Y_i$$

$$H_i = \frac{c_2 C_i}{c_1 P(1 + \tau^*)} = \frac{(c_2 - c_3) C_i}{c_1 P} = \frac{(c_2 - c_3) Y_i}{(c_1 + c_2) P}$$

$$g = \frac{\sum_i^N PH_i\tau^* + A}{C(N)N^\alpha} = \frac{c_3 \sum_i^N Y_i}{(c_1 + c_2) C(N)N^\alpha} + \frac{A}{C(N)N^\alpha}$$

The results are very similar as in the scenario that only property taxes are a revenue source. However, since there is a larger amount of public good provision (g) with the same τ^* in this scenario, P should be larger. Thus, H_i is smaller than in Scenario *a* of heterogeneous communities, while C_i is the same.

When there are three revenue sources (property tax, local sales tax, and intergovernmental grants) for local governments, to maximize the total utility, the ratio of marginal utilities on housing and public goods/services is equal to the ratio of prices:

$$U_{H_i}/U_g = P(1 + \tau^*)/[(PH_i\tau^* + C_i t)/g] = P(1 + \tau^*)/[\frac{(PH_i\tau^* + C_i t)C(N)N^{\alpha-1}}{\sum_i^N (PH_i\tau^* + C_i t) + A}]$$

Since $\sum_i^N PH_i\tau^* + \sum_i^N C_i t + A = C(N)N^\alpha g$, assuming the Cobb-Douglas utility function, $U_g = \frac{c_3}{g}$ and $U_{H_i} = \frac{c_2}{H_i} + \frac{c_3}{g} \cdot P\tau^* N^{-\alpha}/C(N)$. Substituting U_g and U_H into the above equation and first-order conditions, we get

$$U_H/U_g = \frac{c_2 g}{c_3 H} + \frac{P\tau^*}{(\sum_i^N (PH_i\tau^* + C_i t) + A)/g} = \frac{P(1 + \tau^*)}{(PH_i\tau^* + C_i t)/g}$$

i.e.,

$$\frac{PH_i\tau^*}{\sum_i^N(PH_i\tau^* + C_it) + A} = \frac{PH_i(1 + \tau^*)}{PH_i\tau^* + C_it} - \frac{c_2}{c_3}$$

When there are many residents such that the choice of H_i and C_i for any particular resident will not change the level of public good provision, i.e., $\frac{PH\tau^*}{\sum_i^N PH_i\tau^* + A} \rightarrow 0$, then,

$$\frac{PH_i(1 + \tau^*)}{PH_i\tau^* + C_it} - \frac{c_2}{c_3} = 0$$

Thus,

$$\tau^* = \frac{c_3}{c_2 - c_3} - \frac{c_2 C_i t}{PH_i(c_2 - c_3)} < \frac{c_3}{c_2 - c_3}$$

From the first-order condition

$$\frac{U_{H_i}}{U_{C_i}} = \frac{\frac{c_2}{H_i}}{\frac{c_1}{C_i}} = \frac{P(1+\tau^*)}{1+t},$$

we further get

$$C_i = \frac{c_1}{(c_1 + c_2)(1 + t)} Y_i$$

$$H_i = \frac{c_2 C_i (1 + t)}{c_1 P (1 + \tau^*)} = \frac{(c_2 - c_3) C_i}{c_1 P} = \frac{(c_2 - c_3) Y_i}{(c_1 + c_2) P}$$

$$g = \frac{\sum_i^N (PH_i\tau^* + C_it) + A}{C(N)N^\alpha} = \frac{(c_2 - c_3)\tau^* \sum_i^N Y_i}{(c_1 + c_2)C(N)N^\alpha} + \frac{c_1 \sum_i^N Y_i}{(c_1 + c_2)(1 + t)C(N)N^\alpha} + \frac{A}{C(N)N^\alpha}$$

Compared to Scenario *b* of heterogeneous communities, the introduction of intergovernmental grants will directly increase the level of public good provision. If we remember that the oversupply of public goods in Scenario *a* caused the distortion (inefficiency) of the less optimal consumption of private goods and housing, the extra intergovernmental grants for public good provision will further enlarge the oversupply and correspondingly increase (capitalization) the housing prices (P). Therefore, for average communities (compared to a too poor public good provision due to fiscal constraints), this extra public good provision aggravates the distortion (inefficiency) of housing consumption, while it does not influence the consumption of private goods.

CHAPTER IV

4. OPTIMAL DEBT USE WITH VOLATILE REVENUES AND STABLE INFRASTRUCTURE NEEDS

4.1 Introduction

Debt plays an important role in local public finance, especially in capital investment. Different from the federal government, state constitutions often prohibit state and local governments from borrowing for operating budgets. Thus, there are three primary purposes of borrowing for state and local governments (Fisher, 2007, p. 231): (1) to finance public capital projects; (2) to support and subsidize economic development; and (3) to provide cash flow for short-term spending. Among the three, spending for capital projects is the major reason for debt financing in state and local governments. Regarding the second purpose for debt financing, local governments often borrow money with a relatively low interest rate and, then, reloan the money to authorities or local economic development corporations. State and local governments borrow money by selling bonds, and there are usually tax exemptions for bond interest as purchasing incentives to investors.

Capital projects to promote local infrastructures are a significant part of public services that include roads/streets, parks, libraries, and so on. The long-term needs for these facilities trend up with population growth, urbanization, and suburbanization but remain relatively stable across booms and busts of the economic cycle. Therefore, debt in tandem with pay-go has long been a regular and equitable means of financing the construction of such facilities as capital

projects. To better handle the cyclical fluctuations of recurring tax revenues, scholars have suggested an optimal path (model) of debt use (Barro, 1979; Hou, 2013) in financing infrastructures as a countercyclical fiscal tool (i.e., more debt issuance during bust years and more debt retirement during boom years). Past research has examined and provided empirical evidence on the countercyclical use of debt at the national (Barro, 1979) and subnational (Hou, 2013) levels; however, the local level has not been studied. This chapter fills a niche and is among the first to thoroughly test the countercyclical model of debt use by local governments. In most of existing studies, the term of “countercyclical” often implicates the effect of economic stimulus; however, in this essay, this term refers more to compensating the revenue loss, although sometimes this compensation has some effect of promoting economic development.

Built upon and extending Hou’s (2013) framework, this chapter asks the following questions: Connecting with local infrastructure investment, do local governments use debt counter-cyclically? If some local governments use countercyclical debt, how much can it help in fighting a recession, and what is the difference between the localities that use debt as a countercyclical tool and those that do not? Eventually, an optimal pattern of debt use will be calculated based on empirical results. This chapter uses an aggregated U.S. local data set from 1960 to 2008 and a balanced panel data set that includes all counties and municipalities in the state of Georgia from 1985 to 2011 to examine the operational mechanisms of debt issuance over the booms and busts of three full economic cycles in our sample period. I examine all the localities in one state (Georgia), thus subject to the same laws and rules regulating debt use, which is different from across-state studies containing social-economic and statutory variations. It is interesting that within one state, there are large variations in the share of debt in local expenditures and debt burdens measured as total debt outstanding at the end of the fiscal year as

a percentage of personal income or total local revenue. When encountering a recession, how do the localities respond, and how do local fiscal policies, especially debt issuance, vary with their revenue portfolio and political structure in a period of revenue shortfall? This study will contribute to the literature by moving toward a thorough understanding of whether or not and how local governments can use debt optimally to mitigate revenue fluctuations in financing local infrastructure needs.

The rest of this chapter is organized as follows. The following second section reviews the literature on debt financing and pay-go, rationales and determinants of debt financing, and countercyclical use of debt. The third section provides a theoretical framework illustrating how debt financing on local infrastructure investment can work practically and efficiently as a countercyclical tool to help stabilize expenditure fluctuations over the economic cycles. The fourth section introduces the data sets and methodologies used in the chapter. The fifth section provides the empirical results, and the sixth and final section concludes this chapter.

4.2 Literature Review

The Ricardian Equivalence Theorem (Barro, 1974, 1976; Buchanan, 1967, 1976; Feldstein, 1976) suggests that outcomes are independent of whether a public program is financed by current taxes or debt issuance. Since the very early history of the United States, there have been many fluctuations in the dominance between pay-go and debt financing during different periods (Wang & Hou, 2009).³⁸ A great deal of literature exists outlining several perspectives of debt financing. In this section, I review studies on the brief history of debt financing versus taxes,

³⁸ Wang and Hou (2009), p. 93, “Founding of the American Republic saw an open debate, between Alexander Hamilton and Thomas Jefferson, concerning the consolidation of federal and state debts incurred during the Revolutionary War.”

the rationales and determinants, and the use of debt as a countercyclical tool at the national and subnational levels.

4.2.1 *Debt financing and pay-go*

Contrary to debt financing (pay-use), pay-go³⁹ was designed to help control debt increases and reduce excessive deficits, with the purpose of prioritizing expenses and exercising fiscal restraint (control revenue deductions and spending increases). After the government realized that cash transactions were too restrictive and inadequate for capital investment, state and local governments borrowed heavily in the early 19th century in the absence of regulation; however, defaults occurred in several states and cities. The purpose of pay-go at that time was to avoid debt by not spending until they had money in hand (New York Comptroller, 1843).

Balanced budget requirements (BBRs) and debt limitations were also subsequently added in reaction to these defaults (Hou & Smith, 2006; Kiewiet & Szakaly, 1996).

After the Civil War, a new round of borrowing started to support the reconstruction and large-scale internal improvements, until the Progressive Movement reinstated the balanced budget norm (Wang & Hou, 2009). Based on time-series data, Barro (1979) finds positive effects of the temporary increases in government spending on the federal debt issue, especially during war and postwar periods. Recently, pay-go financing has been considered a necessary supplement to debt financing and has been taken for granted “as the flip side of long-term debt financing” (Wang, Hou, & Duncome, 2007). For a countercyclical fiscal policy, Alvin Hansen was recognized as the first to propose the complementary use of pay-go and debt financing in the 1940s (Hou, 2004). Basically, debt financing increases during periods of necessity or emergent funding requirements, such as large capital projects and wars, while pay-go appears more often

³⁹ Pay-go, an abbreviation of “pay as you go,” is a budgeting rule and public finance practice of funding expenditure with available funds rather than borrowing. Source: Tax Policy Center. <http://www.taxpolicycenter.org/briefing-book/background/budget-process/paygo.cfm>

in boom years, in realizing the possible threat of excessive deficits and in the return of conservative fiscal policy.

4.2.2 Rationales and determinants of debt financing

Wang and Hou (2009) point out several rationales for debt financing. One of these arguments claims that the borrowed money will benefit future taxpayers if they are invested in human resources through funding education, job retraining, and health programs. Their income will benefit more substantially from these investments, and thus, the debt can be easily paid by them.⁴⁰ Another rationale for pay-use financing is that the debt could finance programs benefiting people who would never receive funding without these debts. Additionally, governmental spending with debt will promote economic growth based on the Keynesian theory, which will eventually benefit individuals as taxpayers and consumers. Last, the long-term debt can help increase intergenerational equity, because later generations will benefit from capital projects that have a long useable life and, thus, should be responsible for part of the accumulated debt.⁴¹ Another reason that should be noted is consumption smoothing, a widely accepted practice and economic principle, as shown in diminishing marginal utility. The addition to utility in good times from an extra unit is smaller than the loss of utility from an existing unit. Debt financing in recession years may increase the overall utility by transferring from good times to bust years.

However, public debt has been considered a threat to the solvency of governments during much of U.S. history due to the default and even bankruptcy of local governments (Wang & Hou, 2009). The intergenerational equity issue is also embedded in debt financing. For long-term debt, the future generations need to pay off the debt and interest, while they are excluded from the

⁴⁰ Also, people with higher educational attainment tend to purchase more goods and services from the private sector, which implies that they will pay more taxes embedded in these purchases.

⁴¹ This rationale is consistent with the “benefit to pay” principle in taxation.

decision making on debt issuance and capital projects. It has been widely held that state and local governments should in principle balance their budgets annually, though the balanced budget norm has often been violated due to financing large capital projects and wars. The results indicate that pay-go is “associated with lower volatility in capital spending in the long run, but may increase short-run variability” (Wang & Hou, 2009). The unison of the two mechanisms is recommended by Wang and Hou (2009) as a symmetric countercyclical fiscal policy (more pay-go in boom years and more debt in recession years).

Regarding the question of the determinants of state debt financing, debt at the state level is a function of economic conditions that reflect both the need to borrow and the capacity of states to repay debt (Clingermayer & Wood, 1995). Also, political factors, such as culture, partisan competition, and electoral cycles, are relevant elements of state debt. While tax and expenditure limitations on state governments have little or no impact on the increasing reliance on revenue sources from general taxes (Joyce & Mullins, 1991), this implies that increases in debt financing are more likely due to project demands than to revenue shortage. However, the situation in local governments may be different, which deserves more investigation. The changes of state and local debt burden in the 1980s were attributed to increases in demand for capital projects and to the preferences of each state. Poorer states were found to have a larger debt burden than richer states when all other factors are taken into account (Bahl & Duncombe, 1993). Based on these results, Bahl and Duncombe (1993) raise the question of whether or not poorer states might be avoiding present fiscal constraints by offloading high-debt burdens onto future generations. They found that tax and expenditure limitations tend to be associated with higher debt burden. Moreover, state limits on local debt may be beneficial for local governments (Epple & Spatt, 1986).

4.2.3 Debt as a countercyclical tool

For the countercyclical use of debt, Barro (1979) introduces a theoretical model concerning the determination of the public debt issue. The public debt theory promotes an optimal time path of the debt issue at the national level, which means increasing temporary government debt in a bust year to raise current spending and retiring debt in boom years. According to Barro's theory, debt issue is almost independent of the outstanding debt-income ratio or the level of government spending, but is a countercyclical response to the *change* in current income. Hou (2013) substantively extends Barro's (1979) propositions to the state level and concludes that states could have been better prepared for economic downturns if they had issued debt as a countercyclical tool (i.e., borrowing more in recession years and retiring these debts in boom years).

The long-term needs for local infrastructures usually remain relatively stable across booms and busts of the economic cycle, and thus, infrastructure investment can stabilize the economy by itself. Taylor, Baily, and Fischer (1982) illustrate how countercyclical infrastructure investment can work, and Hou (2011) further designs a framework indicating how to use countercyclical federal transfers for infrastructure investment, service maintenance, and business tax relief for states to save in boom years and make it through recession years. As mentioned above, debt is mainly issued for capital projects for state and local governments, and capital construction can bring the largest multiplier effect to the economy based on empirical evidence in the literature. Therefore, with the internal connection between infrastructure investment and debt issue, countercyclical debt use can be a natural tool to combat economic downturns. However, the countercyclical use of debt and its possible effects at the local level have not been studied. This chapter is among the first to thoroughly test how, and to what extent,

countercyclical debt use by local governments can help to increase revenue stability and service provision during recession years.

4.3 Theoretical Framework

The countercyclical use of debt at the local level is different from that at the national or subnational levels in several ways. Hou (2013) raises issues for the subnational government that are different from those for the national government, for example, the exogenous size of the population, negligible inter-state migration, and an almost unaffected interest rate. For the local level, however, some unique assumptions also hold. First, in one state (Georgia in this chapter), all localities are subject to the same laws and rules regulating debt use and debt limits. Second, the population size is much more volatile than that at the state level, since it is much easier to move from one county to another (sometimes moving between incorporated and unincorporated areas within the same county). Third, local governments do not have any influence on the market interest rate; however, the debt cost can vary much more than inter-state differences, since local debt endures a much larger risk than state or federal debt and the cost depends a great deal on local fiscal conditions and revenue capacity. Based on these assumptions, I assume an economic cycle that includes a 2-year recession and a 6-year economic boom.⁴² In the following part of this section, built upon Barro (1979) and Hou (2013), I design a theoretical model covering an entire economic cycle and illustrate how localities can use countercyclical debt to smooth public expenditure and increase citizen welfare.

⁴² On average, the duration of a recession is 1-2 years and a boom lasts 4-6 years (Hamilton, 1993; Gordon, 2010; Hou, 2013).

First, I assume that, in normal years, household income (Y_t) and local government revenue (R_t , mainly tax revenue) both grow at a constant rate ρ and that government program outlays grow at a different rate γ and $\gamma \leq \rho$:⁴³

$$Y_t = (1 + \rho)Y_{t-1}$$

$$R_t = (1 + \rho)R_{t-1}$$

$$O_t + C_t = (1 + \gamma)(O_{t-1} + C_{t-1})$$

where O_t is operating expenditures, and C_t is capital expenditures. Note that all terms used in this framework are real terms, the same as in Barro (1979) and Hou (2013). Restricted by balanced budgeting constraint, the annual budget equation for a local government is as follows:

$$O_t + C_t = R_t - r^*D_{t-1} + d_t$$

where D is countercyclical debt stock, r^* is real interest rate on local debt, and d_t is net amount of debt issued ($d_t = D_t - D_{t-1}$), which is equal to debt issue minus debt retirement annually. Here, I assume ND_t , designated as *normal debt* (to distinguish it from countercyclical debt), remains and increases at the same rate as government revenue, the changes of D_t are counted in changes of R_t , and I restrict d_t to *countercyclical debt* only. Thus, I put the focus on countercyclical debt use, which is extra from the current trend of debt stock.

If local governments implement a countercyclical debt use policy, the net debt issued d_t has different values over economic cycles:

$$d_t \begin{cases} > 0, & \text{in bust years } (t = 1, \dots, t_1) \\ < 0, & \text{in boom years } (t = t_1 + 1, \dots, T) \end{cases}$$

Due to shocks in recession years, governmental revenue falls below the trend by a fraction μ (< 0):

⁴³ Revenue (R_t) here includes all revenues containing own source revenue, intergovernmental transfers, and normal debt.

$$R_t = (1 + \mu)(1 + \rho)R_{t-1}.$$

According to the countercyclical debt use policy, local governments increase capital outlay funded by debt during a recession to smooth expenditure and retire this debt during boom years.

Therefore, for a T-year economic cycle, the budget equations are:

$$\text{Bust: } O_t + (1 + \varphi)C_t = (1 + \mu)R_t - rD_{t-1} + d_t \quad (d_t > 0)$$

$$\text{Boom: } O_t + C_t = R_t - rD_{t-1} + d_t \quad (d_t < 0).$$

I assume that operating budgets remain unchanged with the trend during recessions and φ is the fraction of increased capital outlay (mainly infrastructure investment). Summarizing all the years in the economic cycle with the discount rate at r , we get:

$$\sum_{t=1}^T (O_t + C_t) + \sum_{t=1}^{T_1} \varphi C_t = \sum_{t=1}^T (R_t - rD_{t-1}) + \sum_{t=1}^{T_1} \mu R_t + \sum_{t=1}^T d_t.$$

where t_1 is the duration of recession years. In this model, local government will pay off all the increased debt in the following boom years; thus,

$$\sum_{t=1}^T d_t \cong 0. \text{ }^{44}$$

Recall that $\varphi > 0$, $\mu < 0$, and if, as assumed in Barro (1979), $\gamma \cong \rho$, the budget constraint cannot hold unless local governments also make certain cuts in government expenditures. In the following part of this section, I first assume that the scenario contains no discount rate, that the revenue and expenditures are constant except during bust years, and that the interest of extra countercyclical debt is negligible. Then, these restrictive assumptions are relaxed and the results are generalized to a more complicated scenario which approaches reality.

⁴⁴ In this scenario, I assume that the discount rate is negligible for the short term. The other condition that makes this equation tenable is that the interest rate on debt is exactly equal to the discount rate.

4.3.1 Scenario (1)

According to the average duration of boom and bust, I assume that the recession lasts two years followed by a 6-year economic recovery (i.e., $t_1 = 2$ and $T = 8$), and local revenue recovers back to the original level in the third year ($R_3 = R_1$). With diminishing marginal utility, to smooth outlays over different years, the best way is to equalize the expenditure for each year (i.e., smoothly divide the revenue shortage into all years). Therefore, local governments borrow and pay off the debt in a smooth way:

$$d_1 = d_2 = \frac{1}{2}D > 0$$
$$d_3 = \dots = d_8 = -\frac{1}{6}D < 0.$$

Assume that, over a short period, the growth and discount rates for government revenue and expenditure are both negligible or that the two are equal, which makes the real terms constant. For convenience, at this stage, I also do not consider the extra interest expenditure from the countercyclical debt use.⁴⁵ In this sense, the countercyclical debt is used to equally distribute the revenue shortfall into different years (i.e., to complement *part* of the expenditure cuts).

$$(1 + \mu)R + \frac{1}{2}D = R - \frac{1}{6}D$$

i.e.,

$$D = -1.5\mu R (\mu < 0) \quad (1)$$

An example may help illustrate this point. If, in a two year recession, there is a 10% decrease in revenue due to the recession ($\mu = -10\%$), the optimal countercyclical debt should be $D = -1.5\mu R = 15\%R$, issuing new debt of $d = 7.5\%$ of the revenue for each recession year. Table 4.1 provides different options indicating how this amount of new debt can be optimal.

⁴⁵ These restrictive assumptions are relaxed in the next step.

[Table 4.1 about here]

To generalize the above discussion, denote $G_t = O_t + C_t + rD_{t-1}$, and for households, assume a Cobb-Douglas utility function:

$$U(C, G) = c_1 \ln(C) + c_2 \ln(G)^{46}$$

where Y is private consumption, G is government expenditure, which is mainly funded by property tax, and c_1, c_2 are parameters. In a partial equilibrium of government, without considering the discount rate, the growth rate of revenue and expenditure, and the interest of extra countercyclical debt, to maximize utility,

maximize

$$\sum_{t=1}^T c_2 \ln G_t$$

subject to

$$G_t \leq R_t + d_t \text{ and } \sum_{t=1}^T d_t = 0$$

i.e.,

$$\sum_{t=1}^T G_t \leq \sum_{t=1}^T R_t = \sum_{t=1}^{T_1} (1 + \mu)R_0 + \sum_{t=T_1+1}^T R_t = TR_1 + \mu T_1 R_1$$

where T_1 is the duration (year) of a recession and $\mu (< 0)$ is the fraction of revenue shortfall because of economic downturns. The first-order conditions are the following:

$$G_t = G_{t+1} = R_1 + \mu \frac{T_1}{T} R_0.$$

Thus, under the countercyclical debt policy,

in bust years ($t = 1, \dots, t_1$), we have:

⁴⁶ Another option of the utility function would be $U(C) = \frac{C^{1-\theta}-1}{1-\theta}$.

$$d_t = G_1 - (1 + \mu)R_0 = \frac{T_1 - T}{T} \mu R_0 > 0;$$

in boom years ($t = t_1 + 1, \dots, T$), we have:

$$d_t = G_1 - R_0 = \frac{T_1}{T} \mu R_0 < 0.$$

The total countercyclical debt amount is

$$D = \sum_{t=1}^{T_1} d_t = \frac{T_1 - T}{T} \mu T_1 R_0.$$

By substituting the values of the parameters into these equations, we can easily get the results in the examples illustrated above.

4.3.2 Scenario (2)

Now, I relax the restrictive assumptions and assume that the discount factor is $\frac{1}{1+r}$ and that the revenue and expenditure grow at a constant rate ρ .⁴⁷ In this scenario, the partial equilibrium of government becomes:

maximize

$$\sum_{t=1}^T c_2 \frac{1}{(1+r)^{t-1}} \ln G_t$$

subject to

$$G_t \leq R_t + d_t - r^* \sum_{i=1}^{t-1} d_i$$

and

⁴⁷ In this subsection, I do not consider the interest of extra countercyclical debt, which I will do in Subsection 3.3 with precise calculation.

$$\sum_{t=1}^T d_t = 0$$

where r^* , used to distinguish it from the discount factor r , is the interest rate for the countercyclical debts.⁴⁸ Combining the two subjective conditions, we get

$$\sum_{t=1}^T G_t \leq \sum_{t=1}^T R_t - r^* \sum_{t=1}^T \sum_{i=1}^{t-1} d_i.$$

Thus, the first order conditions are:

$$G_{t+1} = \frac{1}{1+r} G_t. \text{ }^{49}$$

Since

$$R_t = (1 + \rho)R_{t-1} \text{ in boom years and}$$

$$\sum_{t=1}^T R_t = \sum_{t=1}^{T_1} R_t + \sum_{t=T_1+1}^T R_t,$$

according to the above assumptions, in a full economic cycle with a 2-year recession and a 6-year boom, I list the government revenue and expenditure for each period in Table 4.2.

[Table 4.2 about here]

Therefore, we have

$$\sum_{t=1}^T G_t = \frac{G_1(1 - \frac{1}{(1+r)^T})}{1 - \frac{1}{1+r}} = \frac{G_1}{r} (1 + r - \frac{1}{(1+r)^{T-1}})$$

⁴⁸ r^* should vary in different years. In this framework, to facilitate explanation, I assume the interest rate r^* is the same across all years.

⁴⁹ The intertemporal Euler equation implies that $U'(c_t) = (1 + r^*)\beta U'(c_{t+1})$, where r^* is interest rate and β is discount parameter. A special case is $(1 + r^*)\beta = 1$. Thus, compared to our scenario, $\frac{1}{1+r}$ should be equal to $(1 + r^*)\beta$, and $r = 0$ is a benchmark which we applied most often in the simulation. The “discount factor” r used here is actually a combination of interest rate and discount parameter. For more details, refer to the Neoclassical Consumption Model, <http://www.stanford.edu/~chadj/Consumption2009-11-25.pdf> (retrieved June 5, 2014)

$$\begin{aligned}\sum_{t=1}^T R_t &= \sum_{t=1}^{T_1} R_t + \sum_{t=T_1+1}^T R_t \\ &= (1 + \mu)R_0 \frac{1 - (1 + \mu)^{T_1}}{-\mu} + \frac{R_0(1 + \mu)^{T_1}(1 + \rho)[(1 + \rho)^{T-T_1} - 1]}{\rho}.\end{aligned}$$

Thus,

$$\begin{aligned}G_1 &= \frac{r}{1 + r - \frac{1}{(1 + r)^{T-1}}} \left[(1 + \mu)R_0 \frac{1 - (1 + \mu)^{T_1}}{-\mu} + \frac{R_0(1 + \mu)^{T_1}(1 + \rho)[(1 + \rho)^{T-T_1} - 1]}{\rho} \right. \\ &\quad \left. - r^* \sum_{t=1}^T \sum_{i=1}^{t-1} d_i \right]\end{aligned}$$

where

$$\sum_{t=1}^T \sum_{i=1}^{t-1} d_i = Td_1 + (T - 1)d_2 + \dots + d_T.$$

Based on the above results, with $T_1 = 2$ and $T = 8$, we can formulate equations on the countercyclical debt level for each period:

$$\begin{aligned}d_1 &= G_1 - R_1 = G_1 - (1 + \mu)R_0 \\ &= \frac{r}{1 + r - \frac{1}{(1 + r)^{T-1}}} \left[(1 + \mu)R_0 \frac{1 - (1 + \mu)^{T_1}}{-\mu} \right. \\ &\quad \left. + \frac{R_0(1 + \mu)^{T_1}(1 + \rho)[(1 + \rho)^{T-T_1} - 1]}{\rho} - r^* \sum_{t=1}^T \sum_{i=1}^{t-1} d_i \right] - (1 + \mu)R_0\end{aligned}$$

$$d_2 = G_2 - (1 + \mu)^2 R_0 = \frac{G_1}{1 + r} - (1 + \mu)^2 R_0$$

$$d_3 = G_3 - (1 + \mu)^2 (1 + \rho) R_0 = \frac{G_1}{(1 + r)^2} - (1 + \mu)^2 (1 + \rho) R_0$$

...

$$d_T = G_t - (1 + \mu)^2(1 + \rho)^{T-T_1}R_0 = \frac{G_1}{(1 + r)^{T-1}} - (1 + \mu)^2(1 + \rho)^{T-T_1}R_0$$

The T -equation set illustrates the relationship between debt usages in each year. If we assume

$$r^* \sum_{t=1}^T \sum_{i=1}^{t-1} d_i \cong 0;^{50}$$

then

$$\begin{aligned} d_1 &= G_1 - (1 + \mu)R_0 \\ &= \frac{r}{1 + r - \frac{1}{(1 + r)^{T-1}}} \left[(1 + \mu)R_0 \frac{1 - (1 + \mu)^{T_1}}{-\mu} \right. \\ &\quad \left. + \frac{R_0(1 + \mu)^{T_1}(1 + \rho)[(1 + \rho)^{T-T_1} - 1]}{\rho} \right] - (1 + \mu)R_0. \end{aligned}$$

An example of this scenario is provided in Table 4.3. I assign values to each parameter as follows: $T_1 = 2$, $T = 8$, $r = 0$ or 1%, $\mu = -5\%$, and $\rho = 3\%$. The countercyclical use of debt for each period is listed in Table 4.3.⁵¹

⁵⁰ The interest of new accumulated countercyclical debt is:

$$r^* \sum_{t=1}^T \sum_{i=1}^{t-1} d_i = r[Td_1 + (T - 1)d_2 + \dots + d_T]$$

Substitute $\sum_i^T d_i = 0$ into the equation,

$$r^* \sum_{t=1}^T \sum_{i=1}^{t-1} d_i = r[(T - 1)d_1 + (T - 2)d_2 + \dots + d_{T-1}]$$

After considering the interest rate for these countercyclical debts, the debt amount should be a little less than that which I calculate here. The exact amount can be calculated by a loop computation which will be done in Subsection 3.3.

⁵¹ Two specific conditions are that $r = 0$ (there is no discount factor) and $\rho = 0$ (there is no revenue and expenditure growth).

If $r = 0$,

$$d_1 = \frac{1}{T} \left[(1 + \mu)R_0 \frac{1 - (1 + \mu)^{T_1}}{-\mu} + \frac{R_0(1 + \mu)^{T_1}(1 + \rho)[(1 + \rho)^{T-T_1} - 1]}{\rho} \right] - (1 + \mu)R_0$$

If $\rho = 0$,

[Table 4.3 about here]

I then assume different values to the important parameters (revenue shortfall μ , revenue and expenditure growth rate ρ , discount factor r) and run a simulation. The results are shown in Table 4.4.

[Table 4.4 about here]

The results are interesting and illuminating in regard to several aspects. First, while the economy begins to recover in the third year (2-year recession and 6-year boom), following the optimal path, the net countercyclical debts are positive (issue more debt instead of retirement) for four years and become negative in the latter four years. This path keeps consistent regardless of the values of the parameters. Second, with a fixed revenue growth rate ρ and discount factor r , the change of revenue due to economic shock will only change the countercyclical debt burden for the first year; the net countercyclical debt as a ratio of revenue keeps constant in the following years. Third, in the optimal path of countercyclical debt policy, the heavier recession does not imply a greater amount of debt issuance. On the contrary, the deeper recession incurs a lesser amount of countercyclical debt. The reason is that in the optimal path of countercyclical debt use, governments need to retire all these debts over the next boom years. This result indicates a comprehensive consideration of fiscal conditions to use countercyclical debt by governments. Fourth, and finally, based on the first four rows of simulation results, we can also find that the discount factor has a large impact on the countercyclical debt policy. In the first year

$$d_1 = \frac{r}{1+r - \frac{1}{(1+r)^{T-1}}} \left[(1+\mu)R_0 \frac{1 - (1+\mu)^{T_1}}{-\mu} + (T - T_1)R_0 - r^* \sum_{t=1}^T \sum_{i=1}^{t-1} d_i \right] - (1+\mu)R_0$$

of recession, a one percent change in the discount factor (r) will induce a 3-percent difference in the new net debt burden (measured by debt as a ratio of lagged revenue). This raises a concern on the scale of the discount factor. Economists usually assume around 3% as a discount factor; however, based on the simulation results, 1% probably is a better approximation of the discount factor, especially when we use real terms instead of nominal terms. If the r is close to the benchmark at 1% or 0, in the optimal path of debt as a countercyclical tool, the high debt burden in certain years is around 10%, which is feasible and will not go beyond local debt limits.⁵²

4.3.3 *Toward a comprehensive scenario*

Recall that, until now, I have not considered the interest part of accumulated net debt. In this subsection, I will gradually investigate a comprehensive framework, including all related parameters containing the interest rate of countercyclical debt (r^*), government revenue growth (ρ), and the discount factor (r). The interest of increased debt is

$$r^* \sum_{t=1}^T \sum_{i=1}^{t-1} d_i.$$

If we denote D_t as the accumulated stock of new debt (deviations from the trend), that is

$$D_t = \sum_{i=1}^{t-1} d_i,$$

without considering the interest, the values of D_t for each year in *Scenario (1)* are listed in Table 4.5.

[Table 4.5 about here]

⁵² According to the data and statutory requirement in the state of Georgia, the capital budget as a percentage of total budget is around 30% ($\frac{c}{o+c} \cong 30\%$); the ratio of debt service (principal expenditure and interest) to local revenue was lowered from 15% to 10% after 1983 with the ratification of the 1983 Constitution ($\frac{d_t}{R_{t-1}} < 10\%$). Therefore, the extra capital investment induced by countercyclical debt use should be less than $\frac{10\%}{30\%} = 33.3\%$.

Based on the values of D_t listed for each year, if the interest rate is r^* , the total interest for the countercyclical debts will be

$$\sum_{t=1}^T r^* D_t \cong 4r^* D.$$

However, after considering the interest, it is clear that the countercyclical debt changes in each period. According to the balanced budget equation, we have a T -equation set.

$$\begin{aligned} G_1 &= (1 + \mu)R_0 + d_1, \\ G_2 &= (1 + \mu)R_0 + d_2 - r^*d_1, \\ G_3 &= R_0 + d_3 - r^*(d_1 + d_2), \\ &\dots \\ G_T &= R_0 + d_T - r^*(d_1 + d_2 + \dots + d_{T-1}) \end{aligned}$$

Since $G_t = G_{t+1}$, we get

$$\begin{aligned} d_2 &= (1 + r^*)d_1 \\ d_3 &= (1 + r^*)d_2 + \mu R_0 \\ d_4 &= (1 + r^*)d_3 \\ &\dots \\ d_T &= (1 + r^*)d_{T-1} \end{aligned}$$

Summarizing these equations, with $\sum_{t=1}^T d_t = 0$, we have

$$\sum_{t=1}^T d_t = d_1 - (1 + r^*)d_T + \mu R_0 = 0.$$

Substituting $d_T = (1 + r^*)^{T-3}d_3 = (1 + r^*)^{T-3}[(1 + r^*)^2d_1 + \mu R_1]$ into this equation, we get

$$d_1 = \frac{\mu R_0[(1 + r^*)^{T-2} - 1]}{1 - (1 + r^*)^T}.$$

If the duration of recession years is t_1 , then

$$d_T = (1 + r^*)^{T-(t_1+1)}d_{t_1+1} = (1 + r^*)^{T-(t_1+1)}[(1 + r^*)^{t_1}d_1 + \mu R_0]$$

Thus,

$$d_1 = \frac{\mu R_0[(1 + r^*)^{T-t_1} - 1]}{1 - (1 + r^*)^T}$$

Following the results in Table 4.1, if $r_i^* = 5\%$, $\mu = -10\%$ and $t_1 = 2$, Table 4.6 provides a comparison between the paths of optimal debt uses with and without interest on these countercyclical debts. Certain changes do exist, even though they are relatively small.

[Table 4.6 about here]

In *Scenario (2)*, the situation is much more complicated. According to the balanced budget equation, we have a different T -equation set in the following.

$$\begin{aligned} G_1 &= (1 + \mu)R_0 + d_1, \\ G_2 &= (1 + \mu)^2R_0 + d_2 - r^*d_1, \\ &\dots \\ G_{t_1} &= (1 + \mu)^2R_0 + d_{t_1} - r^*(d_1 + \dots + d_{t_1-1}), \\ G_{t_1+1} &= (1 + \mu)^2(1 + \rho)R_0 + d_{t_1+1} - r^*(d_1 + \dots + d_{t_1}), \\ &\dots \\ G_T &= (1 + \mu)^2(1 + \rho)^{T-t_1}R_0 + d_T - r^*(d_1 + d_2 + \dots + d_{T-1}). \end{aligned}$$

With a discount factor r , the first order conditions are as follows:

$$G_{t+1} = \frac{1}{1+r} G_t.$$

Substituting this equation into the balanced budget equations, we get: ⁵³

$$\begin{aligned}
d_2 &= \left[\frac{1}{1+r} - (1+\mu) \right] (1+\mu)R_0 + \left(\frac{1}{1+r} + r^* \right) d_1 \\
&\dots \\
d_{t_1} &= \left[\frac{1}{1+r} - (1+\mu) \right] (1+\mu)^{t_1-1} R_0 + \frac{1}{1+r} [d_{t_1-1} - r^*(d_1 + \dots + d_{t_1-2})] \\
&\quad + r^*(d_1 + \dots + d_{t_1-1}) \\
&= \left[\frac{1}{1+r} - (1+\mu) \right] (1+\mu)^{t_1-1} R_0 + \left(\frac{1}{1+r} + r^* \right) d_{t_1-1} + \frac{r}{1+r} r^*(d_1 + \dots \\
&\quad + d_{t_1-2}) \\
d_{t_1+1} &= \left(\frac{1}{1+r} - 1 - \rho \right) (1+\mu)^{t_1} R_0 + \left(\frac{1}{1+r} + r^* \right) d_{t_1} + \frac{r}{1+r} r^*(d_1 + \dots + d_{t_1-1}) \\
&\dots \\
d_T &= \left(\frac{1}{1+r} - 1 - \rho \right) (1+\mu)^{t_1} (1+\rho)^{T-(t_1+1)} R_0 + \left(\frac{1}{1+r} + r^* \right) d_{T-1} \\
&\quad + \frac{r}{1+r} r^*(d_1 + \dots + d_{T-2}).
\end{aligned}$$

Summarizing these equations, with $\sum_{t=1}^T d_t = 0$, we have

⁵³ If $t_1 = 1$,

$$d_2 = \left(\frac{1}{1+r} - 1 - \rho \right) (1+\mu)R_0 + \left(\frac{1}{1+r} + r^* \right) d_1$$

and for $t > 2$,

$$d_t = \left(\frac{1}{1+r} - 1 - \rho \right) (1+\mu)(1+\rho)^{t-(t_1+1)} R_0 + \left(\frac{1}{1+r} + r^* \right) d_{t-1} + \frac{r}{1+r} r^*(d_1 + \dots + d_{t-2})$$

$$\begin{aligned}
\sum_{t=1}^T d_t &= d_1 + \left(\frac{1}{1+r} - 1 - \mu\right) (1 + \mu) R_0 \frac{1 - (1 + \mu)^{t_1 - 1}}{-\mu} \\
&\quad + \left(\frac{1}{1+r} - 1 - \rho\right) (1 + \mu)^{t_1} R_0 \frac{1 - (1 + \rho)^{T - t_1}}{-\rho} - \left(\frac{1}{1+r} + r^*\right) d_T \\
&\quad + \frac{r}{1+r} r^* [(T - 2)d_1 + (T - 3)d_2 + \dots + d_{T-2}] = 0 \quad (2)
\end{aligned}$$

Since $\frac{r}{1+r} r^* \cong 0$, if the duration of recession years $t_1 \geq 2$,

$$d_t = \left(\frac{1}{1+r} + r^*\right) d_{t-1} + (1 + \mu)^{t_1 - 2} A \quad \text{for } t \leq t_1$$

$$d_t = \left(\frac{1}{1+r} + r^*\right) d_{t-1} + (1 + \rho)^{t - (t_1 + 1)} B \quad \text{for } t > t_1$$

where $A = \left[\frac{1}{1+r} - (1 + \mu)\right] (1 + \mu) R_0$ and $B = \left(\frac{1}{1+r} - 1 - \rho\right) (1 + \mu)^{t_1} R_0$.

$$\begin{aligned}
d_T &= \left(\frac{1}{1+r} - 1 - \rho\right) (1 + \mu)^{t_1} (1 + \rho)^{T - (t_1 + 1)} R_0 \\
&\quad + \left(\frac{1}{1+r} + r^*\right) \left(\frac{1}{1+r} - 1 - \rho\right) (1 + \mu)^{t_1} (1 + \rho)^{T - 1 - (t_1 + 1)} R_0 + \dots \\
&\quad + \left(\frac{1}{1+r} + r^*\right)^{T - (t_1 + 1)} \left(\frac{1}{1+r} - 1 - \rho\right) (1 + \mu)^{t_1} R_0 \\
&\quad + \left(\frac{1}{1+r} + r^*\right)^{T - t_1} \left(\frac{1}{1+r} - 1 - \mu\right) (1 + \mu)^{t_1 - 1} R_0 + \dots \\
&\quad + \left(\frac{1}{1+r} + r^*\right)^{T - 2} \left[\left(\frac{1}{1+r} - 1 - \mu\right) (1 + \mu) R_0 + \left(\frac{1}{1+r} + r^*\right) d_1 \right]
\end{aligned}$$

$$\begin{aligned}
&= \left(\frac{1}{1+r} - 1 - \rho \right) (1+\mu)^{t_1} R_0 (1+\rho)^{T-(t_1+1)} \frac{1 - \left(\frac{1}{1+r} + r^* \right)^{T-t_1}}{1 - \left(\frac{1}{1+\rho} + r^* \right)} \\
&\quad + \left(\frac{1}{1+r} + r^* \right)^{T-t_1} \left(\frac{1}{1+r} - 1 - \mu \right) (1+\mu)^{t_1-1} R_0 \frac{1 - \left(\frac{1}{1+r} + r^* \right)^{t_1-1}}{1 - \left(\frac{1}{1+\mu} + r^* \right)} \\
&\quad + \left(\frac{1}{1+r} + r^* \right)^{T-1} d_1 \\
&= \left(\frac{1}{1+r} - 1 - \rho \right) (1+\rho)^{T-(t_1+1)} (1+\mu)^{t_1} R_0 \frac{1 - \left[\frac{1 + (1+r)r^*}{(1+r)(1+\rho)} \right]^{T-t_1}}{1 - \left[\frac{1 + (1+r)r^*}{(1+r)(1+\rho)} \right]} \\
&\quad + \left(\frac{1}{1+r} + r^* \right)^{T-t_1} \left(\frac{1}{1+r} - 1 - \mu \right) (1+\mu)^{t_1-1} R_0 \frac{1 - \left[\frac{1 + (1+r)r^*}{(1+r)(1+\mu)} \right]^{t_1-1}}{1 - \left[\frac{1 + (1+r)r^*}{(1+r)(1+\mu)} \right]} \\
&\quad + \left(\frac{1}{1+r} + r^* \right)^{T-1} d_1
\end{aligned}$$

By substituting this into equation (2), we get

$$\begin{aligned}
d_1 = & \frac{1}{1 - \left(\frac{1}{1+r} + r^*\right)^T} \left\{ \left(\frac{1}{1+r} - 1 - \rho\right) (1 + \rho)^{T-(t_1+1)} (1 + \mu)^{t_1} R_0 \frac{1 - \left[\frac{1 + (1+r)r^*}{(1+r)(1+\rho)}\right]^{T-t_1}}{1 - \left[\frac{1 + (1+r)r^*}{(1+r)(1+\rho)}\right]} \left(\frac{1}{1+r} + r^*\right) \right. \\
& + \left(\frac{1}{1+r} + r^*\right)^{T-t_1+1} \left(\frac{1}{1+r} - 1 - \mu\right) (1 + \mu)^{t_1-1} R_0 \frac{1 - \left[\frac{1 + (1+r)r^*}{(1+r)(1+\mu)}\right]^{t_1-1}}{1 - \left[\frac{1 + (1+r)r^*}{(1+r)(1+\mu)}\right]} \\
& - \left(\frac{1}{1+r} - 1 - \mu\right) (1 + \mu) R_0 \frac{1 - (1 + \mu)^{t_1-1}}{-\mu} \\
& \left. - \left(\frac{1}{1+r} - 1 - \rho\right) (1 + \mu)^{t_1} R_0 \frac{1 - (1 + \rho)^{T-t_1}}{-\rho} \right\}
\end{aligned}$$

Based on the above formula of d_1 , the countercyclical debt of the following periods (d_2 , d_3 , ..., d_t) can be calculated accordingly by using the debt equations. This is a comprehensive equation covering all the different perspectives on optimal countercyclical debt use.⁵⁴

If $t_1 = 1$,

$$d_T = \left(\frac{1}{1+r} - 1 - \rho\right) (1 + \rho)^{T-(t_1+1)} (1 + \mu) R_0 \frac{1 - \left(\frac{\frac{1}{1+r} + r^*}{1 + \rho}\right)^{T-t_1}}{1 - \left(\frac{\frac{1}{1+r} + r^*}{1 + \rho}\right)} + \left(\frac{1}{1+r} + r^*\right)^{T-1} d_1$$

Similarly,

⁵⁴ This equation also covers all specific conditions including $r = 0$ (without considering discounter factor), $r^* = 0$ (without considering interest of countercyclical debt) and $\rho = 0$ (without considering growth rate of government revenue). Note that for the term $\frac{1-(1+\rho)^{T-t_1}}{-\rho}$ in the equation, when $\rho = 0$, $\frac{1-(1+\rho)^{T-t_1}}{-\rho} \cong T - t_1$.

$$\begin{aligned}
d_1 &= \frac{1}{1 - \left(\frac{1}{1+r} + r^*\right)^T} \left\{ \left(\frac{1}{1+r} - 1 - \rho\right) (1 + \rho)^{T-(t_1+1)} (1 + \mu) R_0 \frac{1 - \left[\frac{1 + (1+r)r^*}{(1+r)(1+\rho)}\right]^{T-t_1}}{1 - \left[\frac{1 + (1+r)r^*}{(1+r)(1+\rho)}\right]} \left(\frac{1}{1+r} + r^*\right) \right. \\
&\quad \left. - \left(\frac{1}{1+r} - 1 - \rho\right) (1 + \mu) R_0 \frac{1 - (1 + \rho)^{T-t_1}}{-\rho} \right\} \\
&= \frac{1}{1 - \left(\frac{1}{1+r} + r^*\right)^T} \left\{ \left(\frac{1}{1+r} - 1 - \rho\right) (1 + \rho)^{T-2} (1 + \mu) R_0 \frac{1 - \left[\frac{1 + (1+r)r^*}{(1+r)(1+\rho)}\right]^{T-1}}{1 - \left[\frac{1 + (1+r)r^*}{(1+r)(1+\rho)}\right]} \left(\frac{1}{1+r} + r^*\right) \right. \\
&\quad \left. - \left(\frac{1}{1+r} - 1 - \rho\right) (1 + \mu) R_0 \frac{1 - (1 + \rho)^{T-1}}{-\rho} \right\}
\end{aligned}$$

By substituting the values of related parameters into these equations, in Table 4.7, I calculate the optimal paths of countercyclical debt use in different scenarios. The results shed light on how governments should use countercyclical debt optimally after considering relevant parameters.

[Table 4.7 about here]

Thus, we have obtained some preliminary conclusions about the optimal countercyclical debt use by governments. First, under certain relaxed assumptions that are close to reality, the optimal path of countercyclical debt always exists, and we can simulate these paths by inserting the values of the parameters. Second, in the optimal path, a deeper recession does not necessarily indicate a higher level of countercyclical debt, For instance, if revenue falls 5% for two

consecutive recession years, to smooth government expenditure, follow the recession, the countercyclical debts as percentages of previous year's revenue are 2.7%, 8.0%, 5.9%, and 3.0%; in comparison, if revenue falls 10% for two consecutive recession years, the percentages are 8.2%, 6.5%, 3.7%, and 0.7%. The reason is that governments need to *optimally* consider how to retire all these debts in the following boom years in order to prepare for the next economic downturn. If the recession is too severe, rational government will use countercyclical debt strategically taking the entire fiscal condition into account rather than just borrow more for severe recession. Moreover, the optimal path of countercyclical debt does not indicate that governments issue debt in recession years and retire debt in all boom years. According to the results, mostly, localities continue to borrow for a few more years after a recession and start to retire only after the recession is clearly over and the economy recovers back to the normal level.⁵⁵ For example, if recession lasts for two years and booms follow for six years, localities continue to use countercyclical debt for four years (two recession years and another two following years) and start to retire these debt for the following four years. Third, the amount of optimal debt, as high as around 10% of the total revenue, is reasonable and feasible both in the context of fiscal conditions and under most statutory debt limits.

Up to this point, the above theoretical framework provides a comprehensive picture of the optimal debt use for governments that hope to combat economic fluctuations. Based on the literature and this framework, I have three concerns or extensions with regard to the optimal path of countercyclical debt use. First, I argue that since sometimes the duration of a bust or boom in an economic cycle is not as predicted in the model, local governments may need to make adjustments accordingly. Second, in the above framework, I make a reasonable assumption that

⁵⁵ In the 2-year recession and 6-year boom case, localities borrow for four years (2 recession years and 2 following years) and retire for the following four years. Hou (2013) also points out that debt issue may continue, because reversing the direction takes some time.

revenue grows on the basis after economic downturns; however, in reality, the timeline that the revenue goes back to the trend would have an impact on debt policy. Third, Barro (1979) assumes that $\gamma \leq \rho < r$ (to facilitate the calculation of indefinite periods), but actually, the real term of government revenue and expenditure is increasing over time ($r < \gamma \leq \rho$), i.e., the nominal terms increase faster than inflation rates.

4.4 Data

In this section, I introduce the data sets for the empirical analyses. I first conduct an aggregated analysis on the different types of local governments in the U.S. and a detailed investigation of localities in the State of Georgia. The aggregated data set is collected in the U.S. census from 1960 to 2008. It includes aggregated statistics (the U.S. total and the state total) of all local governments including counties, cities and townships, school districts, and special districts. Figures 4.1 (and Figure 4.2) describes the trend of nominal and real total (and per capita) debt outstanding for the U.S. local total and different types of localities.

[Figures 4.1 and 4.2 about here]

The Georgia local data is a balanced panel data set that includes all counties and municipalities in the state of Georgia from 1985 to 2011. After removing missing data, 156 counties and 548 municipalities are included in the analyses. The data sources are Georgia Department of Community Affairs, Georgia Department of Revenue, and the U.S. census. This data set includes debt amount, property values, revenue and expenditure structures, and other fiscal characteristics of localities for each year. Using this data set, I examine the operational mechanisms of debt issuance over the booms and busts of the three full economic cycles in our

sample period. As stated in several studies (Farnham, 1985; McEachern, 1978), local data, which is better than an aggregated state level analysis, possesses several advantages. While local government behavior can lead to an aggregation bias in econometric analyses (Feige & Watts, 1972; Kmenta, 1971), the large variations in relevant variables at the local level, such as population and income, call for precise estimates using local data. This problem is even more severe when the variation is substantial in characteristics among local governments.

4.5 Methodology and Results

In this section, I provide details on methodologies and corresponding results about the optimal debt use for local governments. For the aggregated analysis, I follow the framework by Barro (1979) and Hou (2013); for individual localities, I conduct both a panel data analysis and a time series analysis for each locality.

4.5.1 Aggregated analysis

Following Barro (1979) and Hou (2013), the estimation equation is as follows:

$$\ln\left(\frac{B_t}{B_{t-1}}\right) = \alpha_0 + \alpha_1\pi_t + \alpha_2\left[\frac{P_t(G_t - \bar{G}_t)}{\bar{B}_t}\right] - \alpha_3\left[\ln\left(\frac{Y_t}{\bar{Y}_t}\right)(P_t\bar{G}_t + r\bar{B}_t)/\bar{B}_t\right] + \varepsilon$$

where B_t is the stock of nominal debt at the end of a calendar year t , \bar{B}_t is the average amount of debt outstanding during year t , π_t is the average anticipated rate of inflation during year t , P_t is the average price level for year t , G_t is real federal government expenditure (excluding interest payments on debt stock) during year t , \bar{G}_t is the average real federal government expenditure (excluding interest payments on debt stock) during year t , Y_t is the aggregate real income for year t , and \bar{Y}_t is the level of nominal income during year t .

Note that these are definitions of variables in Barro (1979) about which certain clarifications need to be raised. For B_t , the value of a fiscal year is used (Hou, 2013 clarifies this point). Since G_t is the *real* expenditure, for the terms being used in the equations

$(P_t(G_t - \bar{G}_t)/\bar{B}_t$ and $(P_t\bar{G}_t + r\bar{B}_t)/\bar{B}_t$), we need to be careful that the price level P_t should be at the accumulated level instead of on a yearly basis, (i.e., $P_t = \prod_{i=1}^t \frac{P_i}{P_{i-1}} = \frac{P_t}{P_0}$). Barro (1979) also points out that if government expenditures are expected to grow faster than income for some periods, the term $P_t\bar{G}_t/\bar{B}_t$ could be added to pick up the downward effect on the constant.

[Figure 4.3 about here]

As shown in Figure 4.3, from year 1950 to 1973, the growth rate of expenditures was larger than that of income; thus, during these periods, the estimation equation is as follows:⁵⁶

$$\ln\left(\frac{B_t}{B_{t-1}}\right) = \alpha_0 + \alpha_1\pi_t + \alpha_2\left[\frac{P_t(G_t - \bar{G}_t)}{\bar{B}_t}\right] - \alpha_3\left[\frac{\ln\left(\frac{Y_t}{\bar{Y}_t}\right)(P_t\bar{G}_t + r\bar{B}_t)}{\bar{B}_t}\right] + \alpha_4\frac{P_t\bar{G}_t}{\bar{B}_t} + \varepsilon$$

Due to data availability, instead of using the total expenditure for G_t , I use direct general expenditure in the regression to cover a multi-year window.⁵⁷ For the anticipated inflation π_t , I use either the 20-Bond Buyer Index (20BBI) (Hou, 2013) or the implicit price deflator (IPD) (Barro, 1979) in different regressions. As indicated in the literature, the average amount of debt outstanding \bar{B}_t is measured as $\bar{B}_t = \sqrt{B_t \cdot B_{t-1}}$. \bar{G}_t , and \bar{Y}_t for each locality i is calculated as a time trend using the following formulas:

$$\bar{G}_{it} = \alpha_i + \beta_it + \gamma_it^2 + \omega_it^3$$

$$\bar{Y}_{it} = \alpha_i + \beta_it + \gamma_it^2 + \omega_it^3$$

where the higher order terms are used to capture the more rapid increase during recent years. The summary statistics for the independent variables are shown in Table 4.9.

[Table 4.9 about here]

⁵⁶ Hou (2013) creates two dummies (years 1950-1975 and 1973-1982) to control for the periods of extraordinary growth in government expenditure and personal income.

⁵⁷ There is no big difference when I use total expenditure.

For the expected values of coefficients, as illustrated in the literature, α_0 would equal the growth rate ρ if the local expenditure and real income grow at the same rate; if government expenditure grows faster than real income, a downward effect ($\rho - \gamma$) is expected to be on the constant α_0 . The coefficient α_1 of the anticipated inflation rate (20BBI or IPD) should equate to unity with a one-to-one effect on the growth rate of *nominal* debt. A countercyclical debt use indicates that the coefficient of $P_t(G_t - \bar{G}_t)/\bar{B}_t$ should be positive and that the coefficient of $\ln(Y_t/\bar{Y}_t)(P_t\bar{G}_t + r\bar{B}_t)/\bar{B}_t$ should be negative (both below unity), implying that when personal income is below the normal trend, a government tends to issue more debt to increase public expenditure. For the debt burden term $P_t\bar{G}_t/\bar{B}_t$, normal government spending relative to the debt outstanding, the coefficient should be negative if localities take the debt burden into consideration when they issue new debts.

With regard to the aggregated analysis of different localities, according to the results shown in Table 4.10, the constant α_0 ranges from 5% to 20%; different types of localities have different debt growth rates. Consistent with the results in Figure 4.1, school districts and special districts have much higher growth rates than other localities, especially over the time period from the 1980s to the late 2000s. As expected, the coefficient α_1 is more or less around unity in most regressions. The coefficients α_2 and α_3 are mostly not significant, indicating changes in the debt outstanding were keeping with the normal trend without considering much of the influence of economic fluctuations. For the U.S. local total, the coefficient of $P_t(G_t - \bar{G}_t)/\bar{B}_t$ is even negative, which implies that, on an aggregated basis, the local use of debt is procyclical, issuing more debt in boom years and vice versa. Special districts are an exception in that they take the

debt burden into consideration in the process of debt issue decision making (negative α_4), while their debt use is not necessarily countercyclical.

[Table 4.10 about here]

I then run the same regressions at the aggregated region and state levels. I use the eight census regions.⁵⁸ In Table 4.11, the results indicate that at the aggregated regional level, local governments did not systematically implement any countercyclical debt use policy. Most coefficients α_2 and α_3 are not significant; additionally, some α_2 are significantly negative, and some α_3 are significantly positive (positive α_2 and negative α_3 indicate a countercyclical debt use policy). These results are consistent with the above conclusion that the debt use of local governments in the aggregated national level was not countercyclical; some of them are even procyclical. At the aggregated state level, similarly, α_2 and α_3 are not significant for most states. Local governments in some states are using debt counter-cyclically (positive α_2 and/or negative α_3), including Iowa, Michigan, Nebraska, North Carolina, and Wisconsin. Some states, such as Alaska, Florida, Maine, Maryland, West Virginia, and Wyoming, decrease the new debt issuance or increase the retirement when the debt burden is high (negative α_4).

[Table 4.11 about here]

4.5.2 Individual locality analysis

For the individual locality analysis, besides the empirical framework in the literature (Barro, 1979; Hou, 2013), I design a different and more simplified way to capture

⁵⁸ The eight census regions are: Far West, Great Lakes, Mid Atlantic, New England, Plains, Rocky Mountains, Southeast, and Southwest.

countercyclical debt use and investigate the determinants of countercyclical debt policy for counties and cities.

I assume that local revenue and long-term debt outstanding follow a certain trend along the timeline.⁵⁹ When recession comes, as described in the theoretical framework, the revenue will deviate below the trend due to the external shock. At this point of time, whether the debt outstanding is below or above the trend is up to the debt policy of the local government. If a countercyclical debt policy is used, the debt outstanding should be above the trend during recession years; if the debt is procyclical or the government just lets the debt slide, the debt outstanding will probably also be below the trend during recession years.

The trend of local revenue and debt outstanding are described as follows:⁶⁰

$$\bar{R}_{it} = \alpha_i + \beta_i t + \gamma_i t^2$$

$$\bar{D}_{it} = \alpha_i + \beta_i t + \gamma_i t^2$$

where \bar{R}_t is the trend of local revenue and \bar{D}_t is the trend of long-term debt outstanding. i is an indicator of each county or city, and t is year. Figure 4.4 provides an illustration of the trend of long-term debt outstanding and total local revenue for Fulton County and Augusta City in Georgia. After obtaining the trends based on regressions, deviations are calculated, and the relationships between the deviations are gained from the following regressions:

$$D_{it} - \bar{D}_{it} = \alpha_i^* + \beta_i^* (R_{it} - \bar{R}_{it}).$$

⁵⁹ In the subsection, *debt* refers to only long-term debt to fit the proposition of countercyclical debt financing. The data of long-term debt outstanding are not available in our data set; instead, I use the interest payment of long-term debt each year as a proxy for debt outstanding. In calculation, I assume the interest rate is 5%; thus calculated long-term debt outstanding is equal to the next year's interest payment of long-term debt multiplied by 20. For instance, the debt outstanding in fiscal year 2000 would be as follows: $Debt_{2000} = interest_{2001}/5\%$. Note that the assumed interest rate will not influence the results since it is only a fixed multiplier, and as described below, the sign of deviation matters rather than the absolute debt magnitude, especially in the logit regression.

⁶⁰ The cube term is not included, since the time periods are not very long and the cube terms are often dropped in the regression. This time trend regression is somewhat simple here. We may try Kernel density estimation in the next step. Also, another effective way is to regress the equation $\ln(\bar{R}_{it}) = \alpha_i + \beta_i t$ which I use as a robustness check, and the results are similar.

[Figure 4.4 about here]

As illustrated above, for each locality i , a negative β_i^* implies a countercyclical debt use policy, while a positive β_i^* implies a procyclical policy. I then generate a new dummy variable *counter*, which is equal to 1 if β_i^* is positive and 0 if β_i^* is negative. With this new variable *counter*, we are able to identify localities that used a countercyclical debt policy and those that did not. According to this information, with the dummy as a dependent variable, logistic regressions are used to examine the determinants of a countercyclical debt policy (i.e., why some localities use debt counter-cyclically and others do not). As described in the following equation,

$$\text{counter} = \beta_0 + \beta_1 \text{propratio} + \beta_2 \text{grantratio} + \beta_3 \text{capitalratio} + \beta_5 \mathbf{X} + \epsilon,$$

the independent variables include the percentage of property tax in own source revenue (*propratio*); the percentage of intergovernmental grants in total revenue (*grantratio*); the percentage of public works expenditures in the total expenditures (capital expenditure ratio, *capitalratio*); and the factor \mathbf{X} are control variables, including per capita property tax (in 1000), per capita infrastructure expenditure (in 1000), per capita expenditure (in 1000), per capita personal income (in 1000), per capita income square, unemployment rate, infrastructure expenditure as a ratio of total local expenditure, fund balance ratio measured as surplus as a ratio of revenue, debt burden measured as debt outstanding as a ratio of total revenue, population, population growth, and form of government.⁶¹ Table 4.12 provides summary statistics of relevant variables. For three different variables of *counter*, all averages are larger than 0.5; the data indicate that more counties use debt pro-cyclically rather than counter-cyclically. Especially

⁶¹ In terms of control variables, for both counties and municipalities, per capita property tax, per capita infrastructure expenditure, and per capita expenditure are highly correlated; thus, only per capita infrastructure expenditure is included in the regression. The forms of government (for counties) includes: (1) commission, (2) council-administrator, (3) council-manager, and (4) council-elected executive.

when local revenue is below the trend in bust years, approximately two thirds of Georgia counties also decrease the long-term debt below the trend.

[Table 4.12 about here]

For counties in Georgia, the regression results regarding the determinants of countercyclical debt use are shown in Table 4.13. The results provide an illustration of the fiscal behaviors of local governments. Note that for the binary dependent variable, 0 indicates a negative relationship between revenue and debt (counter-cyclical), and 1 indicates a positive relationship (pro-cyclical). Thus, in these regressions, negative coefficients indicate a higher probability of debt use for countercyclical purposes. The coefficients provided in the table are marginal effects based on logistic regressions.

[Table 4.13 about here]

According to Table 4.13, during the entire period, counties with higher ratios of property tax in own revenue were less likely to use debt counter-cyclically. The reason may be that counties with a higher property tax ratio have a more stable revenue, which is less influenced by economic fluctuation; thus, their debt outstanding increases during boom years and decreases during recession years. When revenue is above the trend (i.e., in boom years), the coefficients for the property tax ratios are not significant. When revenue is below the trend (i.e., in recession years), the effects of non-metro counties dominate the coefficients. Non-metro counties with a higher property tax ratio suffer less from the recession; they may not need to increase their debt as much as others to compensate for the decreased expenditures. The property tax ratio implies the stability of local revenue, while other own revenue sources have much more volatilities.

Since other revenue sources are more pro-cyclical than property tax, counties with a lower property tax ratio are under more stress and need to borrow more to offset revenue loss. This offers further confirmation that counties with volatile fiscal capacities need to use countercyclical debt with greater eagerness. Most debt, especially long-term debt, is used in capital expenditure. Thus, the coefficient of capital expenditure as a ratio of local expenditure is statistically significant. While infrastructure investments are often initiated in boom years, which render the positive coefficients (pro-cyclical) in the third column, in bust years, the coefficient shows that the larger the share of infrastructure investment is, the more likely it is that a county can use countercyclical debt. The results imply that if counties use countercyclical debt, infrastructure expenditure is an appropriate path to use for these debts to combat fiscal stress. In this sense, non-metro counties with a potential for more infrastructure investment are in a better position to use debt for countercyclical purposes. The combination of the pro-cyclical use of infrastructure investment in boom years and counter-cyclical use in bust years explains the rapid accumulation of debt outstanding. The coefficients of infrastructure investment indicate that counties were borrowing more in recession years but did not retire these debts even after their fiscal condition recovered, causing an overburden of debt. The consistently positive coefficients of debt burden remind us that a high debt burden does impede the use of countercyclical debt. The reason may be that counties with high debt burdens do not necessary have fiscal/debt capacity to borrow more debt in recession years.

Municipalities are telling a different story. As shown in Table 4.14, infrastructure investment and fund balance are two important factors of counter-cyclical debt policy. Property tax is not statistically significant for the use of counter-cyclical debt since property tax occupies only around 10% of own source revenue in municipalities as shown in Table 4.12. Consistently,

the ratio of infrastructure expenditure plays a very important role in using countercyclical debt. Counties with higher ratios of infrastructure investment in total expenditures are more likely to use debt counter-cyclically. The effects of fund balance are interesting in that in boom years, the coefficient is negative, i.e., municipalities are retiring more debt when they have a high fund balance, while in bust years, the coefficient is positive, indicating that municipalities are still using high fund balances to pay off debt even when a recession comes. The latter phenomenon further highlights the much stronger fiscal capacities of municipalities than counties.

[Table 4.14 about here]

The difference in the determinants of countercyclical debt use for counties versus cities further reminds us of the possible invalidity and bias in aggregated analysis. Though the signs of coefficients have switched back and forth between positive and negative, we can explain the internal reasons for countercyclical debt uses on the basis of two contradictory factors. One is fiscal capacity, and the other is borrowing cost. In recession years, if localities use countercyclical debt, they first need to have enough fiscal capacity for more debt, and second, to take the borrowing cost into consideration. The more fiscal capacity localities have the lower the borrowing cost (interest payment) and, also, the lower the need for debt. Therefore, during recession years, localities with higher property tax ratios may have enough fiscal capacity or credentials to borrow more debt for countercyclical use, but meanwhile, their demand for expenditure smoothing is smaller, since their revenue structure is more stable. The sign of the coefficient will depend on the dominance of the two factors. According to the regression results, counties with a higher property tax ratio have a smaller probability of using countercyclical debt, mostly because they do not need to. The fact that non-metro counties use more countercyclical

debt confirms this conclusion since they have a higher probability of demand. In contrast, cities with higher infrastructure investment ratios are more likely to use countercyclical debt, because they stand in a better position to use countercyclical debt to achieve two goals simultaneously: to combat recession and invest in the infrastructure. With better fiscal capacities, municipalities can do a better job maintaining appropriate fund balances; thus, they can do more about expenditure smoothing to meet city residents' demands to keep the qualities and quantities of public services consistent. Infrastructure expenditure is still the first alternative to using debt. When the share of infrastructure expenditure is high, localities have more potential room for countercyclical debt use; however, when the infrastructure expenditure is low, there is less room to use counter-cyclical debt and, thus, smooth expenditure.

Regarding the effects of counter-cyclical debt on expenditure stability. The brief statistics in Table 4.15 provide a strong evidence that the counter-cyclical debt has effectively decreased expenditure volatility. The results indicates that localities tend to use countercyclical debt when revenue is in larger deviations, i.e., during big recessions or unexpected boom years. The effects of counter-cyclical debt are evident. For localities using countercyclical debt, they have much smaller expenditure gaps even when they keep larger revenue gaps, indicating that counter-cyclical debt effectively decreased the expenditure volatility. *Difference* in the table measures the difference of expenditure gap and revenue gap for each type of local governments. Obviously, localities using counter-cyclical debt possess much bigger differences, especially during bust years. Difference-in-difference (DID) is calculated by the difference between expenditure gap and revenue gap for localities using counter-cyclical debt minus the difference for the other localities. In this context, the counter-cyclical debt is mainly used to decrease expenditure volatility given revenue fluctuations. I conduct left side t-tests to investigate whether

the effects of counter-cyclical debt on decreased expenditure volatility are statistically significant. The results indicate that the counter-cyclical debt is very effective in reducing expenditure volatility. Particularly during bust years, counties and cities using counter-cyclical debt both decreased the expenditure gaps by 8.8% and 4.4% respectively.⁶²

[Table 4.15 about here]

With regard to the robustness of methodology issues, one concern is that, sometimes, the deviations of local revenue from the trend are not necessarily due to economic fluctuations, but may be due to random reasons, such as incorrect revenue forecasting or temporary grant changes. As a robustness check, I calculate the relationship between deviations of local revenue and deviations of debt outstanding only for those localities in which the local revenue was below or above the trend for at least three consecutive years. We can be confident that a deviation for at least three consecutive years is not due to a random change but to systematic fluctuations. The results are very similar to the regressions covering all observations.

4.6 Conclusion and Discussion

In this chapter, I construct a theoretical framework unfolding an optimal debt path over economic cycles and how the countercyclical debt may influence local expenditure. Step by step, I describe different scenarios of countercyclical debt use and finally get a comprehensive scenario of the optimal countercyclical debt policy. Based on different assignment of values for parameters in the theoretical framework, the simulation results are intuitive and illustrate that a

⁶² For the statistical validity, there is a possible selection bias that in many other fiscal perspectives, localities that are using counter-cyclical debt may be different from those that are not. More details can be found in the next chapter by running several complete regressions including comprehensive control variables. The results are similar as described here.

countercyclical debt policy is feasible for localities and will not induce incredible debt burden even when the recession is very deep. The consideration of fiscal stress in the retirement of countercyclical debt will force localities to have comprehensive concerns to choose to borrow appropriate but not too much to fight the recession. This framework provides an important guidance for localities and can be easily used for government official as long as they have a good estimate of the parameters.

The empirical results indicate that different localities have distinct debt policies due to the two above-mentioned elements of debt: fiscal capacity and borrowing cost. On one hand, localities with better fiscal capacity have decent debt-paying ability but lower need to borrow. On the other hand, localities without good fiscal capacity have higher need to borrow but also higher interest cost because of lower credit rating. The two sides accompanied with the regression results tell us that counties design debt policies mainly conditional on the debt-paying ability, while municipalities decide debt policies based on the need of borrowing since they usually have better fiscal capacities. Thus, municipalities use countercyclical debt policies more often than counties, and as shown in Figure 4.1, municipalities and townships have a much higher per capita debt outstanding than counties. The effect of countercyclical debt policy is also evident: according to the T tests, localities with countercyclical debt policy have much lower coefficient of variation in per capita expenditure than those that do not, and the difference is significant at 1% level.

This chapter contributes to the literature by theoretically calculating the optimal path of countercyclical debt use in the context of different values of parameters and empirically extend the analyses from national and subnational levels to the local level. The property tax, as the main own-source revenue for localities, has a determining impact on countercyclical debt policy. The

effect of property tax highlights the importance of the stability of revenue sources for local governments. Therefore, as policy implications, local governments should implement corresponding debt policies on the basis of different components of revenue structure. To effectively implement countercyclical debt policy, localities should intentionally improve their revenue structure to achieve a higher fiscal flexibility. The dual importance of property tax in revenue structure as the main revenue source and in governance as a revenue-service link needs to be given enough attention.

Table 4.1: Different amounts of countercyclical debt use

Year	Revenue	Option 1		Option 2 (optimal)		Option 3	
		Expenditure	Debt *	Expenditure	Debt	Expenditure	Debt
0	100	100	0	100	0	100	0
1	90	95	6	97.5	7.5	100	10
2	90	95	6	97.5	7.5	100	10
3	100	98	-2	97.5	-2.5	96.67	-3.33
4	100	98	-2	97.5	-2.5	96.67	-3.33
5	100	98	-2	97.5	-2.5	96.67	-3.33
6	100	98	-2	97.5	-2.5	96.67	-3.33
7	100	98	-2	97.5	-2.5	96.67	-3.33
8	100	98	-2	97.5	-2.5	96.67	-3.33

Notes: * Debt here refers only to new debt used as a countercyclical tool, which excludes normal debt use in local finance. The same applies in the following.

Table 4.2: Government revenue and expenditure for each year with countercyclical debt use

Year in a full cycle	Revenue	Expenditure	Debt	Debt outstanding (at the beginning of year)
1	$R_0(1 + \mu)$	$R_0(1 + \mu) + d_1$	d_1	0
2	$R_0(1 + \mu)^2$	$R_0(1 + \mu)^2 + d_2 - r^*d_1$	d_2	d_1
3	$R_0(1 + \mu)^2(1 + \rho)$	$R_0(1 + \mu)^2(1 + \rho) + d_3 - r^*(d_1 + d_2)$	d_3	$d_1 + d_2$
4	$R_0(1 + \mu)^2(1 + \rho)^2$...	d_4	...
5	$R_0(1 + \mu)^2(1 + \rho)^3$...	d_5	...
6	$R_0(1 + \mu)^2(1 + \rho)^4$...	d_6	...
7	$R_0(1 + \mu)^2(1 + \rho)^5$...	d_7	...
8	$R_0(1 + \mu)^2(1 + \rho)^6$	$R_0(1 + \mu)^2(1 + \rho)^6 + d_8 - r^* \sum_{i=1}^7 d_i$	d_8	$\sum_{i=1}^7 d_i$

Table 4.3: Optimal use of countercyclical debt in the context of relaxed assumptions

Panel A: discount factor $r = 0$					
Year	Revenue	Growth rate	Expenditure	Debt	Debt/Rev_{t-1}
0	100		100	0	0
1	95.00	-5%	98.32	3.32	3.3%
2	90.25	-5%	98.32	8.07	8.5%
3	92.96	3%	98.32	5.36	5.9%
4	95.75	3%	98.32	2.57	2.8%
5	98.62	3%	98.32	-0.30	-0.3%
6	101.58	3%	98.32	-3.26	-3.3%
7	104.62	3%	98.32	-6.31	-6.2%
8	107.76	3%	98.32	-9.45	-9.0%
Panel A: discount factor $r = 1\%$					
Year	Revenue	Growth rate	Expenditure	Debt	Debt/Rev_{t-1}
0	100		100	0	0
1	95.00	-5%	101.78	6.78	6.8%
2	90.25	-5%	100.77	10.52	11.1%
3	92.96	3%	99.77	6.81	7.5%
4	95.75	3%	98.78	3.04	3.3%
5	98.62	3%	97.80	-0.81	-0.9%
6	101.58	3%	96.84	-4.74	-4.8%
7	104.62	3%	95.88	-8.75	-8.6%
8	107.76	3%	94.93	-12.84	-12.3%

Table 4.4: Simulation of countercyclical debt uses

Scenarios			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Parameters	Revenue fall	μ	-5%	-5%	-5%	-5%	-5%	-10%	-10%	-10%	-10%	-10%
	Growth rate	ρ	1%	2%	3%	4%	3%	1%	2%	3%	4%	3%
	Discount factor	r	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%
Years	1	d_1	-1.7%	0.7%	3.3%	6.0%	6.8%	-5.7%	-3.5%	-1.2%	1.2%	2.0%
	2	d_2	3.2%	5.8%	8.5%	11.3%	11.1%	3.7%	6.1%	8.7%	11.4%	11.2%
	3	d_3	2.3%	4.1%	5.9%	7.9%	7.5%	3.1%	4.8%	6.7%	8.6%	8.3%
	4	d_4	1.3%	2.0%	2.8%	3.6%	3.3%	2.0%	2.7%	3.5%	4.3%	4.0%
	5	d_5	0.3%	0.0%	-0.3%	-0.6%	-0.9%	1.0%	0.7%	0.4%	0.1%	-0.2%
	6	d_6	-0.7%	-2.0%	-3.3%	-4.5%	-4.8%	0.0%	-1.3%	-2.6%	-3.9%	-4.1%
	7	d_7	-1.7%	-4.0%	-6.2%	-8.4%	-8.6%	-1.0%	-3.3%	-5.6%	-7.7%	-8.0%
	8	d_8	-2.7%	-5.9%	-9.0%	-12.0%	-12.3%	-2.0%	-5.3%	-8.4%	-11.4%	-11.7%

Notes: * The values here refer to newly issued countercyclical debt as a percentage of government revenue last year, in mathematics, d_t/rev_{t-1} .

Table 4.5: Net debt increase (above the trend) with countercyclical debt use

t (year)	1	2	3	4	5	6	7	8
d_t (net debt increase)	$\frac{1}{2}D$	$\frac{1}{2}D$	$-\frac{1}{6}D$	$-\frac{1}{6}D$	$-\frac{1}{6}D$	$-\frac{1}{6}D$	$-\frac{1}{6}D$	$-\frac{1}{6}D$
D_t (outstanding)	$\frac{1}{2}D$	D	$\frac{5}{6}D$	$\frac{4}{6}D$	$\frac{3}{6}D$	$\frac{2}{6}D$	$\frac{1}{6}D$	0

Table 4.6: Comparison between optimal debt uses with and without interest

Year	Rev	Optimal debt use			Optimal debt use (with interest)			
		Exp	Debt	Debt/Rev _{t-1}	Exp	Debt	Debt/Rev _{t-1}	Debt outstanding
0	100	100	0	0	100	0	0	0
1	90	97.5	7.5	7.5%	97.12	7.12	7.1%	0.00
2	90	97.5	7.5	7.7%	97.12	7.48	8.3%	7.12
3	100	97.5	-2.5	-2.6%	97.12	-2.15	-2.4%	14.60
4	100	97.5	-2.5	-2.6%	97.12	-2.25	-2.3%	12.46
5	100	97.5	-2.5	-2.6%	97.12	-2.37	-2.4%	10.20
6	100	97.5	-2.5	-2.6%	97.12	-2.49	-2.5%	7.83
7	100	97.5	-2.5	-2.6%	97.12	-2.61	-2.6%	5.35
8	100	97.5	-2.5	-2.6%	97.12	-2.74	-2.7%	2.74

Table 4.7: A list of revenue and expenditure due to optimal countercyclical debt use⁶³

Scenarios			Recession=1 year				Recession=2 years			
Parameters	μ	ρ	-5%				-5%			
			3%				3%			
			0%				0%			
			5%				5%			
			Revenue	Expenditure	d_t	d_t/Rev_{t-1}	Revenue	Expenditure	d_t	d_t/Rev_{t-1}
Years	0		100	100	0	0	100	100	0	0
	1	d_1	95.00	104.80	9.80	9.8%	95.00	97.75	2.75	2.7%
	2	d_2	97.85	104.80	7.44	7.8%	90.25	97.75	7.64	8.0%
	3	d_3	100.79	104.80	4.88	5.0%	92.96	97.75	5.31	5.9%
	4	d_4	103.81	104.80	2.10	2.1%	95.75	97.75	2.79	3.0%
	5	d_5	106.92	104.80	-0.91	-0.9%	98.62	97.75	0.05	0.1%
	6	d_6	110.13	104.80	-4.16	-3.9%	101.58	97.75	-2.90	-2.9%
	7	d_7	113.43	104.80	-7.68	-7.0%	104.62	97.75	-6.09	-6.0%
	8	d_8	116.84	104.80	-11.46	-10.1%	107.76	97.75	-9.54	-9.1%
$D = Sum(d_t)$					0			0		
Scenarios			Recession=1 year				Recession=2 years			
Parameters	μ	ρ	-10%				-10%			
			3%				3%			
			0%				0%			
			5%				5%			
			Revenue	Expenditure	d_t	d_t/Rev_{t-1}	Revenue	Expenditure	d_t	d_t/Rev_{t-1}
Years	0		100	100	0	0	100	100	0	0
	1	d_1	90.00	99.29	9.29	9.3%	90.00	88.43	-1.57	-1.6%
	2	d_2	92.70	99.29	7.05	7.8%	81.00	88.43	7.35	8.2%
	3	d_3	95.48	99.29	4.62	5.0%	83.43	88.43	5.29	6.5%
	4	d_4	98.35	99.29	1.99	2.1%	85.93	88.43	3.05	3.7%
	5	d_5	101.30	99.29	-0.86	-0.9%	88.51	88.43	0.62	0.7%
	6	d_6	104.33	99.29	-3.95	-3.9%	91.17	88.43	-2.00	-2.3%
	7	d_7	107.46	99.29	-7.27	-7.0%	93.90	88.43	-4.84	-5.3%
	8	d_8	110.69	99.29	-10.86	-10.1%	96.72	88.43	-7.90	-8.4%
$D = Sum(d_t)$					0			0		

Notes: The parameters are: μ , revenue fall; ρ , growth rate; r , discount factor; r^* , interest rate.

⁶³ See more comparisons in Appendix Table 4.8.

Table 4.8: Optimal countercyclical debt uses in different scenarios

Panel (1): recession=2 years

Scenarios		(1)		(2)		(3)		(4)		(5)		(6)		
Parameters	μ	-5%		-5%		-5%		-10%		-10%		-10%		
	ρ	2%		2%		3%		2%		3%		3%		
	r	0%		0%		0%		0%		0%		1%		
	r^*	4%		5%		5%		4%		5%		5%		
		d_t	d_t/Rev_{t-1}	d_t	d_t/Rev_{t-1}	d_t	d_t/Rev_{t-1}	d_t	d_t/Rev_{t-1}	d_t	d_t/Rev_{t-1}	d_t	d_t/Rev_{t-1}	
Years	1	d_1	0.47	0.5%	0.41	0.4%	2.75	2.7%	-3.64	-3.6%	-1.57	-1.6%	1.32	1.3%
	2	d_2	5.24	5.5%	5.18	5.5%	7.64	8.0%	5.22	5.8%	7.35	8.2%	9.48	10.5%
	3	d_3	3.65	4.0%	3.63	4.0%	5.31	5.9%	3.81	4.7%	5.29	6.5%	6.63	8.2%
	4	d_4	1.95	2.1%	1.97	2.1%	2.79	3.0%	2.31	2.8%	3.05	3.7%	3.57	4.3%
	5	d_5	0.15	0.2%	0.19	0.2%	0.05	0.1%	0.71	0.8%	0.62	0.7%	0.28	0.3%
	6	d_6	-1.76	-1.8%	-1.71	-1.8%	-2.90	-2.9%	-0.98	-1.1%	-2.00	-2.3%	-3.24	-3.7%
	7	d_7	-3.78	-3.9%	-3.75	-3.8%	-6.09	-6.0%	-2.77	-3.2%	-4.84	-5.3%	-7.01	-7.7%
	8	d_8	-5.93	-5.9%	-5.93	-6.0%	-9.54	-9.1%	-4.67	-5.2%	-7.90	-8.4%	-11.03	-11.8%
Sum (d_t)		0		0		0		0		0		0		

Notes: The parameters are: μ , revenue fall; ρ , growth rate; r , discount factor; r^* , interest rate.

Panel (2): recession=1 year

Scenarios		(1)		(2)		(3)		(4)		(5)		(6)		
Parameters	μ	-5%		-5%		-5%		-10%		-10%		-10%		
	ρ	2%		2%		3%		2%		3%		3%		
	r	0%		0%		0%		0%		0%		1%		
	r^*	4%		5%		5%		4%		5%		5%		
		d_t	d_t/Rev_{t-1}	d_t	d_t/Rev_{t-1}	d_t	d_t/Rev_{t-1}	d_t	d_t/Rev_{t-1}	d_t	d_t/Rev_{t-1}	d_t	d_t/Rev_{t-1}	
Years	1	d_1	6.51	6.5%	6.41	6.4%	9.80	9.8%	6.17	6.2%	9.29	9.3%	12.54	12.5%
	2	d_2	4.87	5.1%	4.83	5.1%	7.44	7.8%	4.61	5.1%	7.05	7.8%	9.46	10.5%
	3	d_3	3.13	3.2%	3.13	3.2%	4.88	5.0%	2.96	3.2%	4.62	5.0%	6.14	6.6%
	4	d_4	1.27	1.3%	1.31	1.3%	2.10	2.1%	1.21	1.3%	1.99	2.1%	2.57	2.7%
	5	d_5	-0.69	-0.7%	-0.64	-0.6%	-0.91	-0.9%	-0.66	-0.7%	-0.86	-0.9%	-1.25	-1.3%
	6	d_6	-2.78	-2.7%	-2.73	-2.7%	-4.16	-3.9%	-2.63	-2.7%	-3.95	-3.9%	-5.34	-5.3%
	7	d_7	-4.98	-4.8%	-4.96	-4.7%	-7.68	-7.0%	-4.72	-4.8%	-7.27	-7.0%	-9.72	-9.3%
	8	d_8	-7.32	-6.8%	-7.35	-6.9%	-11.46	-10.1%	-6.94	-6.8%	-10.86	-10.1%	-14.40	-13.4%
Sum (d_t)		0		0		0		0		0		0		

Table 4.9: Summary statistics of values of independent variables

Year	π (20BBI)	π (IPD)	$\ln\left(\frac{Y}{\bar{Y}}\right)$	$P\bar{G}/\bar{B}$	$P(G - \bar{G})/\bar{B}$	$\ln\left(\frac{Y}{\bar{Y}}\right)P(\bar{G} + rB)/\bar{B}$	G/\bar{Y}
1955	0.025	0.021	-0.046	0.850	-0.127	-0.039	0.068
1956	0.028	0.063	-0.028	0.819	-0.112	-0.023	0.070
1957	0.033	0.043	-0.044	0.816	-0.105	-0.036	0.072
1961	0.035	0.027	-0.079				0.081
1962	0.032	0.026	-0.062	0.731	-0.033	-0.046	0.083
1963	0.032	0.023	-0.061	0.716	-0.030	-0.044	0.084
1964	0.032	0.019	-0.038	0.712	-0.027	-0.027	0.085
1965	0.033	0.030	-0.011	0.711	-0.017	-0.008	0.087
1966	0.038	0.048	0.009	0.711	0.006	0.006	0.091
1967	0.039	0.051	0.015	0.722	0.023	0.011	0.093
1968	0.044	0.058	0.035	0.746	0.022	0.026	0.094
1969	0.057	0.068	0.041	0.761	0.058	0.031	0.099
1970	0.063	0.081	0.028	0.768	0.077	0.022	0.102
1971	0.055	0.077	0.029	0.767	0.120	0.023	0.108
1972	0.053	0.064	0.061	0.755	0.165	0.046	0.115
1973	0.052	0.066	0.083	0.773	0.140	0.064	0.112
1974	0.062	0.110	0.044	0.823	0.102	0.037	0.107
1975	0.070	0.096	0.015	0.867	0.121	0.013	0.110
1976	0.066	0.048	0.029	0.906	0.142	0.026	0.112
1977	0.057	0.063	0.038	0.938	0.114	0.036	0.109
1978	0.060	0.065	0.054	0.978	0.076	0.053	0.105
1979	0.065	0.088	0.032	1.059	0.031	0.033	0.101
1980	0.086	0.108	-0.013	1.135	-0.032	-0.015	0.096
1981	0.114	0.100	-0.025	1.187	-0.079	-0.030	0.093
1982	0.116	0.061	-0.043	1.187	-0.098	-0.051	0.092
1983	0.095	0.044	-0.038	1.131	-0.097	-0.043	0.092
1984	0.101	0.043	-0.007	1.092	-0.096	-0.007	0.092
1985	0.091	0.041	-0.002	1.048	-0.076	-0.002	0.094
1986	0.073	0.029	0.008	0.972	-0.035	0.008	0.098
1987	0.077	0.047	0.005	0.914	-0.014	0.005	0.101
1988	0.077	0.033	0.013	0.910	-0.012	0.012	0.101
1989	0.072	0.048	0.014	0.941	-0.013	0.013	0.102
1990	0.073	0.050	-0.003	0.962	-0.006	-0.003	0.103
1991	0.069	0.035	-0.033	0.971	-0.004	-0.032	0.103
1992	0.064	0.036	-0.027	0.974	-0.006	-0.026	0.104
1993	0.056	0.026	-0.041	0.984	-0.019	-0.041	0.103
1994	0.062	0.027	-0.038	0.990	-0.036	-0.037	0.101
1995	0.060	0.027	-0.037	1.000	-0.033	-0.037	0.102
1996	0.058	0.023	-0.030	1.019	-0.042	-0.031	0.101

Year	π (20BBI)	π (IPD)	$\ln\left(\frac{Y}{\bar{Y}}\right)$	$P\bar{G}/\bar{B}$	$P(G - \bar{G})/\bar{B}$	$\ln\left(\frac{Y}{\bar{Y}}\right)P(\bar{G} + rB)/\bar{B}$	G/\bar{Y}
1997	0.055	0.022	-0.017	1.014	-0.041	-0.018	0.101
1998	0.051	0.020	0.015	1.002	-0.025	0.015	0.103
1999	0.054	0.040	0.018	0.995	-0.013	0.018	0.105
2000	0.057	0.048	0.040	0.994	-0.012	0.040	0.105
2001	0.052	0.035	0.025	0.984	0.002	0.024	0.107
2002	0.050	0.021	0.005	0.954	0.022	0.004	0.109
2003	0.047	0.035	-0.008	0.938	0.022	-0.007	0.110
2004	0.047	0.051	0.000	0.922	0.016	0.000	0.109
2005	0.044	0.057	-0.003	0.915	0.004	-0.003	0.108
2006	0.044	0.050	0.014	0.917	0.003	0.013	0.108
2007	0.044	0.052	0.017	0.899	0.024	0.015	0.111
2008	0.049	0.051	-0.016	0.888	0.023	-0.014	0.111

Table 4.10: Results of the aggregated analysis of the U.S. totals for different localities

π (20BBI) α_1	π (IPD) α_1	$P(\bar{G} - \bar{G})/\bar{B}$ α_2	$\ln\left(\frac{Y}{\bar{Y}}\right)P(\bar{G} + rB)/\bar{B}$ α_3	$P\bar{G}/\bar{B}$ α_4	Constant α_0	Obs.	R^2
<i>US local total</i>							
0.509*** (0.188)		-0.0513 (0.0794)	0.150 (0.173)		0.0404*** (0.0121)	47	0.191
0.810*** (0.258)		-0.101 (0.0834)	0.172 (0.170)	-0.0769 (0.0463)	0.0893*** (0.0318)	47	0.241
	0.432** (0.168)	-0.182** (0.0783)	0.150 (0.174)		0.0511*** (0.00881)	47	0.179
	0.457** (0.186)	-0.201** (0.0966)	0.156 (0.177)	-0.0126 (0.0375)	0.0610* (0.0306)	47	0.182
<i>US counties</i>							
0.975* (0.490)		-0.122 (0.212)	0.106 (0.489)		0.0364 (0.0364)	21	0.250
1.043** (0.444)		-0.219 (0.197)	0.338 (0.454)	0.0918** (0.0419)	-0.0863 (0.0649)	21	0.423
	0.964* (0.522)	-0.283 (0.211)	0.216 (0.493)		0.0551* (0.0295)	21	0.230
	0.616 (0.663)	-0.321 (0.217)	0.348 (0.519)	0.0513 (0.0595)	0.00706 (0.0631)	21	0.264
<i>US cities and townships</i>							
-0.0901 (0.344)		-0.151 (0.236)	-0.331 (0.563)		0.0863*** (0.0250)	21	0.114
-0.432 (1.042)		-0.191 (0.267)	-0.244 (0.630)	0.0898 (0.257)	0.0487 (0.111)	21	0.121
	-0.421 (0.349)	-0.0601 (0.231)	-0.385 (0.543)		0.102*** (0.0198)	21	0.180
	-0.531 (0.412)	-0.0338 (0.241)	-0.331 (0.564)	0.0514 (0.0964)	0.0728 (0.0583)	21	0.195
<i>US school districts</i>							
-2.220*** (0.446)		-0.0725 (0.0716)	-0.198 (0.160)		0.214*** (0.0301)	22	0.610
-3.040*** (0.444)		0.0312 (0.0666)	-0.356** (0.139)	0.0357*** (0.0112)	0.175*** (0.0273)	22	0.756
	-1.427** (0.503)	0.122 (0.0795)	-0.234 (0.205)		0.146*** (0.0289)	22	0.359
	-1.439** (0.511)	0.0758 (0.106)	-0.185 (0.220)	-0.00984 (0.0146)	0.172*** (0.0482)	22	0.376
<i>US special districts</i>							
0.591 (0.825)		0.720 (1.007)	0.552 (3.414)		0.0440 (0.0622)	21	0.142
-0.540 (0.884)		1.790* (1.011)	-3.703 (3.559)	-1.214** (0.525)	0.343** (0.141)	21	0.357
	1.174 (0.760)	0.522 (0.865)	-0.445 (2.924)		0.0227 (0.0446)	21	0.225
	0.625 (0.764)	0.988 (0.841)	-2.110 (2.857)	-0.892* (0.468)	0.212* (0.108)	21	0.368

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

Table 4.11: Results of the aggregated analysis of local totals for different regions and states

Regions/States	π (IPD)		$P(G - \bar{G})/\bar{B}$		$\ln\left(\frac{Y}{\bar{Y}}\right)P(\bar{G} + rB)/\bar{B}$		$P\bar{G}/\bar{B}$		Constant		Obs.	R^2
	α_1		α_2		α_3		α_4		α_0			
<i>Regions</i>												
Far West	0.222	(0.555)	-0.142	(0.0975)	0.0650	(0.248)	0.0531	(0.0837)	0.0134	(0.0576)	43	0.160
Great Lakes	-0.394	(0.332)	0.0743	(0.0947)	-0.116	(0.145)	0.0350	(0.0274)	0.0465**	(0.0212)	43	0.053
Mid Atlantic	0.366	(0.562)	-0.132	(0.0937)	0.447**	(0.196)	-0.00879	(0.0691)	0.0464	(0.0360)	43	0.125
New England	0.341	(0.290)	-0.0530	(0.0598)	0.288***	(0.0892)	-0.0235	(0.0219)	0.0626**	(0.0243)	43	0.233
Plains	0.205	(0.349)	0.200	(0.202)	-0.0859	(0.286)	-0.134	(0.0943)	0.172*	(0.0872)	43	0.132
Rocky Mountains	2.681***	(0.635)	0.0356	(0.248)	-0.170	(0.366)	0.224**	(0.0961)	-0.263**	(0.106)	43	0.439
Southeast	0.920***	(0.305)	-0.306*	(0.156)	0.577*	(0.322)	-0.0233	(0.0667)	0.0421	(0.0466)	43	0.263
Southwest	0.240	(0.358)	0.0134	(0.294)	1.094***	(0.303)	-0.0720	(0.0892)	0.111*	(0.0624)	43	0.539
<i>States</i>												
Alabama	-0.394	(0.731)	0.299	(0.398)	-0.302	(1.264)	-0.00953	(0.0326)	0.0992**	(0.0453)	43	0.026
Alaska	-1.164	(1.294)	-0.624**	(0.269)	1.578**	(0.670)	-0.216**	(0.0874)	0.230**	(0.0953)	43	0.209
Arizona	1.337*	(0.743)	-0.0775	(0.283)	1.223	(0.783)	-0.0756	(0.0624)	0.0425	(0.0550)	43	0.232
Arkansas	-1.250	(1.081)	1.008	(0.679)	-1.518	(1.228)	-0.0411	(0.0489)	0.171**	(0.0720)	43	0.076
California	1.383**	(0.571)	-0.375**	(0.176)	0.295	(0.341)	-0.00882	(0.0322)	0.00275	(0.0322)	43	0.198
Colorado	1.170*	(0.685)	0.193	(0.301)	0.236	(0.455)	-0.0229	(0.0628)	0.0268	(0.0467)	43	0.160
Connecticut	0.0516	(0.368)	0.0810	(0.101)	0.281	(0.174)	-0.00947	(0.0108)	0.0526**	(0.0242)	43	0.103
Delaware	-1.117	(0.995)	0.106	(0.371)	-1.475	(0.961)	-0.0435	(0.0414)	0.148**	(0.0679)	43	0.094
D. C.	-1.487	(0.989)	0.0170	(0.326)	0.437	(0.619)	-0.103**	(0.0490)	0.236***	(0.0731)	43	0.226
Florida	2.310***	(0.551)	-0.174	(0.149)	1.235*	(0.633)	-0.0723*	(0.0416)	-0.0170	(0.0366)	43	0.365
Georgia	0.741	(0.533)	0.0299	(0.154)	0.425	(0.404)	-0.0256	(0.0287)	0.0540	(0.0357)	43	0.091
Hawaii	-1.355	(1.449)	0.489	(0.330)	0.0715	(0.814)	0.168*	(0.0885)	0.0835	(0.0697)	43	0.152
Idaho	1.079	(0.797)	0.0538	(0.216)	0.254	(0.299)	0.0180	(0.0168)	-0.0270	(0.0538)	43	0.115
Illinois	-0.136	(0.487)	0.348	(0.289)	-0.452	(0.368)	0.0438*	(0.0225)	0.0394	(0.0271)	43	0.159
Indiana	-0.225	(0.760)	0.438	(0.370)	-0.131	(0.439)	0.0155	(0.0302)	0.0757	(0.0486)	43	0.037
Iowa	-0.564	(0.820)	1.045**	(0.449)	-0.425	(0.324)	-0.0220	(0.0256)	0.111*	(0.0551)	43	0.154
Kansas	1.313*	(0.702)	1.251	(0.939)	1.161	(0.772)	-0.0395	(0.0544)	0.00190	(0.0513)	43	0.222

Regions/States	π (IPD)		$P(G - \bar{G})/\bar{B}$		$\ln\left(\frac{Y}{\bar{Y}}\right) P(\bar{G} + rB)/\bar{B}$		$P\bar{G}/\bar{B}$		Constant		Obs.	R^2
	α_1		α_2		α_3		α_4		α_0			
Kentucky	-0.220	(0.634)	0.758	(1.220)	0.701	(1.086)	-0.144	(0.0951)	0.137***	(0.0471)	43	0.100
Louisiana	0.202	(0.564)	0.283	(0.495)	0.770	(0.485)	-0.0374	(0.0248)	0.0653*	(0.0379)	43	0.268
Maine	0.464	(0.665)	0.0692	(0.279)	0.605	(0.394)	-0.0466**	(0.0226)	0.0833*	(0.0455)	43	0.181
Maryland	0.934***	(0.329)	0.0276	(0.126)	-0.0647	(0.274)	-0.0489***	(0.0142)	0.0263	(0.0228)	43	0.381
Massachusetts	0.430	(0.406)	-0.250	(0.182)	0.512**	(0.224)	-0.0244	(0.0205)	0.0460*	(0.0266)	43	0.156
Michigan	-1.509***	(0.531)	1.077***	(0.386)	-0.590*	(0.316)	0.00723	(0.0220)	0.160***	(0.0330)	43	0.257
Minnesota	0.143	(0.846)	-1.225	(0.977)	-0.977	(0.903)	-0.0872	(0.0625)	0.103*	(0.0586)	43	0.093
Mississippi	0.588	(1.005)	0.0442	(0.490)	0.0993	(0.668)	-0.0185	(0.0348)	0.0426	(0.0666)	43	0.020
Missouri	-0.961*	(0.542)	0.313	(0.275)	-0.0794	(0.429)	0.0247	(0.0200)	0.104***	(0.0325)	43	0.099
Montana	1.059	(2.121)	-0.278	(0.731)	0.659	(0.734)	-0.00735	(0.0620)	-0.00133	(0.155)	43	0.027
Nebraska	-1.353	(0.811)	1.406*	(0.698)	1.792*	(0.977)	-0.0282	(0.0540)	0.164***	(0.0572)	43	0.242
Nevada	0.0798	(1.148)	0.0516	(0.265)	-0.326	(0.603)	0.0400	(0.0921)	0.0847	(0.0587)	43	0.038
New Hampshire	0.154	(0.508)	0.0306	(0.111)	0.477***	(0.161)	-0.0211	(0.0149)	0.0832**	(0.0342)	43	0.220
New Jersey	0.546	(0.360)	-0.249	(0.231)	0.349	(0.264)	-0.0152	(0.0151)	0.0401	(0.0242)	43	0.147
New Mexico	1.773**	(0.782)	-0.617	(0.560)	3.127***	(0.916)	-0.0377	(0.0356)	-0.0117	(0.0573)	43	0.327
New York	0.145	(0.419)	0.166	(0.230)	0.626**	(0.282)	0.0217	(0.0221)	0.0381	(0.0248)	43	0.187
North Carolina	1.321**	(0.591)	0.0486	(0.145)	-0.960*	(0.476)	-0.0139	(0.0314)	0.00821	(0.0399)	43	0.318
North Dakota	-0.147	(0.852)	0.303	(0.377)	0.0758	(0.259)	-0.0285	(0.0414)	0.0835	(0.0614)	43	0.033
Ohio	0.571	(0.433)	-0.401	(0.259)	0.244	(0.238)	-0.00364	(0.0155)	0.0233	(0.0248)	43	0.089
Oklahoma	1.365	(0.911)	0.544	(0.560)	0.276	(0.355)	-0.0295	(0.0374)	-0.00414	(0.0645)	43	0.171
Oregon	0.146	(0.629)	0.286	(0.462)	0.206	(0.440)	-0.00968	(0.0313)	0.0812*	(0.0422)	43	0.070
Pennsylvania	0.438	(0.876)	-0.407	(0.848)	0.392	(1.420)	-0.0619	(0.0686)	0.0654	(0.0551)	43	0.025
Rhode Island	-0.471	(0.529)	0.0795	(0.152)	-0.234	(0.258)	0.00918	(0.0144)	0.0657*	(0.0357)	43	0.048
South Carolina	1.161	(1.633)	-0.0380	(0.408)	0.269	(1.647)	-0.0419	(0.103)	0.0510	(0.0995)	43	0.020
South Dakota	0.249	(1.126)	-0.144	(0.472)	0.426	(0.380)	0.00659	(0.0430)	0.0549	(0.0864)	43	0.033
Tennessee	0.453	(1.282)	-0.880	(1.156)	1.382	(2.166)	-0.0243	(0.0826)	0.0538	(0.0811)	43	0.016
Texas	0.182	(0.376)	0.332	(0.291)	1.244***	(0.371)	-0.00414	(0.0351)	0.0724***	(0.0239)	43	0.477
Utah	4.666***	(1.069)	-0.486	(0.349)	2.851*	(1.579)	-0.0309	(0.108)	-0.186**	(0.0811)	43	0.404

Regions/States	π (IPD)		$P(G - \bar{G})/\bar{B}$		$\ln\left(\frac{Y}{\bar{Y}}\right) P(\bar{G} + rB)/\bar{B}$		$P\bar{G}/\bar{B}$		Constant		Obs.	R^2
	α_1		α_2		α_3		α_4		α_0			
Vermont	1.371	(1.212)	0.229	(0.376)	-0.358	(0.654)	-0.0201	(0.0330)	0.000949	(0.0841)	43	0.064
Virginia	-0.0198	(0.456)	0.258	(0.220)	0.0191	(0.483)	0.0103	(0.0257)	0.0700**	(0.0289)	43	0.056
Washington	0.156	(0.692)	0.0560	(0.529)	0.758	(1.022)	-0.0898	(0.0604)	0.0841*	(0.0495)	43	0.070
West Virginia	1.242	(0.958)	0.0819	(0.488)	1.863***	(0.619)	-0.156**	(0.0608)	0.0714	(0.0749)	43	0.266
Wisconsin	-0.00871	(0.410)	0.552**	(0.261)	-0.265	(0.208)	0.000907	(0.0177)	0.0660**	(0.0262)	43	0.133
Wyoming	0.686	(1.050)	-0.306	(0.183)	0.654**	(0.248)	-0.0551**	(0.0232)	0.0687	(0.0762)	43	0.225

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.12: Summary statistics of dependent and independent variables

<i>Counties</i>					
Variables	N	Mean	SD	Min	Max
Counter	134	0.58	0.50	0	1
Counter (boom)	125	0.51	0.50	0	1
Counter (bust)	131	0.66	0.48	0	1
property tax / own revenue	147	0.43	0.10	0.12	0.64
taxes / total revenue	147	0.70	0.07	0.49	0.84
grants / total revenue	147	0.08	0.04	0.02	0.20
infrastructure / total expenditure	147	0.21	0.07	0	0.39
per capita property tax (,000)	147	0.34	0.54	0.01	5.26
per capita expenditure (,000)	147	0.84	1.61	0.02	16.13
per capita infrastructure expenditure (,000)	147	0.18	0.45	0	4.49
debt outstanding / revenue	147	0.19	0.18	0	1.39
fund balance / revenue	147	0.11	0.10	-0.34	0.29
per capita income (,000)	147	20.22	4.50	8.79	45.95
population (,000)	147	56.97	114.29	1.69	811.99
population growth (1/1000)	147	0.01	0.01	-0.05	0.06
government form	147	2.66	0.90	1	4
<i>Municipalities</i>					
Counter	369	0.52	0.50	0	1
Counter (boom)	337	0.49	0.50	0	1
Counter (bust)	359	0.51	0.50	0	1
property tax / own revenue	418	0.11	0.10	0	0.66
grants / total revenue	418	0.08	0.10	0	0.84
infrastructure / total expenditure	418	0.48	0.17	0	0.89
per capita property tax (,000)	416	0.12	0.21	0	3.57
per capita expenditure (,000)	416	1.10	0.99	0.01	9.45
per capita infrastructure expenditure (,000)	416	0.59	0.74	0	8.48
debt outstanding / revenue	418	0.43	0.51	0	4.49
fund balance / revenue	418	0.12	0.10	-0.32	0.56
population (,000)	416	7.49	27.82	0.09	440.23
population growth (1/1000)	414	0.20	1.85	-0.40	31.33

Table 4.13: Determinants of countercyclical debt use for Georgia counties

Variables	(1) All	(2) Boom	(3) Boom (metro)	(4) Boom (non-metro)	(5) Bust	(6) Bust (metro)	(7) Bust (non-metro)
property tax / own revenue	4.19* (2.45)	4.58 (3.01)	8.92 (5.66)	5.45 (4.81)	5.92* (3.35)	5.43 (5.64)	11.44* (6.58)
grants / total revenue	10.33* (6.23)	9.06 (7.10)	7.58 (12.80)	8.56 (10.71)	0.37 (7.98)	-26.47 (21.70)	33.71* (17.33)
infrastructure / total expenditure	-4.23 (3.36)	2.85 (3.54)	12.85* (6.95)	-5.70 (6.19)	-7.52* (4.12)	-3.97 (7.54)	-7.33 (7.45)
per capita expenditure (,000)	0.01 (0.12)	-0.01 (0.13)	1.02 (0.75)	-0.13 (0.46)	0.26 (0.23)	0.39 (0.45)	0.30 (0.30)
debt outstanding / revenue	3.46** (1.61)	3.21* (1.79)	9.56** (4.00)	2.23 (2.84)	0.21 (1.84)	-2.40 (2.76)	9.89** (4.87)
fund balance / revenue	2.15 (2.62)	4.80* (2.84)	2.81 (5.02)	7.70* (4.53)	0.47 (3.49)	-5.62 (7.04)	-1.16 (5.45)
Constant	-7.70 (5.35)	-1.47 (6.13)	-2.84 (5.80)	-13.79 (21.11)	2.56 (5.14)	-13.32 (8.70)	-20.13 (25.85)
Observations	127	97	49	48	91	47	44
Pseudo R^2	0.170	0.115	0.142	0.154	0.152	0.329	0.316

Notes: Logit regressions are used, and the coefficients are marginal effects. Only counties with at least 5 year's data were included in the regression, which is why the number of observations is smaller than the number of counties (159). Controls variables are included but not shown here. Standard errors in parentheses. Significance levels are: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.14: Determinants of countercyclical debt use for cities

	(1) All	(2) Boom	(3) Bust
property tax / own revenue	-0.80 (1.25)	-1.26 (1.82)	-1.54 (1.42)
grants / total revenue	-1.57 (1.79)	1.32 (2.54)	-2.64 (1.90)
infrastructure / total expenditure	-1.88** (0.82)	-2.31* (1.20)	-1.38 (1.02)
per capita expenditure (,000)	0.13 (0.13)	-0.12 (0.15)	0.15 (0.14)
debt outstanding / revenue	-0.26 (0.21)	0.04 (0.36)	-0.12 (0.25)
fund balance / revenue	1.44 (1.26)	-3.75** (1.87)	2.72* (1.44)
population (,000)	-0.01 (0.01)	-0.00 (0.00)	-0.01 (0.00)
population growth	-0.51 (0.46)	-0.79 (1.00)	-0.10 (0.13)
Constant	1.10* (0.59)	1.83** (0.86)	0.79 (0.68)
Observations	349	227	295
Pseudo R^2	0.031	0.037	0.029

Notes: Logit regressions are used, and the coefficients are marginal effects. Only municipalities with at least 5 year's data were included in the regression.

Robust standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.15: The effects of counter-cyclical debt use on expenditure stability

Counter-cyclical debt	All		Boom		Bust	
	Yes	No	Yes	No	Yes	No
County						
No. of counties	52	101	75	77	45	108
Revenue Gap	14.7%	10.5%	9.8%	9.0%	-18.2%	-12.7%
Expenditure Gap	12.6%	10.4%	10.0%	12.2%	-3.2%	-6.3%
Difference	-2.1%	-0.1%	0.2%	3.3%	-15.0%	-6.5%
DID (t-test, left)	-2.0%		-3.1%		-8.8%**	
City						
No. of cities	177	192	173	164	175	184
Revenue Gap	21.9%	20.3%	15.1%	15.4%	-26.5%	-22.4%
Expenditure Gap	15.7%	16.8%	2.7%	2.8%	-11.1%	-11.4%
Difference	-6.3%	-3.4%	-12.4%	-12.6%	-15.4%	-11.0%
DID (t-test, left)	-2.8%*		0.2%		-4.4%*	

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

Notes:

1. The gaps of revenue and expenditure (and debt) are calculated as the percentage in deviations of real values from predicted values based on the time trend.
2. Whether a localities is using debt counter-cyclically or pro-cyclically are based on the relationships between debt gap and revenue gap. If revenue gap and debt gap both are positive or negative, the debt is pro-cyclical; if one is positive and the other is negative, the debt is counter-cyclical. The results are based on coefficients of regressions.
3. For the first two columns, gaps are in absolute values, i.e., all deviations are recalculated as positive values including those of recession years. The other columns are in original gaps (positive or negative).
4. The number of counties and cities are different due to the data availability. Some counties/cities do not have debt at all and some of them only have debt in occasional years which is not enough to calculate whether it is pro-cyclical or counter-cyclical.

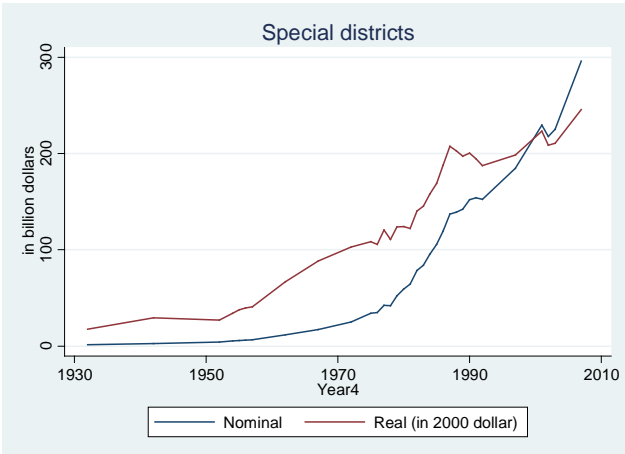
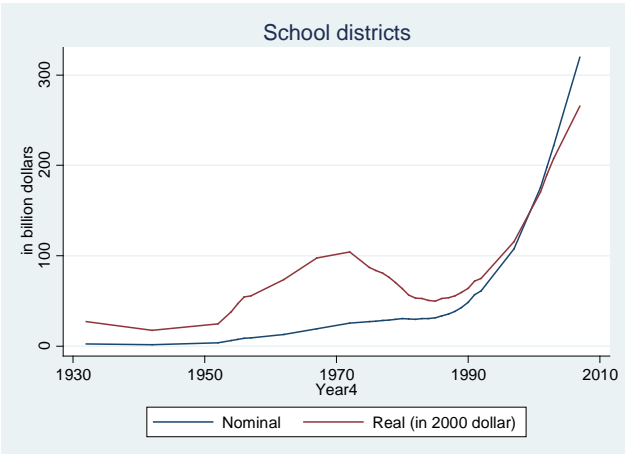
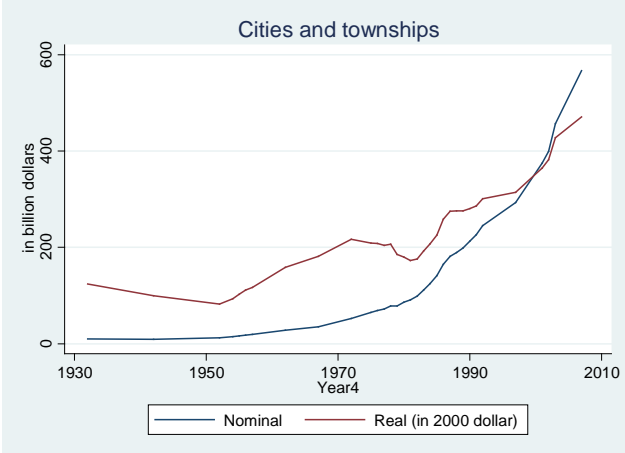
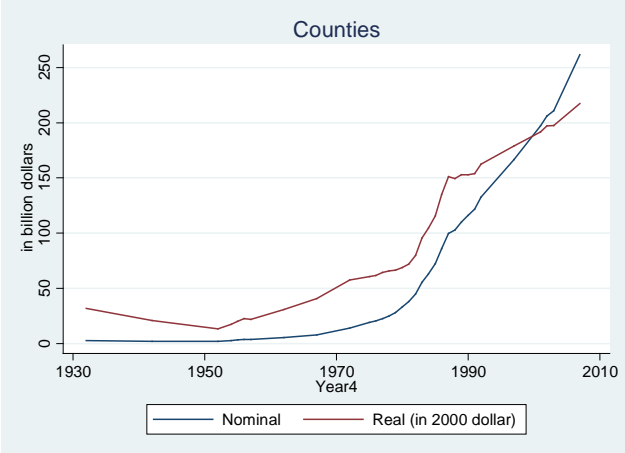
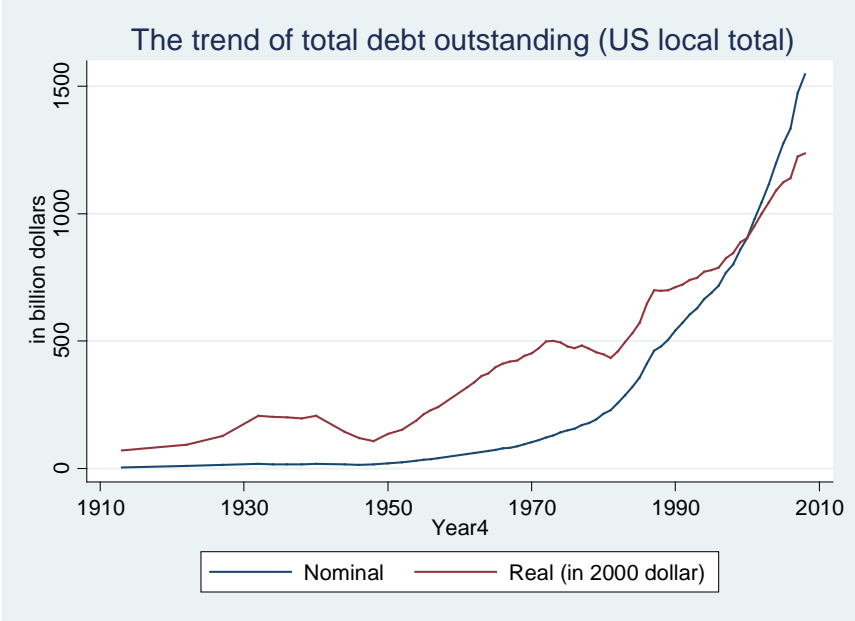


Figure 4.1: The trend of total debt outstanding for the U.S. local totals for different localities

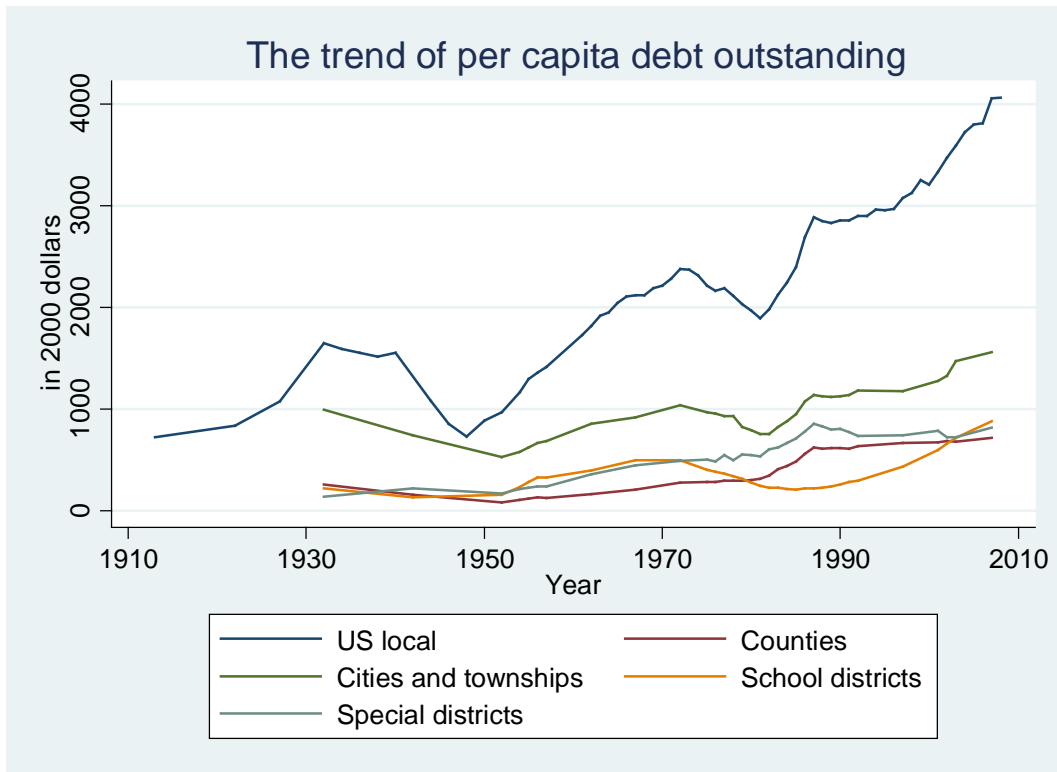


Figure 4.2: The trend of per capita debt outstanding (real in 2000 dollars) for localities

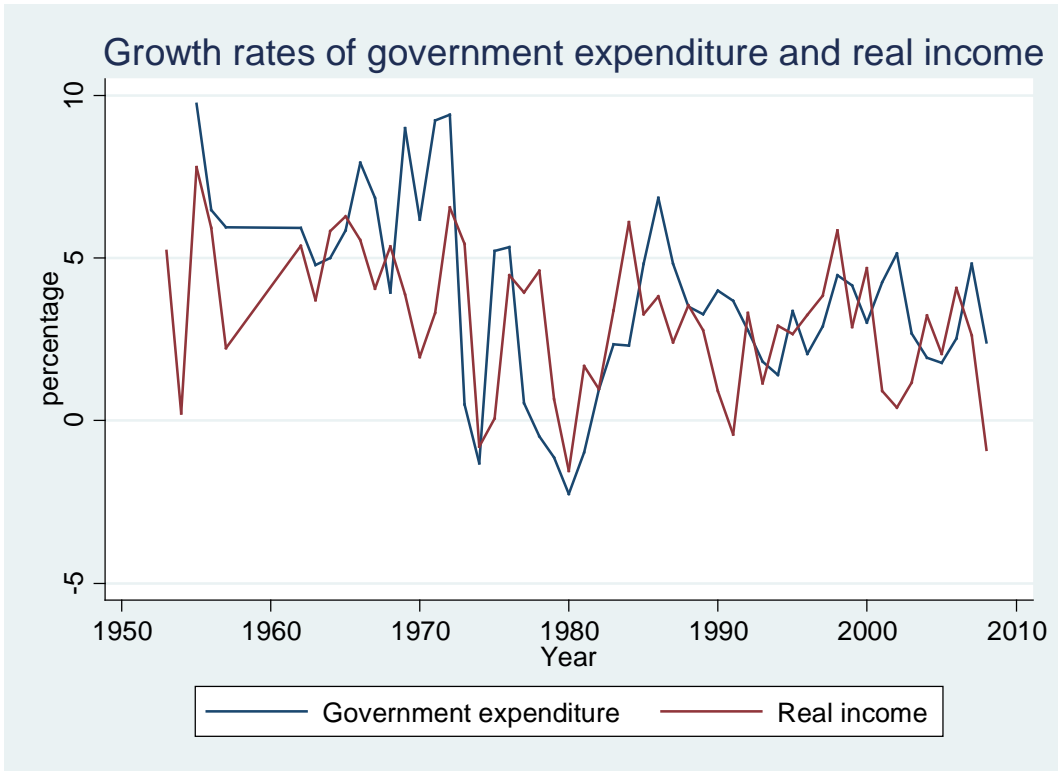


Figure 4.3: The trend of the growth rate of real government expenditure and real income for the U.S. local total

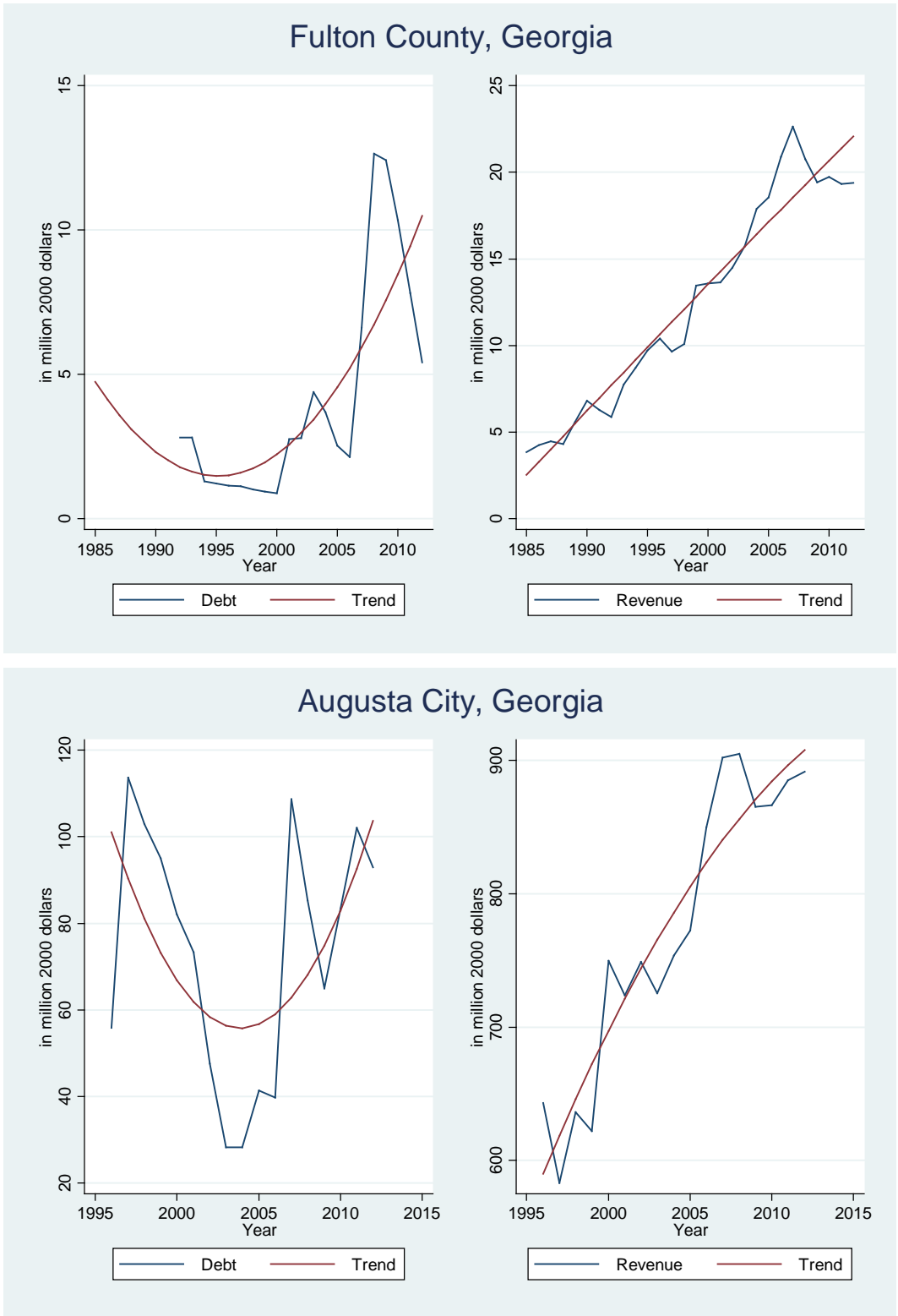


Figure 4.4: Trends of long-term debt outstanding and total local revenue for two sample localities

CHAPTER V

5. THE EFFECTS OF PROPERTY TAX AND INFRASTRUCTURE INVESTMENT ON LOCAL OWN-SOURCE EXPENDITURE STABILITY

5.1 Introduction

In public expenditures, the spending patterns of state and local governments differ substantially from state to state. However, for the assignment of service responsibilities among different levels of government in the U.S., Shah (2006, p. 330) summarizes that, conforming to economic theory, services for which benefits are primarily local are assigned to local governments, while the responsibility of social welfare programs is commonly “shared between the central and subnational jurisdictions.” Local governments in the United States play a very important role in public expenditures; as of 2011, among state and local governments, local expenditures account for more than 50 percent (around 52.3%) of total direct expenditures excluding intergovernmental transfers. Since welfare programs are often funded by federal and/or state governments, if I calculate direct expenditures besides public welfare, local expenditures represent around 60 percent of expenditures for state and local governments.⁶⁴

During recessions, governmental agencies without preparations will encounter unexpected difficult times. On the one hand, government revenue will continue to fall because of significant decreases in taxes on corporate income and individual income as well as on

⁶⁴ The data is retrieved from the U.S. census (Source: <http://www.census.gov/govs/local/>). Direct expenditures include spending on current operations, capital outlay, interest on debt, and transfer payments to individuals (excluding intergovernmental transfers). As of 2011, the expenditure on public welfare occupies 29.1% of direct expenditures for state governments and only 3.2% for local governments.

consumption sales. On the other hand, to help people suffering during recession years, government expenditures need to increase greatly due to the increased use of existing public programs and the creation of new programs. Local governments face even more pressure due to limited fiscal tools constrained by balanced budget requirements and debt restrictions. Combined with the significance of local expenditures in service provision, maintaining the stability of local expenditures is really an important task for local governments and an essential component of social welfare for local residents. The fluctuations in government expenditure also add considerable complexity to fiscal management, rendering ineffective development planning (Lim, 1983; Prest, 1962, p. 13), reducing business confidence and leading to a lower level of investment (Idachaba, 1975, p. 98; Macbean, 2011, p. 247).

While the conventional theory of public finance analytically separates revenue and expenditure, as mentioned in Wagner (2007, p. 126), the two sides of the budget are not independent with the connection of the generation of revenue and legislative appropriation. Especially for local governments, with property tax as the most important own source revenue, the natural connection between tax and service is internally established. However, while there have been many studies investigating government revenue diversification and revenue stability (Carroll, 2005, 2009; Hendrick, 2002; Suyderhoud, 1994; Yan, 2012), very few has directly addressed the issue of expenditure stability/fluctuations.⁶⁵

Therefore, in this essay, I ask: how can the revenue structure contribute to the stability of local government expenditure, among other determining factors? Specifically, because different types of taxes have different elasticity, I am especially interested in what role property tax has played in stabilizing local expenditure. Besides revenue streams, how do the expenditure

⁶⁵ For instance, as noted in Samuelson (1958), in Pigou's *A study in Public Finance*, 1928 (Pigou, 1947), there are 200 pages on taxes, while there are only 20 pages on expenditures.

structures themselves, such as the categories of expenditure (capital outlay or daily service), influence local expenditure fluctuations?⁶⁶ As mentioned above, local public expenditures are a significant part in total public spending, and public programs are in high demand by residents during recession years. Thus, decreased fluctuation of local expenditure could largely increase the welfare of citizens. Moreover, public expenditure creates positive externalities both in the production and the consumption sectors (Cazzavillan, 1996). At the local level, this chapter is the first study to directly investigate local expenditure stability, and it will contribute to the literature by providing a clear picture of how to address local government expenditure instability based on certain revenue structures and expenditure characteristics, particularly when facing economic fluctuations.

The rest of this chapter is organized as follows. The second section provides a brief literature review on public expenditure theory and empirical evidence on expenditure changes and/or fluctuations. The theory and hypotheses sections follow in the third section. The fourth section describes data from Georgia counties and municipalities used in this chapter, and the fifth section investigates the methodology and offers analytical results. The final section concludes and discusses the implications and limitations of this chapter.

5.2 Literature Review

Based on the broad picture in the United States, Schroeder (2006) intensively analyzes the services and expenditures of state and local governments. He argues that capital spending is time-sensitive (“lumpy”), transfer payments depends highly on economic conditions, and interest on debt depends on past debt stock and the interest rate. He focuses only on current operations

⁶⁶ Except this category, another perspective of expenditure structure is the method of service provision, such as self-providing or contracting out. A detailed investigation is the topic of another article.

excluding the above categories. He concludes that for the fundamental services, including primary and secondary education, libraries, and police and fire protection, as well as ordinary local utilities, such as water, sewerage, and solid waste disposal, local governments are the predominant providers, and they occasionally provide electricity and gas. Also, due to decentralization, depending on the relative preferences for public services, substantial differences exist in how subnational governments allocate their budgets.

With regard to the determinants of public expenditure, Alt and Chrystal (1981) summarize five separate strands of literature on the growth of public expenditures and revenue.⁶⁷ Then, using data from Britain and the United States, they test several models of public expenditure growth, including permanent income, electoral cycle models and stabilization policy models, and find that public expenditure grows proportionally to national income, electoral-cyclical factors are unimportant determining factors of government expenditure, and more related to this essay, there is a limited role for public expenditure in economic stabilization policies. The authors' argument is that government expenditures grow in proportion to national income, because it is convenient for politicians to plan it this way, and the plans once made are difficult to change. Thus, government expenditures are not used much as a part of stabilization policies. In reality, since it was been found to be difficult to adjust public expenditure flexibly in response to short-term fluctuations, the stabilization problem was mainly handled with revenues in the budget (Alt & Chrystal, 1981). Using impulse response functions from ARMA models and Cochrane's non-parametric method, Goff (1998) also finds that in the aggregate, government spending displays strong persistence to temporary shocks, simple decomposition methods have a

⁶⁷ The five strands can be briefly described as follows: (1) redistributive legislation (Alt, 1979; Frohlich & Oppenheimer, 1984; Meltzer & Richard, 1976); (2) the cost-benefit approach (Buchanan & Wagner, 1977; Weingast, Shepsle, & Johnsen, 1981); (3) countercyclical economic policy (Knott, 1978); (4) politicians' ambitions to gain reelection (Frey & Schneider, 1978b; Tufte, 1980); and (5) elected politicians maximize support by aiding a particular client group (Frey & Schneider, 1978a).

weak statistical foundation, and this persistence in spending has increased during the 20th century. Finally, the displacement effect supports interest group and bureaucracy models of government spending growth (Goff, 1998). According to the results of 44 British county boroughs, Alt (1971) concludes that significant associations between expenditure levels in certain public service areas and both socio-economic and political variables exist, which could be taken as corroborating evidence of the persistence in expenditure.

At the federal level, by analyzing the causal relations between federal expenditure and taxation, Hoover and Sheffrin (1992) find that before the mid-1960's, at some point, taxes caused spending, and after the late 1960's, taxes and spending were causally independent. From the perspective of comparative politics, they argue that there is a lack of causal ties between taxes and spending, because unlike parliamentary democracies, the United States has many important actors with divergent interests and agendas, making budgetary and tax initiatives disconnected.

According to the properties of a neoclassical growth model with a government sector and corresponding simulation, Ambler and Paquet (1996) assume that the government maximizes the welfare of a representative private agent and conclude that, in the optimal policy path, current expenditures should behave similarly to private consumption and public investment should behave very much like private investment spending. They also find that in the U.S. data, similar to private consumption expenditures, government nonmilitary expenditures are less volatile than output, while public investment spending is substantially more volatile than output, as is private investment spending. Compared to and compatible with the data, their model predicts that total government spending (including both nonmilitary and military) should have about the same volatility as total output. In terms of government spending shocks, Ramey (2011) reexamines the empirical evidence for estimating the effects of government spending and finds that the implied

government spending multipliers range from 0.6 to 1.2. This paper also reviews the trends and fluctuations in the components of government spending and concludes that defense spending accounts for almost all of the volatility in government spending.

Built on the classic model of budget incrementalism and the model of disproportionate information processing, Breunig, Koski, and Mortensen (2010) analyze the stability and punctuations in public spending within and across Denmark and the United States. They find similar tendencies at the aggregated level with substantial variation between categories of public spending. Thus, they suggest focusing on more disaggregated spending dynamics and to unpack the overall budgets for detecting the particular sources of stability and changes in public expenditure. Hou (2005) addresses the effects of fiscal reserves on own-source expenditure at the state level; since during recessions, the federal government may increase aid to states, he considers only state own-source expenditure (calculated as total expenditure minus public welfare spending). He finds that fiscal reserves do exert positive effects on state own-source expenditure in downturn years, with budget stabilization funds (BSF) having a much larger effect than general fund surpluses (GFS). Taking expenditure/spending stability as the goal of fiscal reserves (i.e., the countercyclical fiscal capacity, CCFC), Hou and Moynihan (2008) use “budget cut”/“revenue action”/“net revenue change” to measure program stability, find that the CCFC is efficient for maintaining program stability and argue for greater investment in this capacity of government.

For developing countries, based on a sample for 24 developing countries during the 1973–1992 period, Schuknecht (2000) finds that election-oriented fiscal policy making in developing countries mainly affects public expenditure, that is, increasing public expenditure rather than lowering taxes, and public investment cycles are particularly prominent in this

process. Focusing on a group of 45 less developed countries (LDC) over the period 1965-1973, Lim (1983) estimates the instabilities in government revenue and expenditure, examines the effect of revenue instability and other factors on expenditure stability, and decomposes the contributions of various sub-categories of expenditure to the instability of public expenditure. The conclusion is that revenue instability was the main 'cause' of spending instability, and the availability of international reserves, domestic and foreign borrowing and foreign grants dampen the destabilizing effects of revenue fluctuations.

Most of the public spending literature, including the above, either theoretically and/or empirically addresses the determinants of public expenditure itself or studies the effects of certain political/economic factors or institutions on public expenditure stability/fluctuations. Very few have directly investigated the public expenditure stability over economic cycles, especially at the local level, for a long time period given the importance of local expenditure in service provision.⁶⁸ For local governments, since property tax is the main and a stable own revenue source and a natural link exists between property tax and service provision, the relationship between revenue structure and expenditure stability highlights the key role of property taxation in the interesting research question. The division of capital outlay and service expenditure further complicates this question and makes this research interesting and promising, both for its contribution to the literature and to practical policy implications.

5.3 Theory and Hypotheses

During recession years, the fluctuation of the economy will influence all sectors directly through its effect on personal income. In these years, household income will decrease due to

⁶⁸ Lim's (1983) research questions share some similarities with this paper; however, this is a rough cross-country correlation analysis based on less developed countries (LDC), and there is no investigation on how revenue instability and sub-categories of expenditures may influence government expenditure instability.

fewer job opportunities, and the government revenue from income and sales taxes will shrink, correspondingly. On the other hand, as the most important source of local own-source revenue, property tax is often regarded as the most stable revenue source during recessions for localities. Thus, the revenue structure has a direct impact on the fluctuation of public good provision. For instance, when we assume that there are three revenue sources (property tax, local sales tax, and intergovernmental grants) for local governments, in heterogeneous communities, the local government provides public goods under a budget constraint as follows:⁶⁹

$$g = \frac{\sum_i^N (PH_i \tau^* + C_i t) + A}{C(N)N^\alpha} = \frac{(c_2 - c_3)\tau^* \sum_i^N Y_i}{(c_1 + c_2)C(N)N^\alpha} + \frac{c_1 \sum_i^N Y_i}{(c_1 + c_2)(1 + t)C(N)N^\alpha} + \frac{A}{C(N)N^\alpha}$$

The three parts of the right side in the above equation indicate the effects of three different revenue sources on the provision of public goods. We can denote revenue composition as the following three parts:

$$R = T_P + T_S + A$$

where R is total local revenue, T_P is property tax revenue, T_S is local sales (and other) tax revenue, and A is intergovernmental grants. Introducing the time variable into the equation, we get an equation over the economic cycle:

$$\sum_t R_t = \sum_t T_{Pt} + \sum_t T_{St} + \sum_t A_t.$$

I assume, as evidenced in the empirical literature, that the income elasticity of sales tax (T_{St}) is larger than the elasticity of property tax (T_{Pt}) (Kurnow, 1963; Saez, 2001; Sexton & Sexton, 1986). The elasticity of intergovernmental grants (A_t) from higher level(s) of government on personal income should be counter-cyclical to help provide for the increased demand for public goods during recession years (Sjoquist, Stavick, & Wallace, 2007); however, A_t has also been

⁶⁹ See Chapter 3 for more details.

found to be pro-cyclical (Reschovsky, 2003). Thus, the income elasticity of local government revenue heavily depends on the revenue composition of each local government. If we denote σ as the share of property tax in total revenue,

$$T_P = \sigma_1 R,$$

since

$$E_R = \frac{\partial R/R}{\partial Y/Y} = \frac{\partial(T_P + T_S + A)/(T_P + T_S + A)}{\partial Y/Y}$$

i.e.,

$$E_R = \frac{\partial R/R}{\partial Y/Y} = \frac{\partial T_P/T_P}{\partial Y/Y} \cdot \frac{T_P}{T_P + T_S + A} + \frac{\partial T_S/T_S}{\partial Y/Y} \cdot \frac{T_S}{T_P + T_S + A} + \frac{\partial A/A}{\partial Y/Y} \cdot \frac{A}{T_P + T_S + A},$$

we get:

$$E_R = \sigma_1 E_{T_P} + \sigma_2 E_{T_S} + \sigma_3 E_A.$$

where E is elasticity, and σ is the ratio of each type of revenue in the revenue compositions. Due to the different characteristics and tax design of taxes, the elasticity of taxes can be diverse. Therefore, the revenue structure (i.e., the shares of different revenue sources) is an important indicator of the elasticity of revenue, thus has an essential effect on expenditure elasticity/instability.

Another way to measure revenue (or expenditure) volatility is to determine the extent to which actual revenue differs from expected revenue, which was originated by White (1983), applied in some previous research (Braun & Otsuka, 1998; Dye & McGuire, 1991) and further developed and used in several recent studies (Carroll, 2009; Carroll & Stater, 2009; Hou, 2005). For each locality, the revenue growth trend was described as (Carroll & Goodman, 2011):

$$R_{it} = \exp(\alpha + \beta t)$$

where total general revenue R_{it} of each locality is modeled as a function of a time variable year t . The absolute deviations of the residuals from the regression equations as percentages of predicted values serve as a measurement of revenue volatility. Each absolute value of residuals represents the difference between the actual revenue for municipality i in year t and the predicted revenue based on the municipality's unique expected growth trend.

In terms of the time trend of expenditures, built on Goff (1998), I assume that

$$E_t = E_0 e^{(1+\mu)rt}$$

where E_0 is the starting level of expenditure, r is the growth rate of revenue, and μ is a stationary disturbance term, which can have impacts for k periods with $E(\mu) = 0$. Reorganizing this equation, we get:

$$\ln(E_t) = \ln(E_0) + (1 + \mu)rt.$$

Thus, the expenditure gap can be denoted as⁷⁰

$$gap = \ln(E_t) - \ln(\hat{E}_t) = \mu rt \text{ and } \frac{d(gap)}{dt} = \mu r$$

where \hat{E}_t is the predicted value (normal trend) of E_t . From this equation, we can easily find that the gap/fluctuation of public expenditure is a function of revenue changes r and the disturbance term μ , which can be influenced by economic volatility and expenditure compositions.

The local infrastructure, as a type of public good, has a unique characteristic in this framework. Capital projects usually cannot be finished within one fiscal year but always extend to as long as three fiscal years, and projects often start in boom years under better fiscal conditions. When a recession comes, the outlay on these projects needs to continue without suspension, which may smooth the disturbance term over years. This phenomenon makes those

⁷⁰ Since $E_t/\hat{E}_t \rightarrow 1$, $\ln(E_t) - \ln(\hat{E}_t) = \ln(E_t/\hat{E}_t) \cong E_t/\hat{E}_t - 1$, which is the percentage of deviation from the trend.

local governments with more local infrastructure projects experience more difficult times during recessions. Thus, the investment decision-making process of local infrastructures is very important for a local government. Our expectation is that local governments with lower revenue elasticity are more likely to start a big project involving investment in their infrastructure. With the local infrastructure expenditure stickier (not as pro-cyclical as other public expenditures), we may further expect that local governments with more local infrastructure investments will experience less decrease during recession years.

Based on these arguments, I have the following hypotheses, of which the implied assumption is that the elasticity of property tax is smaller than other taxes and revenue sources and the intergovernmental transfers are countercyclical:

H1: Revenue stability is the main cause of expenditure stability. The higher the elasticity of tax/revenue structure is, the lower the public expenditure stability.

H1a: The higher the property tax as a percentage of total revenue or total tax revenue is, the higher the revenue stability and thus expenditure stability.

H1b: The higher the intergovernmental grants as a percentage of total revenue or total tax revenue is, the higher the revenue stability and thus expenditure stability.

H1c: The higher the sales tax as a percentage of total revenue or total tax revenue is, the lower the revenue stability and thus expenditure stability.

H2: The higher the proportion of local infrastructure investment in total expenditure is, the higher the expenditure stability during recession years.

H2a: Local infrastructure projects lasting for more years, such as highways, have larger impacts on increasing expenditure stability during recession years.

H3: The impacts of revenue structure and expenditure compositions on expenditure stability may be different for counties and municipalities.

5.4 Data

In this essay, I use the local government data from the State of Georgia. I compiled a balanced panel data set that includes all counties and municipalities in Georgia from 1985 to 2011. The data sources are the Georgia Department of Community Affairs, Georgia Department of Revenue, and the U.S. census. The data set includes revenue and expenditure structures and other fiscal characteristics of localities for each year. In the data set, to eliminate erroneous input, I delete all observations with the expenditure at least 50% higher or lower than the revenue. Finally, the cleaned data include 155 counties and 534 municipalities. Using this data set, I examine the effects of revenue and expenditure compositions on the local government spending instability.

Figure 5.1 provides a brief comparison between the trends of revenue and expenditure for counties and municipalities in Georgia. We can easily find that for counties, conforming to Alt and Chrystal's (1981) findings at the national level, real per capita expenditure is much smoother than real per capita revenue. For municipalities, however, the difference between revenue and expenditure is small, and both series exhibit larger fluctuations than those of counties. The mechanisms of these differences are interesting and will be investigated further in more detail in the following sections of this chapter.

[Figure 5.1 about here]

Decomposing the categories/compositions of local revenue and expenditures, Figures 5.2 and 3 show that different revenue sources and expenditure compositions reveal very distinct levels of fluctuation over economic cycles. In Figure 5.2, the trend of real property tax revenue is very flat and smooth, while non-property tax revenue has a very similar fluctuation with total revenue. For expenditure, infrastructure investment is smooth while non-infrastructure expenditure is volatile. Figure 5.3 offers more details. For counties, the intergovernmental grants are stable, while sales tax is very volatile; the government operation cost is stable, and other services, including health and welfare, culture and recreation, and housing and development are very volatile. For municipalities, a similar style applies, while each revenue source has higher fluctuations than that of counties, and each expenditure composition has lower fluctuation.

[Figures 5.2 and 5.3 about here]

The differences of revenue and expenditure stability between counties and municipalities and between revenue and expenditure within counties or municipalities highlight the interest in the connection between revenue stability and expenditure stability and the roles of property tax and infrastructure investment among them. The tradeoffs between the elasticity of different revenue sources plays an important role in stable revenue and thus in the effect on expenditure stability. Based on the data set, in Table 5.1, we calculate the elasticity of different revenue sources for Georgia local governments at different time periods. Generally, the preliminary results indicate that the elasticity of property tax is lower than the elasticity of local sales tax, which is consistent with existing studies. When I divide counties into metro and non-metro counties, the elasticity of property tax is higher for metro counties than non-metro counties, while the elasticity of local sales tax is lower for metro counties. This difference implies that the

property tax base (property value) is more volatile in urban areas, and the local sales tax is more volatile in rural areas, because rural (poorer) residents have apparently more limited budget constraints during recession years and are more vulnerable to economic downturns. Thus, state transfer, as a tool for stability and consumption smoothing, has lower elasticity in rural areas. Especially during the recent recession, the difference of the elasticity of state transfer between urban and rural areas is very significant.

[Table 5.1 about here]

5.5 Methodology and Results

This section presents the methodology and results of the investigation. I first calculate the expenditure instability measured by the expenditure gap and expenditure variation/volatility. Finally, I discuss the results and offer considerations for further research.

5.5.1 Expenditure gap

As discussed in the theory section, following previous studies, I use the expenditure gap to calculate the public expenditure instability.

$$\ln(E_{it}) = \beta_0 + \beta_1 t$$

where total public expenditure E_{it} , similar to revenue, is modeled as a function of time variable year t and $n-1$ dichotomous variables identifying each local government i . The absolute value of the residuals from this regression equation is the measurement of expenditure volatility.⁷¹

Therefore, the expenditure instability is denoted as the absolute percentage change:

$$\text{Expenditure gap} = |\ln(E_{it}) - \ln(\hat{E}_{it})| \cong |E_{it}/\hat{E}_{it} - 1|$$

[Figure 5.4 about here]

⁷¹ I also use the curvilinear time trend model $\ln(E_{it}) = \beta_0 + \beta_1 t + \beta_2 t^2$ as validity test.

Note that the gap here includes both positive and negative gaps with positive gaps often preferred by the government while attempting to avert negative gaps. I use absolute values to measure the expenditure instability as the dependent variable. The Kernel density estimate of expenditure gap for both counties and municipalities is displayed in Figure 5.4 and is very close to the normal distribution. The independent variables include revenue instability, which is measured in the same way, expenditure compositions, especially the share of infrastructure investments, and other control variables. Summary statistics of all relevant variables are provided in Table 5.2. Property tax and sales tax account for around 40% and 30% of the total revenue for counties and around 10% and 40% for municipalities. For infrastructure investment, on average, it accounts for 20% and 50% of total expenditures for counties and municipalities, respectively.

[Table 5.2 about here]

Another way to measure the stability of expenditures is the coefficient of variation (CV):⁷²

$$CV_{it} = \frac{\sigma}{\mu} = \frac{\text{standard deviation}}{\text{mean}}$$

where μ and σ are the mean and standard deviation of the expenditure gap (percentage) across years for each county/municipality. The drawback of this measurement and relative mean difference is that, instead of a panel data set, this measurement provides only one value for each locality. This cross-sectional analysis can be used for the validity test of both measurement (gap vs. CV) and modeling (panel vs. cross-sectional).

⁷² Another alternative measurement is the relative mean difference (Persky, 1990): $d = \frac{1}{n} \sum |v_i - m|/m$, where n is the number of observations over years, v_i is the value of the i^{th} year of the expenditure gap and m is the average value of all expenditure gaps. Similar to the Gini coefficient, this statistic is a measure of the spread in a distribution.

5.5.2 Empirical models

Using the above model, I calculate the gap in the expenditures as the dependent variable. The key independent variables are revenue structure (including property tax, sales tax, and intergovernmental grants) and expenditure compositions, of which property tax gap and infrastructure investment as a ratio of total local expenditures are our focuses. The control variables include per capita property tax, per capita infrastructure expenditure (in 1000), per capita total expenditure (in 1000), per capita personal income (in 1000), per capita income (square), unemployment rate, population growth, population structure (age and race), debt burden (measured as debt outstanding as a ratio of total revenue), per pupil education expenditure (only for school districts), and form of government. I use fixed effects to estimate the panel data set and use cross sectional analysis as a validity test when applying the coefficient of the variable. The fixed effects model is as follows.

$$gap_{it} = \beta_0 + \beta_1 property_{it-1} + \beta_2 invest_{it-1} + \gamma X_{it-1} + \mu_i + \delta_t + \varepsilon_{it}$$

where gap is expenditure gap, $property$ is property tax ration, $invest$ is infrastructure investment ratio, X is a vector of control variables, and μ_i , δ_t , and ε_{it} are county/municipality, year, and the error term respectively. All independent variables are 1-year lagged to avoid endogeneity problems. If we use the coefficient of variation (CV) to measure expenditure fluctuation for each locality, the model changes to the cross sectional model as:

$$CV_i = \beta_0 + \beta_1 property_i + \beta_2 invest_i + \gamma X_i + \varepsilon_i$$

where CV_i is the coefficient of variation for each locality based on values of the expenditure gap each year. X_i is a vector of controls including variables that cannot be captured by a fixed

effects model, such as population structure (age and race), urban density and form of government.

5.5.3 Results and validity test

Table 5.3 provides the results of fixed effects models estimating the effects of revenue structure and expenditure compositions on expenditure stability, measured by the expenditure gap for each county in each year. As hypothesized, revenue stability is the main cause of expenditure stability; around 10% of the revenue gap will be spread/diffused directly into the expenditure gap. The share of infrastructure investment in local expenditure does contribute to the stabilization of the expenditure. A 100 percent increase in the infrastructure investment share can decrease 5% of the expenditure gap, which is sizeable, while the mean of the expenditure gap is only around 11%. This result implies that the infrastructure investment tends to stabilize local expenditure volatility due to, by nature, the long-term investment over several years. With regard to different revenue sources, property tax gap and sales tax gap have very similar effects on expenditure volatility. Note that on average, the share of property tax in total revenue is around 40% for Georgia counties, and the share of sales tax is only 29% (Table 5.2). The lower share of sales tax revenue plays an equal role as property tax in expenditure volatility, indicating a larger influence of sales tax on increasing expenditure gap. For different compositions of infrastructures, the investment in highways, streets, and solid waste system help to reduce the expenditure gap. Among the control variables, the operation cost of government (i.e., general government expenditure as a percentage of the total expenditures) can also contribute to decreasing the expenditure gap, providing certain flexibility on expenditure adjustment.

[Tables 5.3 and 5.4 about here]

For municipalities, according to the results in Table 5.4, most of the effects are similar to those for counties. Revenue gap is the main reason of expenditure gap. However, different from the coefficients for counties, of the revenue sources, only sales tax gap contributes to expenditure gap. The results are consistent with the revenue composition in municipalities that sales tax accounts for 34% of total revenue while property tax accounts for only 11%. Of different types of infrastructure investment, instead of highways and streets, the expenditures in water and solid waste systems contribute to decreasing expenditure gap. Unexpectedly, the fund balance ratio helps increase the expenditure gap. A possible reason is that municipalities are inclined to spend money pro-cyclically since they do not have a stable budget as counties.

The effects are different between counties and municipalities, and they can also be different across different years of economic conditions. Thus, I divide the data into different scenarios, economically boom and bust years for metro and non-metro counties, to capture the differences between positive and negative gaps and between developed and less developed areas. As shown in Table 5.5, while the revenue gap is the main cause of the expenditure gap, for counties, the effect is greater in bust years, in which localities are subject to more restricted budget constraint. A positive revenue gap is harmless and often preferred by local governments. This result implies that counties are more sensitive to the negative revenue gap and try to implement other necessary tools to weaken the effects of revenue loss on expenditures. The results further imply the significant variances among different types of counties and municipalities. The results of separate regressions also highlight the importance of sales tax gap in contributing to the expenditure gap, which is consistent with the calculated income elasticity of each revenue source shown in Table 5.1. For the infrastructure investment, the water

infrastructure significantly decreases the expenditure gap in bust years for different localities, while highway and street investment decreases the expenditure gap during bust years for municipalities.

[Table 5.5 about here]

To emphasize the importance of property tax in local revenue, I further divide the counties into three groups conditional on different property tax reliance. As shown in Table 5.6, the results indicate that revenue structure, especially property tax reliance, plays an important role in the effects of revenue gap on expenditure gap. The larger of property tax reliance, i.e., the more stable of revenue structure, the lower effects of revenue gap on expenditure gap. While for counties with property tax reliance less than 30%, the coefficient is 0.142; for counties with property tax reliance larger than 50%, the coefficient is only about half at 0.078. As expected, for counties with small property tax reliance, sales tax gap has a significant effect on expenditure gap increase.

[Table 5.6 about here]

If we investigate the effects based on the coefficient of variation across years, the data set changes into cross-sectional. The results for counties and municipalities are shown in Tables 5.7 and 5.8. For both counties and municipalities, almost all of the variations in revenue (more than 90 percent) are spread into the expenditure side. The same as fixed effects analysis, the impacts of different revenue sources are not consistent over specifications but conform to the above conclusions. For local infrastructure investment, while the fixed effects models implicate more infrastructure investment happened during boom years, cross-sectional analyses indicate that

localities with more infrastructure share in expenditures tend to have a lower expenditure variation. Among the compositions of local infrastructure, highways and streets and solid waste infrastructures have a significantly negative effect on expenditure variation. Localities with a higher debt burden have a higher expenditure variation, highlighting the importance of the necessary fiscal capacity in addressing fiscal stress. With other factors constant, the higher the black population and elderly population in the localities are, the lower the expenditure variation, highlighting the consistent expenditures for these groups over economic cycles.

[Tables 5.7 and 5.8 about here]

5.6 Conclusion and Discussion

Connecting with the previous chapters that estimate the relationships between property tax, local infrastructure and countercyclical debt policy, this essay disentangles the components of expenditure fluctuation and analyzes the impacts of different revenue sources and infrastructure investment on expenditure stability. With regard to the local public finance perspective, the key goal of local governments is to consistently provide public service to residents, effectively and efficiently. As mentioned throughout this dissertation, based on the economic theory, fluctuations often decrease utility and, sometimes, may deteriorate daily lives, which we should avoid as much as possible.

In this chapter, I find that, as expected, revenue stability is the main pillar for expenditure stability. Especially in the cross-sectional comparison, more than 90 percent of revenue fluctuation will be spread into expenditure gaps. Among the compositions of revenue, there exist variations of the results different types of localities and for different specifications. Property tax is a very important role in stabilize local expenditure. For counties with larger property tax

reliance, I find a much smaller effect of revenue gap on expenditure gap. Sales tax, possessing a high income elasticity, has a large impact in contributing expenditure gap. The local infrastructure is found to be countercyclical and, thus, decrease the expenditure gap; different types of infrastructure investments do have significant differences with regard to their effects on expenditure stability. Conforming to the results in Chapter 4, intentionally or unintentionally, many localities are using debt counter-cyclically, and debt has a negative impact on expenditure gaps, especially during recession years. The debt burden of local governments, however, decreases the expenditure stability over economic cycles, highlighting the necessity of maintaining the fiscal capacity to fight with fiscal stresses.

Adhering to the local level, this essay decomposes both the revenue and expenditure structures of different types of local governments (counties and municipalities) and provides a detailed study on the impact of revenue compositions and infrastructure investment on expenditure stability. At the level, this study is among the first to conduct a detailed investigation of expenditure stability and determining factors. The empirical results help remind localities to keep an eye on their revenue structures to main expenditure stability, and the distribution of infrastructure investment over different periods can significantly affect the outcome of certain projects. The components of revenue sources and different types of expenditures may have some potential connections. For instance, long-term debt is mostly used for infrastructure investment, and property tax is often for education and other basic local services. These connections deserve more thorough investigations to improve the fiscal picture of expenditure stability, and finally, this stream of research on local expenditure stability will greatly help to increase residential welfare.

Table 5.1: Elasticity of property tax, local sales tax, and state-local transfer on personal income, Georgia counties, by economic cycle.

		1985-1992	1993-2001	2002-2011
Property tax	Metro	1.01	0.99	1.00
	Rural	0.80	0.78	0.80
Local sales tax	Metro	1.14	1.07	0.97
	Rural	1.25	1.21	1.19
State transfer	Metro	0.89	0.92	0.93
	Rural	0.87	0.85	0.74

Table 5.2: Summary statistics of all variables**Panel A: Counties**

Variables	N	Mean	SD	Min	Max
year	4118	1998.46	7.96	1985	2012
expenditure gap	4118	0.11	0.10	0	0.98
revenue gap	4118	0.12	0.10	0	1.21
property tax gap	4118	0.13	0.14	0	2.22
sales tax gap	4118	0.21	0.19	0	2.39
IG grants gap	4118	0.47	0.46	0	5.30
infrastructure / total expenditure	4118	0.22	0.09	0	0.70
property tax / total revenue	4118	0.40	0.12	0.04	0.86
sales tax / total revenue	4118	0.29	0.11	0.01	0.88
intergovernmental grants / total revenue	4118	0.08	0.06	0	0.59
highways & streets / total expenditure	4118	0.13	0.07	0	0.52
water / total expenditure	4118	0.03	0.06	0	0.41
solid waste / total expenditure	4118	0.05	0.05	-0.04	0.55
general government / total expenditure	4118	0.23	0.08	0.02	0.80
housing & development / total expenditure	4118	0.03	0.02	0	0.25
debt outstanding / revenue	4118	0.10	0.23	0	3.39
population (,000)	4118	51.73	108.29	1.68	977.77
per capita expenditure (,000)	4118	0.68	1.40	0.01	22.47
per capita personal income (,000)	4118	20.63	7.53	7.42	61.96
per capita fund balance (,000)	4118	0.13	0.29	-3.99	4.29
fund balance /revenue	4118	0.16	0.16	-0.46	0.61
metro counties	155	0.45	0.5	0	1
ratio of population older than 65 (2000)	155	0.12	0.03	0.02	0.26
ratio of black (2000)	155	0.28	0.17	0	0.78
government form	155	2.67	0.89	1	4

Panel B: Municipalities

Variables	N	Mean	SD	Min	Max
year	10087	2000.3	6.23	1990	2011
expenditure gap	10087	0.12	0.14	0	3.13
revenue gap	10087	0.13	0.14	0	3.35
property tax gap	10087	0.19	0.42	0	12.84
sales tax gap	10087	0.14	0.16	0	3.14
IG grants gap	10087	0.81	0.97	0	8.27
infrastructure / total expenditure	10086	0.50	0.21	0	1.18
property tax / total revenue	10087	0.11	0.1	0	1
sales tax / total revenue	10087	0.34	0.2	0	1.25
intergovernmental grants / total revenue	10087	0.06	0.1	0	0.89
highways & streets / total expenditure	10086	0.09	0.09	0	0.85
water / total expenditure	10086	0.25	0.18	0	1.05
solid waste / total expenditure	10086	0.06	0.06	0	0.58
general government / total expenditure	10086	0.23	0.17	0	1.31
housing & development / total expenditure	10086	0.02	0.05	0	0.74
debt outstanding / revenue	10085	0.21	0.47	0	5.84
population (,000)	10087	6.79	26.31	0.02	537.96
per capita expenditure (,000)	10087	1.03	3.80	0	138.35
per capita fund balance (,000)	10087	0.13	0.73	-3.33	51.58
fund balance /revenue	10087	0.12	0.17	-0.49	0.51
ratio of population older than 65 (2000)	516	0.14	0.06	0.02	0.46
ratio of black (2000)	516	0.30	0.23	0	0.89

Table 5.3: The effects of the revenue structure and expenditure compositions on the expenditure stability for counties (DV: expenditure gap, forward 1 year)

Variables	(1)	(2)	(3)	(4)	(5)
revenue gap	0.104*** (0.017)		0.103*** (0.018)	0.102*** (0.018)	
property tax gap		0.040** (0.016)			0.039** (0.016)
sales tax gap		0.041*** (0.010)			0.039*** (0.010)
IG grants gap		-0.000 (0.004)			0.000 (0.004)
highways & streets / total expenditure				-0.054* (0.032)	-0.057* (0.032)
water / total expenditure				0.052 (0.048)	0.055 (0.048)
solid waste / total expenditure				-0.192*** (0.046)	-0.183*** (0.046)
infrastructure / total expenditure		-0.045* (0.025)	-0.047* (0.025)		
general government / total expenditure		-0.045 (0.029)	-0.047 (0.029)	-0.051* (0.028)	-0.050* (0.028)
housing & development / total expenditure		0.020 (0.076)	0.035 (0.075)	0.030 (0.075)	0.016 (0.076)
debt outstanding / revenue		0.001 (0.008)	-0.002 (0.008)	-0.005 (0.008)	-0.003 (0.008)
population (,000)		0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
per capita expenditure (,000)		0.004 (0.003)	0.003 (0.003)	0.000 (0.003)	0.001 (0.003)
per capita personal income (,000)		-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
fund balance /revenue		-0.009 (0.011)	-0.011 (0.011)	-0.010 (0.011)	-0.008 (0.011)
Constant	0.102*** (0.008)	0.121*** (0.014)	0.122*** (0.013)	0.132*** (0.014)	0.131*** (0.014)
Observations	3575	3575	3575	3575	3575
R ²	0.057	0.057	0.059	0.064	0.061

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variable is forwarded for 1 year to address the endogeneity issue. Year dummies are included in all regressions. Because there are some changes in county borders across sample years, outliers defined as larger than 99% quantile are removed. Thus, observations with expenditure gap, revenue gap, or property tax gap larger than 50%, or sales tax gap larger than 100%, or intergovernmental grants gap larger than 200% were excluded in the regressions. Results with the full sample are very similar. The same applies to the following fixed effects regressions.

Table 5.4: The effects of the revenue structure and expenditure compositions on the expenditure stability for municipalities (DV: expenditure gap, forward 1 year)

Variables	(1)	(2)	(3)	(4)	(5)
revenue gap	0.080*** (0.013)		0.077*** (0.013)	0.077*** (0.013)	
property tax gap		0.005 (0.009)			0.005 (0.009)
sales tax gap		0.019* (0.011)			0.019* (0.011)
IG grants gap		0.002 (0.002)			0.002 (0.002)
infrastructure / total expenditure		-0.032** (0.015)	-0.031** (0.015)		
highways & streets / total expenditure				-0.030 (0.023)	-0.031 (0.023)
water / total expenditure				-0.034** (0.016)	-0.037** (0.016)
solid waste / total expenditure				-0.079** (0.031)	-0.082*** (0.031)
general government / total expenditure		-0.023 (0.017)	-0.021 (0.017)	-0.019 (0.015)	-0.022 (0.016)
housing & development / total expenditure		-0.004 (0.036)	-0.011 (0.036)	-0.007 (0.034)	-0.000 (0.035)
debt outstanding / revenue		0.001 (0.003)	0.001 (0.003)	0.001 (0.003)	0.001 (0.003)
population (,000)		0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
per capita expenditure (,000)		0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)
fund balance /revenue		0.016** (0.007)	0.015** (0.007)	0.016** (0.007)	0.017** (0.007)
Constant	0.091*** (0.005)	0.107*** (0.010)	0.103*** (0.010)	0.102*** (0.008)	0.107*** (0.008)
Observations	6408	6406	6406	6406	6406
R ²	0.024	0.021	0.026	0.027	0.022

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Year dummies are included in all regressions.

Table 5.5: The effects on the expenditure gap in different scenarios (DV: expenditure gap)

Variables	Metro counties		Non-metro counties		Municipalities	
	Boom	Bust	Boom	Bust	Boom	Bust
revenue gap	0.151*** (0.044)	0.159*** (0.043)	0.024 (0.037)	0.157*** (0.037)	0.081*** (0.020)	0.145*** (0.020)
property tax gap	0.054 (0.033)	0.045 (0.033)	0.028 (0.032)	0.032 (0.035)	0.002 (0.014)	-0.004 (0.013)
sales tax gap	0.072*** (0.023)	0.048** (0.021)	0.005 (0.021)	0.029 (0.019)	0.018 (0.016)	0.048*** (0.016)
IG grants gap	0.002 (0.009)	0.015* (0.009)	-0.01 (0.008)	-0.002 (0.008)	0.001 (0.002)	0.005** (0.002)
infrastructure / total expenditure	0.092* (0.056)	-0.074 (0.060)	-0.039 (0.044)	-0.106** (0.053)	-0.024 (0.023)	-0.046** (0.021)
highways & streets / total expenditure	0.103 (0.077)	-0.087 (0.081)	-0.063 (0.056)	-0.051 (0.065)	-0.019 (0.037)	-0.075** (0.031)
water / total expenditure	0.09 (0.084)	0.169* (0.090)	0.192 (0.140)	-0.069 (0.135)	-0.009 (0.025)	-0.066*** (0.022)
solid waste / total expenditure	0.003 (0.112)	-0.481*** (0.125)	-0.179** (0.075)	-0.389*** (0.105)	-0.033 (0.050)	-0.128*** (0.041)
fund balance / revenue	-0.085** (0.033)	0.015 (0.027)	-0.033 (0.024)	0.065*** (0.024)	-0.045*** (0.014)	0.066*** (0.011)
debt outstanding / revenue	0.023 (-0.018)	-0.025* (-0.014)	0.028 (-0.021)	-0.048*** (-0.017)	0.016*** (-0.005)	-0.008* (-0.004)
Observations	916	690	1088	881	3235	3622

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Year dummies and all other control variables are included in all regressions and are not shown here. When revenue structure (property tax / total revenue, sales tax / total revenue, and intergovernmental grants / total revenue) is included, and revenue gap is excluded. Similarly, when infrastructure compositions (highways & streets / total expenditure, water / total expenditure, and solid waste / total expenditure) are included, the share of infrastructure investment (infrastructure / total expenditure) is excluded. The same applies to Table 6.

Table 5.6: The effects on expenditure stability conditional on property tax reliance (PTR)

Variables	PTR < 0.3	0.3 < PTR < 0.5	PTR > 0.5
revenue gap	0.142***	0.100***	0.078*
	(0.045)	(0.023)	(0.044)
property tax gap	0.000	0.051**	0.070*
	(0.040)	(0.021)	(0.040)
sales tax gap	0.100***	0.020	0.033
	(0.032)	(0.013)	(0.021)
IG grants gap	-0.004	0.000	-0.001
	(0.012)	(0.005)	(0.009)
infrastructure / total expenditure	0.046	-0.043	-0.026
	(0.058)	(0.033)	(0.068)
highways & streets / total expenditure	0.017	-0.058	-0.027
	(0.081)	(0.043)	(0.076)
water / total expenditure	0.029	0.094	-0.447
	(0.093)	(0.065)	(0.360)
solid waste / total expenditure	0.154	-0.257***	0.002
	(0.110)	(0.060)	(0.150)
fund balance / revenue	0.032	-0.001	0.007
	(0.030)	(0.014)	(0.028)
debt outstanding / revenue	0.039*	-0.021**	0.029
	(0.023)	(0.010)	-0.027
Observations	649	2272	654

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Year dummies and all other control variables are included in all regressions and are not shown here.

Table 5.7: Cross-sectional analysis for counties (DV: coefficient of variation)

Variables	(1)	(2)	(3)	(4)	(5)
revenue fluctuation	0.937*** (0.050)		0.936*** (0.050)		0.958*** (0.053)
infrastructure / total expenditure	-0.069 (0.075)	-0.329** (0.142)			
property tax / total revenue		-0.196 (0.161)		-0.221 (0.197)	0.184* (0.110)
sales tax / total revenue		-0.464** (0.184)		-0.483** (0.211)	0.189 (0.122)
intergovernmental grants / total revenue		-0.303 (0.308)		-0.375 (0.335)	0.127 (0.186)
highways & streets / total expenditure			-0.207* (0.121)	-0.194 (0.233)	-0.273** (0.128)
water / total expenditure			0.008 (0.116)	-0.289 (0.257)	0.146 (0.143)
solid waste / total expenditure			-0.097 (0.180)	-0.679* (0.344)	0.014 (0.193)
general government / total expenditure	-0.059 (0.107)	-0.203 (0.195)	-0.044 (0.107)	-0.141 (0.198)	-0.070 (0.109)
housing & development / total expenditure	0.109 (0.395)	0.042 (0.718)	0.165 (0.396)	-0.018 (0.732)	0.270 (0.402)
debt outstanding / revenue	0.133*** (0.048)	0.428*** (0.085)	0.116** (0.050)	0.419*** (0.086)	0.114** (0.050)
population (,000)	0.000 (0.000)	-0.000*** (0.000)	-0.000 (0.000)	-0.000*** (0.000)	0.000 (0.000)
per capita own-source revenue (,000)	-0.001 (0.004)	-0.006 (0.007)	-0.003 (0.004)	-0.007 (0.008)	-0.004 (0.004)
per capita personal income (,000)	0.001 (0.002)	0.001 (0.003)	0.000 (0.002)	0.001 (0.003)	-0.000 (0.002)
ratio of population older than 65	0.208 (0.161)	-0.633** (0.283)	0.262 (0.169)	-0.691** (0.297)	0.313* (0.172)
ratio of black	-0.038 (0.029)	-0.216*** (0.054)	-0.045 (0.030)	-0.212*** (0.055)	-0.040 (0.032)
Constant	-0.005 (0.057)	0.787*** (0.158)	0.027 (0.060)	0.803*** (0.165)	-0.107 (0.104)
Observations	155	155	155	155	155
R ²	0.811	0.390	0.815	0.394	0.819

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5.8: Cross-sectional analysis for municipalities (DV: coefficient of variation)

Variables	(2)	(3)	(4)	(5)	(6)
revenue fluctuation	0.910*** (0.018)		0.904*** (0.018)		0.917*** (0.018)
infrastructure / total expenditure	0.066** (0.026)	-0.180** (0.075)			
property tax / total revenue		-0.475*** (0.113)		-0.276** (0.109)	-0.065 (0.044)
sales tax / total revenue		-0.266*** (0.075)		-0.183** (0.081)	-0.045 (0.033)
intergovernmental grants / total revenue		0.007 (0.182)		0.021 (0.186)	-0.479*** (0.075)
highways & streets / total expenditure			0.000 (0.053)	0.118 (0.154)	0.084 (0.062)
water / total expenditure			0.001 (0.024)	0.063 (0.059)	0.019 (0.023)
solid waste / total expenditure			-0.137* (0.077)	-0.462** (0.189)	-0.069 (0.076)
general government / total expenditure	0.073*** (0.028)	0.258*** (0.077)	0.031 (0.023)	0.329*** (0.079)	0.065** (0.032)
housing & development / expenditure	0.468*** (0.132)	1.438*** (0.323)	0.418*** (0.133)	1.599*** (0.326)	0.579*** (0.132)
debt outstanding / revenue	0.020* (0.011)	0.045* (0.026)	0.015 (0.011)	0.033 (0.027)	0.023** (0.011)
population (,000)	-0.000 (0.000)	-0.001*** (0.000)	-0.000 (0.000)	-0.001** (0.000)	-0.000 (0.000)
per capita own-source revenue (,000)	-0.000 (0.001)	-0.002 (0.003)	-0.000 (0.001)	-0.002 (0.003)	-0.001 (0.001)
ratio of population older than 65	-0.068 (0.059)	-0.596*** (0.141)	-0.046 (0.059)	-0.700*** (0.140)	-0.024 (0.057)
ratio of black	-0.075*** (0.015)	-0.252*** (0.039)	-0.071*** (0.015)	-0.254*** (0.039)	-0.039** (0.016)
Constant	0.004 (0.021)	0.661*** (0.067)	0.053*** (0.018)	0.525*** (0.043)	0.059*** (0.019)
Observations	515	515	515	515	515
R^2	0.869	0.238	0.868	0.243	0.879

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

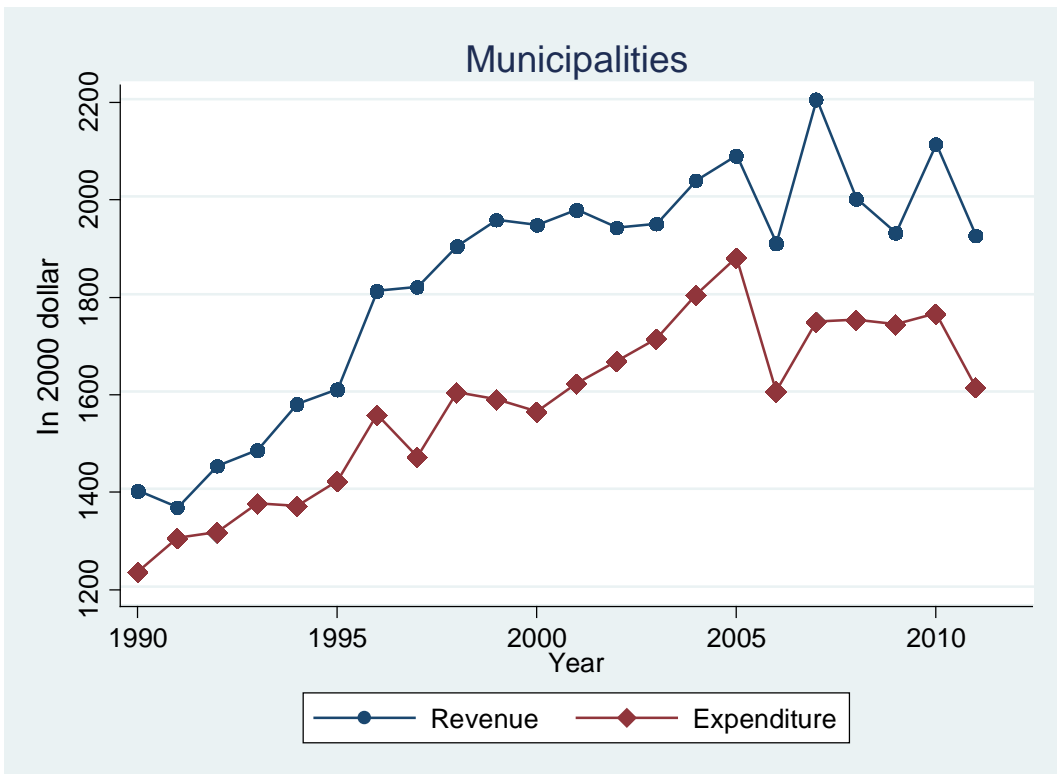
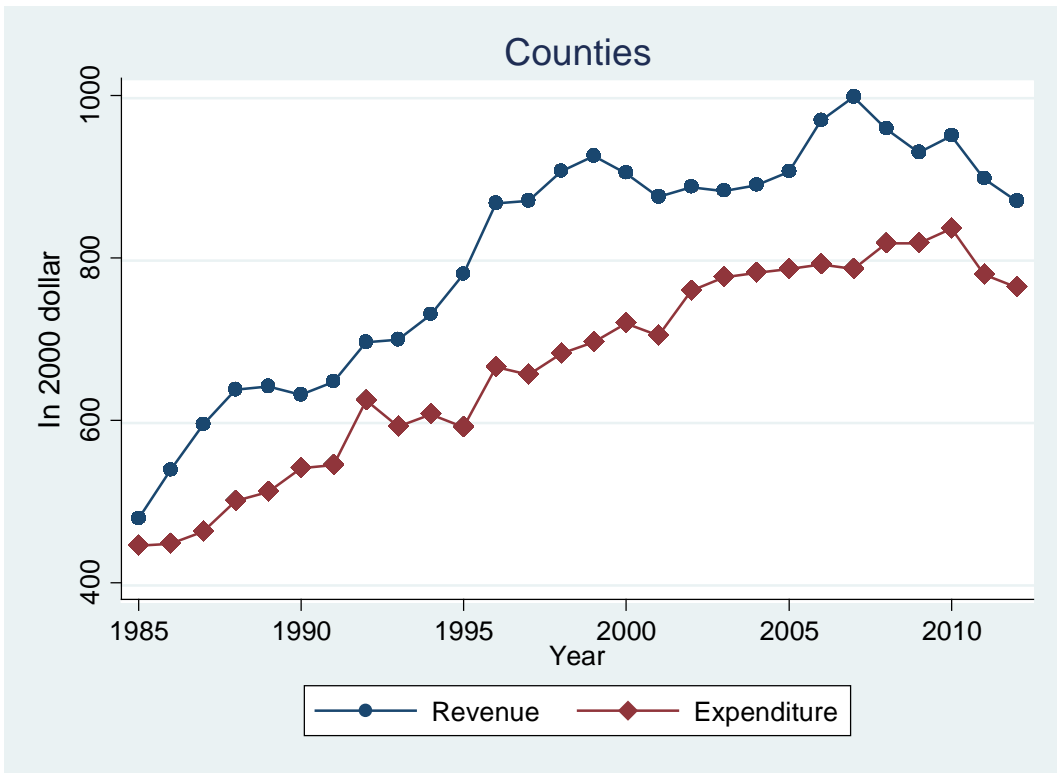


Figure 5.1: The trends of revenue and expenditure (per capita) for counties and municipalities

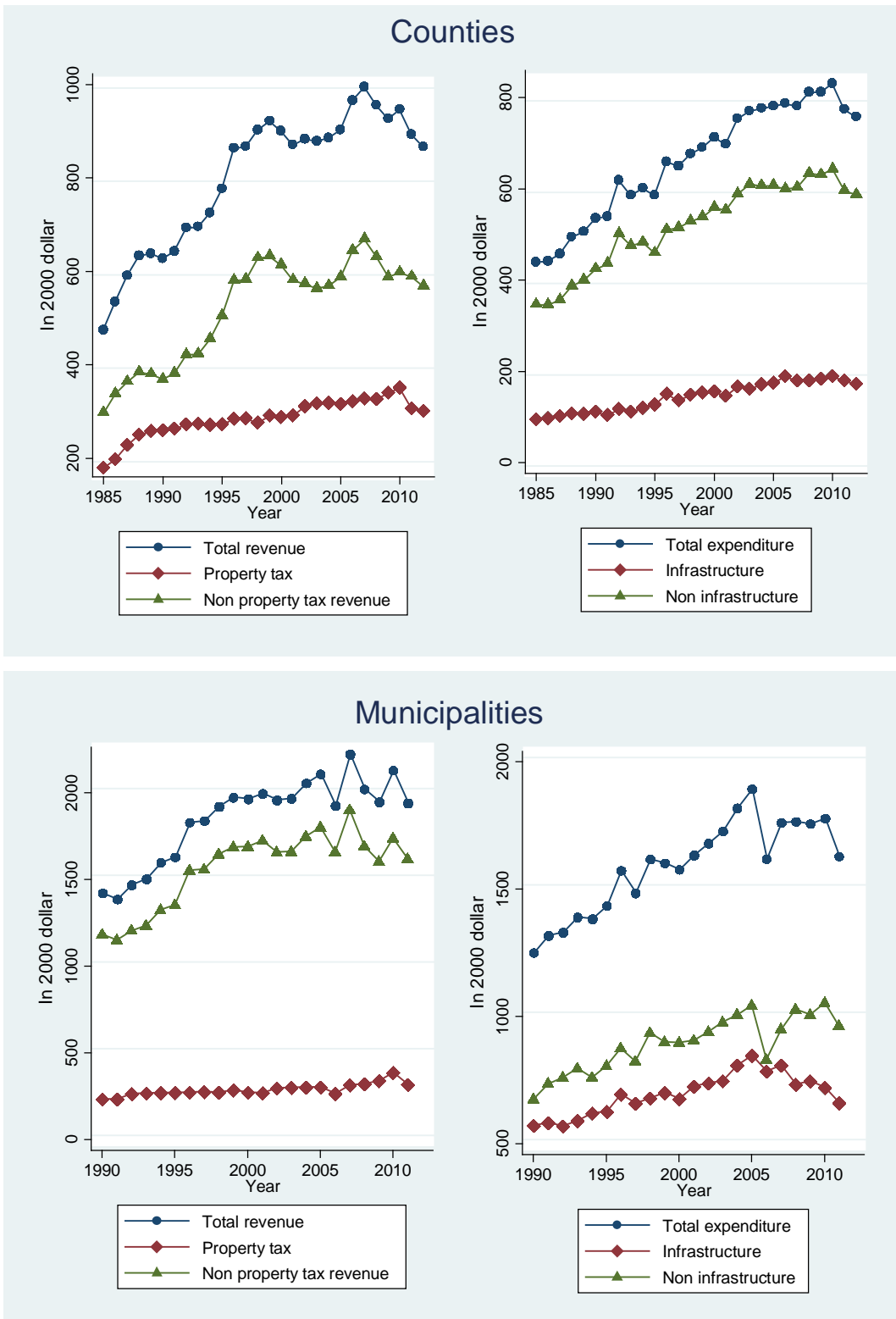


Figure 5.2: The trends of revenue and expenditure (per capita) in compared categories

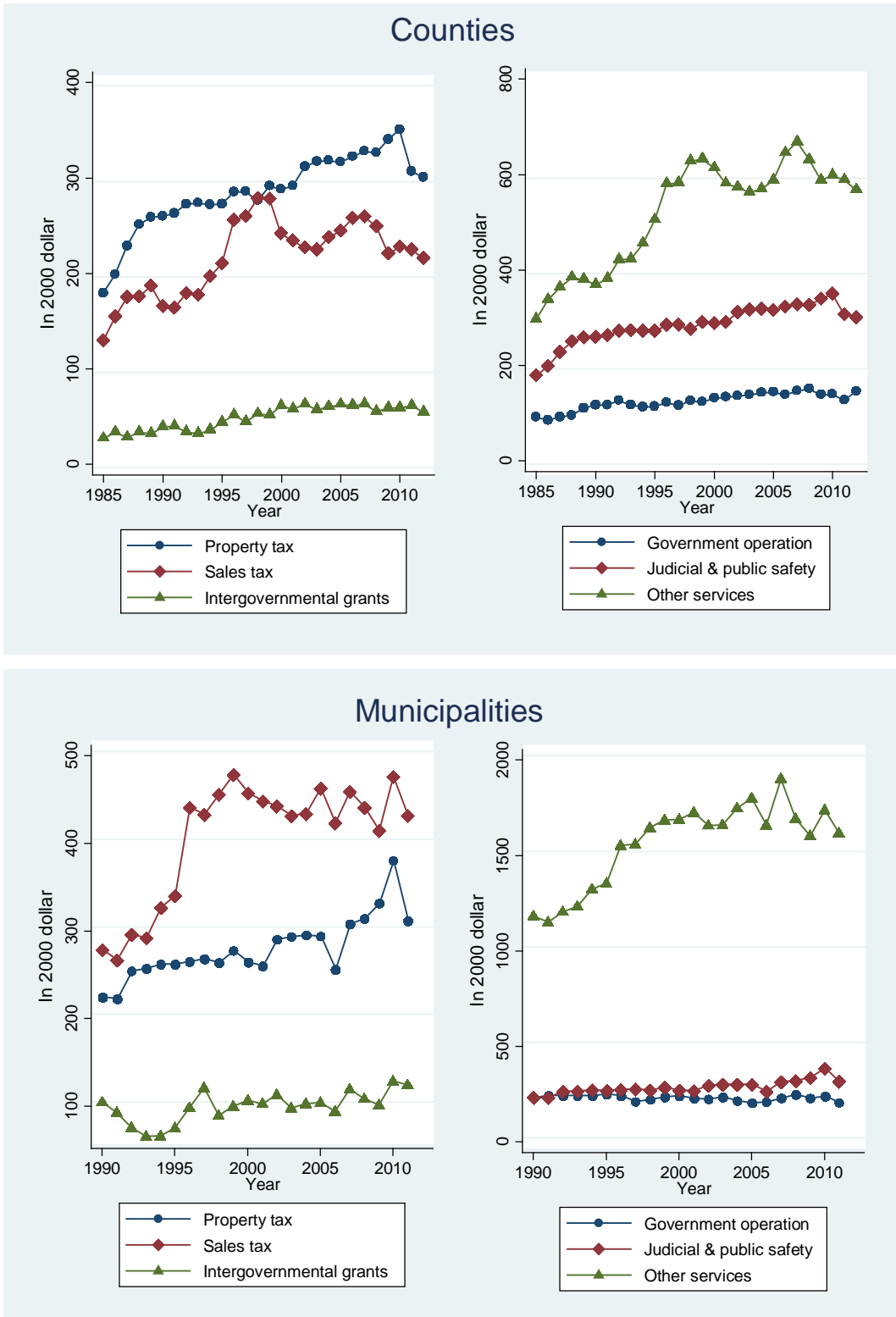


Figure 5.3: The trends of revenue and expenditure in detailed categories

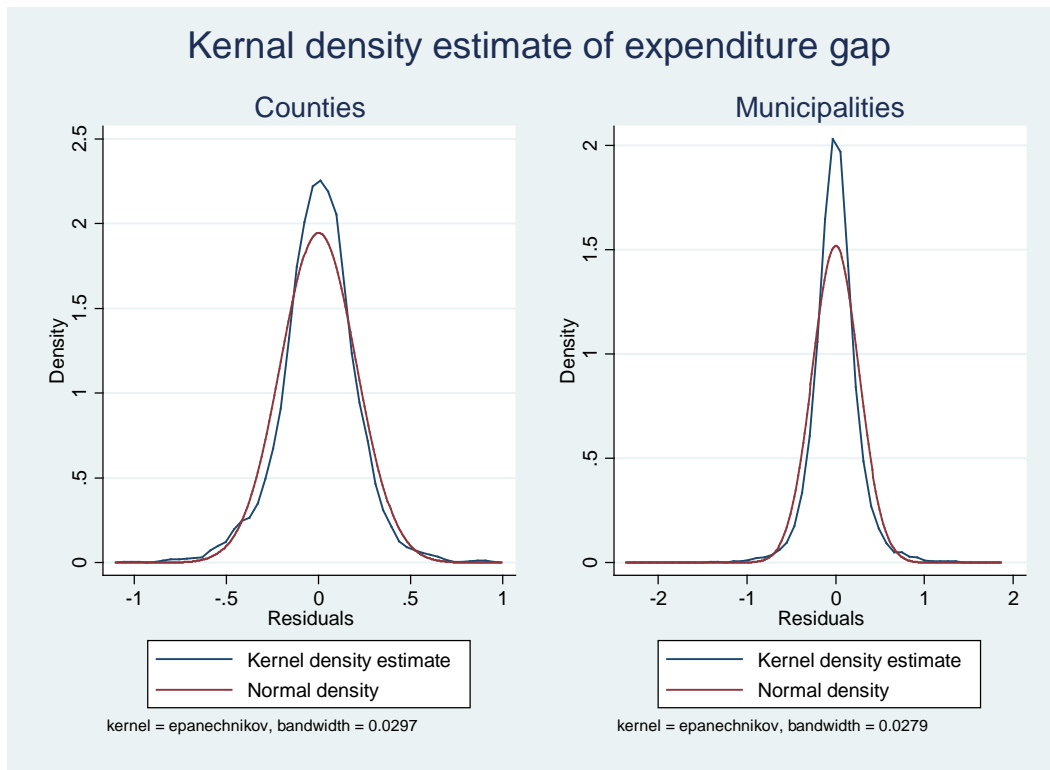


Figure 5.4: Kernel density estimate of expenditure gap with normal distribution

CHAPTER VI

6. CONCLUSION

With studies of public finance issues at the national and subnational levels having been abundant, there is still a lack of comprehensive research on public fiscal administrations specifically focusing on the local level. Composed of four essays, this dissertation fits into this niche and addresses several significant perspectives in local public finance, including the dynamics of housing and land prices; the relationships between property tax, infrastructure investment, and housing prices; optimal debt use of local governments; and local own-source expenditure stability.

The first essay addresses the controversial issue about the relationships between the dynamics of housing and land prices. With three distinct perspectives existing simultaneously: (1) land prices contribute to housing prices (a cost-driven perspective); (2) housing prices affect land prices (a derived demand perspective); and (3) a bidirectional relationship (a mutual causation perspective), this essay proposes a theoretical framework that allows these different perspectives to be reconciled. The corresponding empirical evidence also indicates that the relationship between changes or dynamics in housing prices and land prices depends on the reasons for the changes in different contexts. Using the parcel level repeat sales data of both land and housing units in the state of Georgia, the results based on a 3SLS model closely conform to the theoretical expectations. In a developed area, it is more likely that the housing prices lead to

changes in land prices, while in an area in the process of urbanization, the change in land prices is more likely to cause a change in housing prices.

While both local infrastructure and property taxation have been adequately examined by scholars, the connection between them is still not very clear. The second essay assembles a panel data set that includes both county level data and parcel level household data in the state of Georgia and employs a two-stage method with two instruments and GLS estimators. The main results indicate that for rural and small urban counties, an increase of one dollar in property tax revenue can return to residents only around 40 cents in local infrastructure expenditure; while in medium and large urban counties, it is 60 cents. As land values are highly sensitive to local infrastructure investment, the results extend the argument that the effect is much larger for rural parcels. The elasticity of land prices on infrastructure investment is 1.42 for rural parcels compared to 0.57 for urban parcels. Different from most studies that use data from municipalities in different states, this essay combines within-state local data and household data, keeps the analyses on the same institutional and legal circumstances, and extends the results from metro cities to a comparison between urban and rural counties.

With the volatile local revenue and relatively stable infrastructure investment, the third essay examines whether local governments use debt counter-cyclically or not and estimates the impacts of countercyclical debt policies. In this essay, I construct a theoretical framework unfolding the optimal debt path over economic cycles and conduct simulations to estimate how the countercyclical debt may influence local expenditure. Empirically, on an aggregated basis, the local use of debt is pro-cyclical, issuing more debt in boom years and vice versa. The individual locality analysis based on counties and municipalities in Georgia indicate that different localities have distinct debt policies due to fiscal capacity and borrowing cost. The two

sides accompanied with the regression results tell us that counties design debt policies as mainly conditional on the debt-paying ability, while municipalities decide debt policies based on their need for borrowing, since they usually have better fiscal capacity. Thus, municipalities use countercyclical debt policies more often than counties. The effect of a countercyclical debt policy is also evident: localities with a countercyclical debt policy have a significantly lower coefficient of variation in per capita expenditure than those that do not.

The fourth and final essay estimates the local own-source expenditure stability and determining factors with regard to revenue compositions and local infrastructure investment. As expected, revenue stability is the main pillar for expenditure stability. Different types of infrastructure investment do have significant differences with regard to their effects on expenditure stability, and many localities are using debt counter-cyclically to decrease the expenditure gaps. The results help remind localities to keep an eye on their revenue structures to main expenditure stability, and the distribution of infrastructure investment over different periods can significantly affect the outcomes of certain projects.

Despite the effort to pursue results that are as valid as possible, this dissertation does have several limitations. First, the local level data (counties and municipalities) used in this dissertation is restricted to only one state—Georgia. Also, the parcel level data do not cover all of the localities in Georgia, even though the tests indicate that the collected data are very representative. While almost every state has its specific characteristics in the U.S., the limited data critically hamper the extension of the results, and thus, external validity is an issue for this dissertation. However, for a local level analysis, it is usually an inevitable problem due to data accessibility. Second, as mentioned throughout the dissertation, several methodological issues still exist, including omitted variable bias and inconsistent results across different specifications.

The measurement of key variables, such as expenditure gaps and the time trends of revenue and debt, has a large potential to subject to measurement errors, which we need to fix or conduct robustness tests.

For the direction of further research, based on the explorations of this dissertation, I have the following suggestions. First, we need a broader investigation covering more issues in local public finance to help build a more complete understanding of local fiscal administration, since local public finance is so complicated that we can never cover all of the issues due to the large heterogeneity. Second, related to the data limitations, it is better to extend the data to local governments of other states, or if possible, it is best to cover all local governments in the nation if we have such accessibility. Third, while mostly only counties and municipalities are covered in this dissertation, we should attach more attention to a comparison of different types of local government. For instance, different from other localities, special districts are unique in the U.S. and deserve more thorough investigations of their fiscal administrations and their impacts on economic development and service provision.

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